ENTRAINMENT INVESTIGATIONS AT A FOSSIL-FUELED, STEAM-ELECTRIC PLANT

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CONTENTS

Acknowledgements	i
Principal Investigators	ii
Proposal	iii
Objectives and tasks	v
Introduction	1
Methods and Materials	6
Sampling techniques	6
Chemical and Physical Measurements	7
Biological Measurements	8
Sample Incubation	10
Operating Procedures	10
Statistical analysis of data	12
Results and discussion	14
Tests of Significant Differences	55
Conclusions	58
Additional Studies	59
Appendix I Organism List	61
Bibliography	67

FIGURES AND TABLES

Figure 1 - Map of Danskammer Area 3

Figure 2 - Diagram of Danskammer Plant 4

Table 1 - Physical Parameters -Statistical 15

Table 2 - Biological Populations - Statistical 17

Table 3 - Biological Populations - Statistical 18

Table 4 - Biological Populations - Statistical 19

Table 5 - Number of Genera 0 hour 21

Table 6 - Number of Genera 0 hour 22

Table 7 - Number of Genera 24 hour 23

Table 8 - Number of Genera 24 hour 24

Table 9 - Daily Water Temperature 26

Table 10 - Daily Turbidity Readings 27

Table 11 - Daily Dissolved Oxygen Readings 28

Table 12 - Daily pH Readings 29

Table 13 - Daily Phosphate Levels 30

Table 14 - Daily Chlorine Levels 31

Table 15 - Daily Surirella Counts 32

Table 16 - Daily Navicula Counts 33

Table 17 - Daily Coscinodiscus Counts 34

Table 18 - Daily Melosira Counts 35

Table 19 - Daily Gyrosigma Counts 36

Table 20 - Daily Chrysophyta Counts 38

Table 21 - Daily Chlorophyta Counts 39

Table 22 - Daily Phytoplankton Counts 40

Table 23 - Daily Zooplankton Counts 41

Table 24 - Daily Total Organisms Count 42

Table 25 - Intake Correlations 43

Table 26 - Discharge Correlations 45

Table 27 - Intake and Discharge Diatom Correlations 46

Table 28 - 0 hour Delta Value Correlations 47

Table 29 - 0 hour Delta Value Correlations 48

Table 30 - Coscinodiscus Counts, 24 hour 49

Table 31 - Total Organism Count, 24 hour 50

Table 32 - Correlations of Delta Values 53

Table 33 - Tests of Significant Differences 57

Appendix I - Organisms Collected 61

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PROPOSAL

We propose to investigate the net effect of the Danskammer facility in respect to the plankton populations that actually pass through the plant. Our operating null hypothesis is: "There are no significant differences between plankton populations taken at incurrent stations and populations taken at excurrent stations in terms of population numbers and population diversity."

We also propose to investigate a time effect by incubating incurrent and excurrent plankton samples in specially designed "river incubating chambers" for periods of twenty-four hours, forty-eight hours and ninty-six hours for subsequent population analysis.

We also propose to investigate possible chemical changes in the water as it passes through the generating facility using approved field techniques.

The use of the "river incubating chambers" seems to be a unique innovation in the study of thermal effects on populations of plankton The chambers will permit a free interchange of gases and liquids in the natural river environment, yet maintain a barrier to plankton gains or losses from outside the chamber.

In addition to the research objectives, we propose the following educational objectives as a part of the grant proposal:

1. Utilize first year students enrolled in the Natural Resource Conservation Curriculum at Dutchess Community College. This study will provide the students an opportunity to refine skills in identification and sampling techniques as well as providing an opportunity to earn funds to continue their education.

2. Utilize summer session students enrolled in field-oriented courses as an educational technique for instruction, identification and analysis of plankton populations.

Laboratory space and supplementary equipment will be provided by Dutchess Community College upon approval of President James F. Hall.

Equipment and references acquired as a part of the research grant will become the property of Dutchess Community College at the end of the grant period.

A statistician will be hired on a consulting basis to establish a statistical basis for population sampling schedules and counting techniques. The statistician will also meet with other research groups on the Hudson River to assess their methods of data handling. Analysis of the data will be done by computer programs already available.

The principal investigators will be responsible for publication and distribution of copies of the final report to the advisory committee and to Central Hudson Gas and Electric Corporation.

OBJECTIVES AND TASKS

Overall objective: To determine the differences in chemical, physical, and biotic characteristics of water passing through the Danskammer generating facility.

Objective 1: To determine the differences in chemical characteristics.

Task A. Collect samples at incurrent and excurrent stations.

" B. Determine (with pH field meter and/or field kits) the pH of water at collection stations.

" C. Determine the level of dissolved oxygen (with D.O. meter or field test kits) of the water at collection stations.

" D. Determine residual chlorine level of the water at the collection stations.

" E. Determine chlorine ion concentration from water at collection points. (Performed in laboratory).

" F. Determine total phosphate ion concentration from water at collection points. (Performed in laboratory).

" G. Determine total nitrate ion concentration from water at collection points. (Performed in laboratory).

" H. Determine oxygen demand index (ODI) from water at collection points. (Performed in laboratory).

" I. Determine hardness from water taken at collection points. (Performed in laboratory).

Objective 2: To determine the differences in certain physical characteristics from water at the sampling stations.

Task A. Determine turbidity using Secchi disc and colorimetric methods from water at the sampling points.

" B. Determine temperatures and temperature fluctuations in water at the sampling points.

Objective 3: To determine differences in the biotic characteristics from water samples taken at the sampling stations.

Task A. Collect 3 liter samples at 1 meter depth with Kemerer sampler from each sampling station.

" B. Place 1 liter of each sample into incubating chambers and incubate in river at ambient conditions for:

24 hrs.

48 hrs.

96 hrs.

" C. Return 1 liter of each sample to laboratory for immediate analysis (time - 0 hrs. incubation). Using Sedgewick-Rafter method for concentration and analyzing with use of Sedgewick-Rafter and Palmer counting cells.

" D. Identify organisms found in each sample and record species and numbers of each type.

Objective 4: Analysis of data.

Task A. Preparation of species list from samples taken at each station.

" B. Statistical analysis for determination of significant differences in numbers of each species and for numbers of species collected from each station.

" C. Statistical treatment to determine correlation coeffecients of significant species with physical and chemical parameters measured.

INTRODUCTION

Studies of the effects of thermal discharges on aquatic ecosystems are proliferating nearly as fast as the power generating facilities that produce the major portion of the thermal discharges. Reviews of the literature on thermal effects demonstrate the burgeoning scientific inquiry on a world-wide basis (Coutant and Goodyear, 1971). The studies fall generally into two major categories; laboratory tests of thermal effects on individual species or broad-based field surveys that encompass a multitude of parameters and interrelationships (Coutant, 1972). The latter often results in data of such complexity that many primary concerns are not clearly or adequately demonstrated.

Normally the direction of these field investigations is toward the assessment of the impact of heated water on the total aquatic environment, rather than analyses of specific ecosystem compartments (Brezina, 1970; Cairns, 1971; Hechtel, 1970; Merriman, 1970; Normandeau, 1970; Whitehouse, 1971 and Williams, 1971). These studies often present evidence of ecosystem change, but not at significant levels or not attributable to thermal discharges. However, the investigators suggest that cooling devices be employed to minimize the potential ecological effects of heated discharge waters.

Other investigators, such as Castenholz (1969), Cairns (1969, 1970), Moll (1971), Morgan and Stross (1969) and Patrick (1971), have limited their inquiries to specific population compartments within the aquatic ecosystem and have cited significant differences within

those compartments that can be attributed to thermal discharges. Individual population studies do produce less complex data that can and does demonstrate significant changes.

A third area of investigation, entrainment effects, is beginning to appear in the literature, but in limited numbers (Cairns, 1971). These studies make an effort to determine the effects on water and its biological inclusions produced by passage through high temperature zones in the steam-electric generating facilities. As larger and larger volumes of fresh water will be used for cooling waters in the future, we must begin to examine more critically the passage or entrainment effects. Singer (1968) estimates that one quarter of the nation's available freshwater will pass daily through cooling devices for steam electric generating plants by 1985. This incredibly large use of water can have a serious effect on all aquatic ecosystems if entrainment does cause significant changes in the physical, chemical and/or biological characteristics of the cooling water.

In an effort to elucidate some of the aspects of entrainment effects, a seven week study was conducted at the Danskammer steam electric generating plant. This fossil-fueled 532 megawatt facility is owned and operated by Central Hudson Gas and Electric Corporation. The plant is located 65.1 miles north of the Battery on the west bank of the Hudson River, near the community of Roseton, New York. (cf. Figure 1) The plant uses Hudson River water for cooling purposes and returns the discharge directly to the river. (cf. Figure 2) A previous study carried out in this area by Feldman (1971) was useful in the design and implementation of this study.

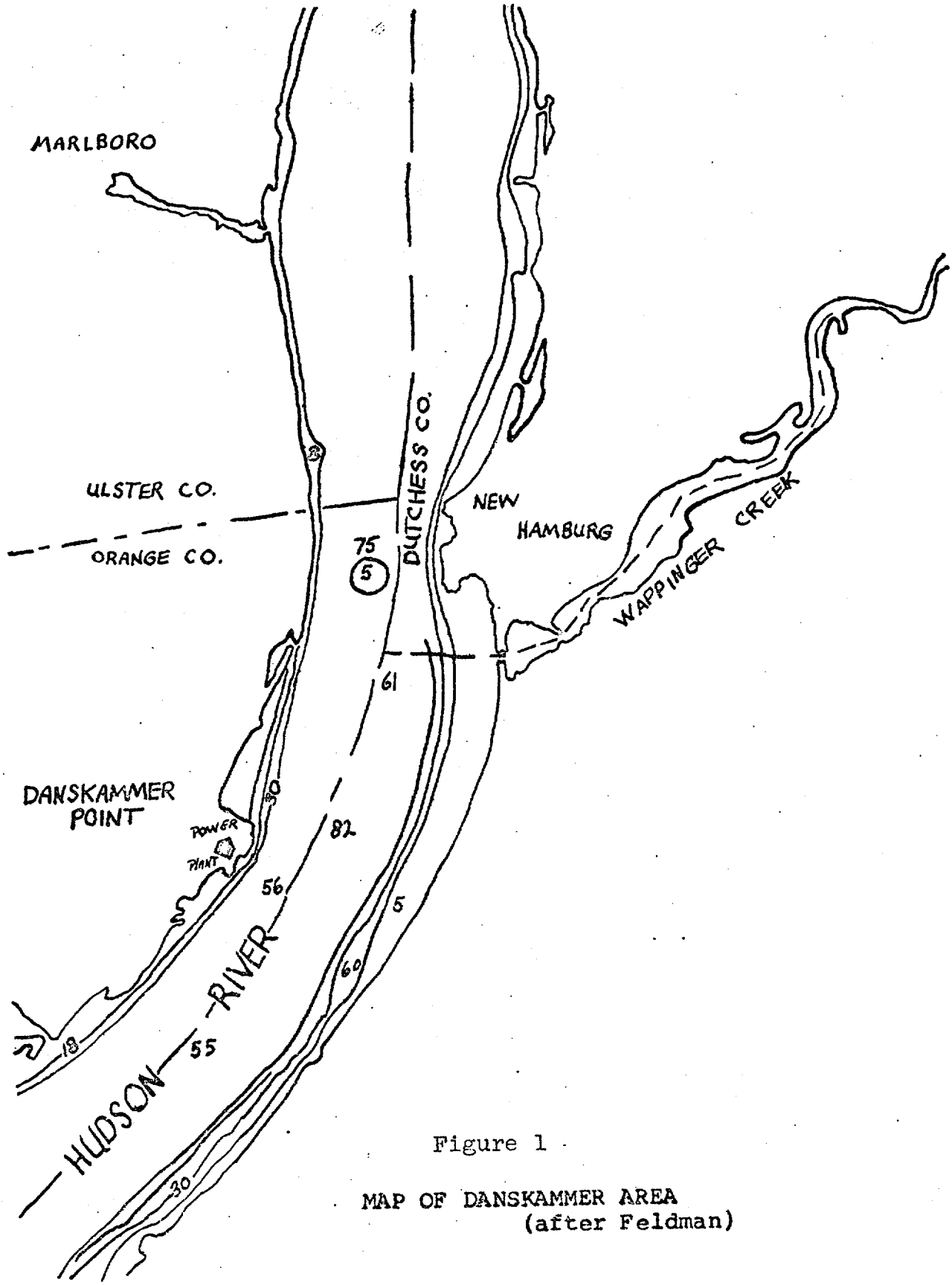


Figure 1

MAP OF DANSKAMMER AREA
(after Feldman)

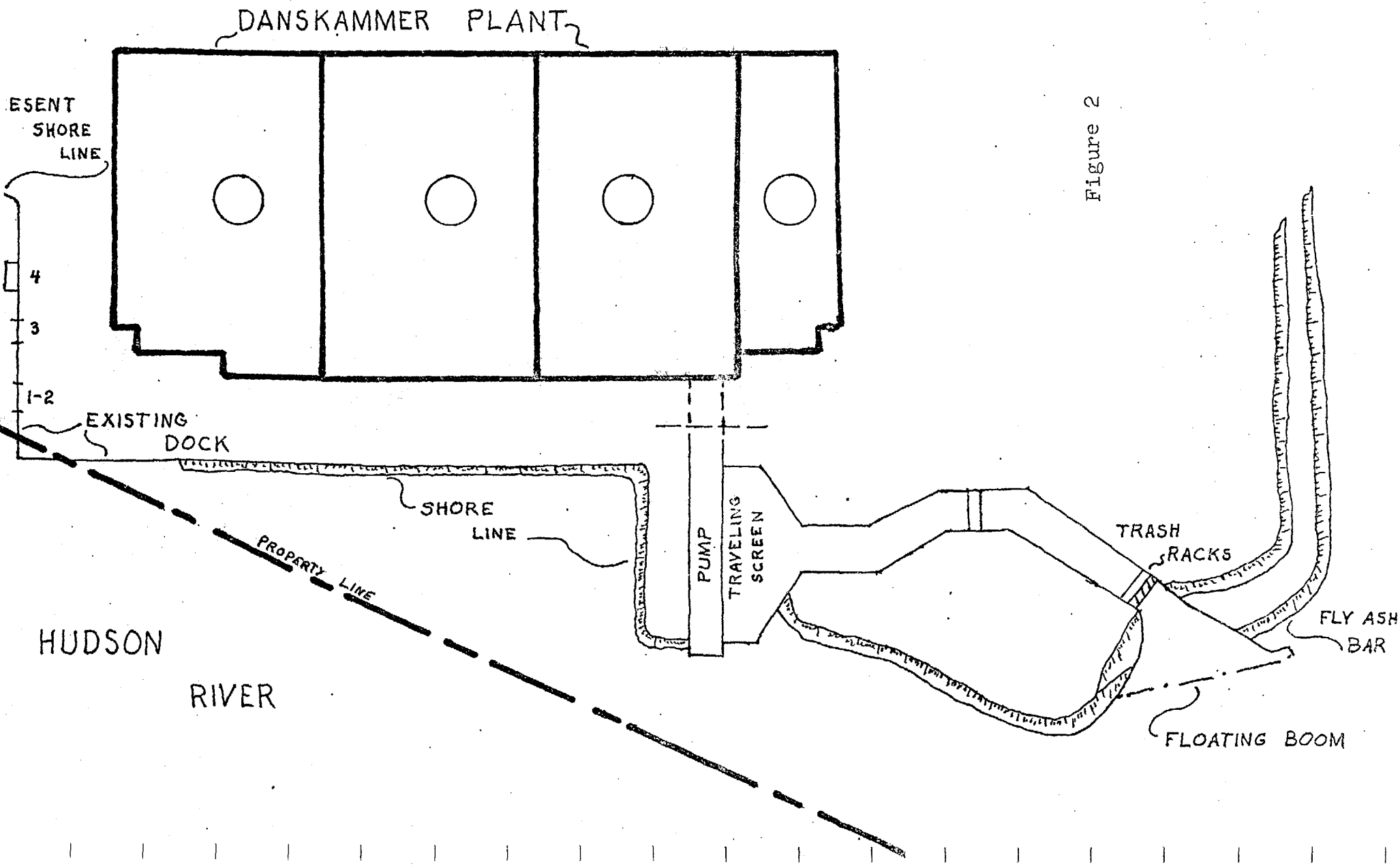

DANSKAMMER PLANT
ESENT
SHORE
LINE
4
3
1-2
EXISTING
DOCK
SHORE
LINE
PROPERTY LINE
HUDSON
RIVER
PUMP
TRAVELING
SCREEN
TRASH
RACKS
FLY ASH
BAR
FLOATING BOOM

Figure 2

The primary thrust of the study was to investigate plankton communities found in samples taken directly from intake and discharge waters at the Danskammer plant. Samples were examined in respect to population numbers and species diversity.

Measurements of selected physical and chemical characteristics of influent and effluent waters were also recorded in an effort to correlate these parameters with biological data.

A time effect was also incorporated into the study through incubation of intake and discharge samples in specially designed "river incubating chambers." Samples were incubated for periods of twenty-four hours, forty-eight hours and ninety-six hours at ambient river conditions. The plankton populations in the samples were analyzed following the incubation period.

The study sought to define potential plankton species that were apparently less tolerant of the sudden increased temperatures experienced during the four minute entrainment period. Less heat-tolerant species would provide future entrainment investigations with potential bioassay information in respect to intensity of heat in high temperature zones. In effect, they would provide clues that would demonstrate the highest temperature during the entrainment period, rather than temperatures recorded at discharge points.

The research also added to the baseline data produced by previous surveys of the Danskammer - Roseton area of the Hudson River. This may be particularly important in view of the construction of the 1200 megawatt Roseton generating facility which is approximately one half mile downriver of the Danskammer plant. The new plant, soon to be

in full operation, will add to the existing thermal load of the Hudson River in this area. It is possible that Danskammer discharge waters may elevate temperatures of intake waters for the Roseton plant, thereby causing subsequent problems at discharge. Existing baseline data may help to demonstrate a threshold temperature in the Hudson River that cannot be exceeded without significant changes to the ecosystem.

Students enrolled in the Natural Resources Conservation Program at Dutchess Community College, Poughkeepsie, New York, were employed as field and laboratory technicians. The students were able to refine skills in identification and sampling techniques while earning the necessary funds to continue their education in environmental sciences.

This research project was funded through a $13,250 research grant from Central Hudson Gas and Electric Corporation. Laboratory facilities and materials were provided through the cooperation of Dutchess Community College.

METHODS AND MATERIALS

Sampling Techniques

Intake samples were collected using a Millipore 1/6 horsepower vacuum pump connected through a vacuum flask to clean glass-collecting containers. A one-quarter inch, weighted, rubber hose from the collecting container was immersed in the incurrent channel. The sample site was on a bridge approximately 150 feet upstream of the traveling screens in front of the plant pumping machinery. Samples were taken at an average depth of 10-15 centimeters. At least a four liter sample was taken at this station for analysis.

Discharge samples were taken with similar apparatus, but with some modification of technique. Due to the high velocity and the subsequent turbulence of the discharge, it was impossible to use any flexible tubing for the collection. One-quarter inch steel collecting pipes were imbedded in the plant's discharge pipes, so that samples could be taken directly from the effluent waters before the discharge had an opportunity to mix with other waters in the river. The collecting pipes were designed by the authors and installed by Central Hudson personnel at the Danskammer station. The Millipore pump with the vacuum flask was attached to the steel pipes and samples were taken in the glass-collecting containers as in the intake samples. It was necessary to draw off several liters of water prior to sampling in order to eliminate rust and other sediments accumulated in the steel pipes between sampling sessions.

Chemical and Physical Measurements

Water temperature was recorded daily at each sample site. Temperatures were taken using a Yellow Springs Instrument Company dissolved oxygen - temperature meter, Model 54. Temperatures were cross-checked with an inexpensive, battery-powered fishing thermometer. Both instruments gave similar readings in all tests.

Dissolved oxygen, in parts per million, was determined at each site by two methods. A Hach Chemical Company dissolved oxygen field kit was employed daily at intake and discharge stations for the dissolved oxygen data. Frequently the results were verified with the Y.S.I. dissolved oxygen - temperature meter, Model 54. Differences were infrequent between the two methods and never exceeded 0.5 ppm.

The pH value of incurrent and excurrent samples were determined on site employing a Hach Chemical Company pH Field Kit.

Water samples were returned to the laboratory for further tests of physical and chemical parameters, including turbidity, total phosphate level, chloride level, and amount of residual chlorine.

Intake and discharge turbidity in Jackson Turbidity Units (JTU) was measured by colorimetric methods, employing the Hach Chemical Company Engineering Kit, Model DR-EL. and a Bausch and Lomb Spectronic 20 colorimeter.

Total phosphate levels in parts per million for each sample was determined by tests included in the Hach Chemical Company Engineering Kit.

Chloride determinations in parts per million for each sample were also accomplished with the Hach Engineering Kit. The kit was also employed for the residual chlorine tests.

The Hach material was selected so that data would correspond with data from the previous study of the Danskammer area (Feldman, 1971).

Biological Measurements

Population analysis of samples was accomplished through direct counts of organisms present and identified to genera from randomly selected portions of intake and discharge samples.

The initial one liter water samples were separated into equal portions with a Folsom Plankton Splitter assuring randomness in the separation process.

Following separation, 500 ml. portions of the sample were concentrated to 10 ml. volumes using the sand filtration method defined in Standard Methods for the Examination of Water and Wastewater, 12th Edition. Filter discs in the funnel had a pore size of 64 microns. Frequently, samples contained excessive silt loads which forced a reduction in the amount of sample that could effectively be filtered. In those cases, the volumes filtered were reduced to 200 - 250 ml.

Concentrated samples were transferred from the concentration funnel to 50 ml. beakers and subsequently transferred to 13 ml. glass vials.

A 0.1 ml. portion of the concentrated sample was pipetted into a Palmer counting cell as described by Palmer (1962). Counts were done using standard, mechanical stage laboratory microscopes with 10X, 43X and 97X objectives. The 10X ocular lenses were equipped with a Whipple disc to define the count areas.

Strip counts involving one-tenth of the volume of the Palmer cell were made and organism present in these strips were identified and recorded. A minimum of four separate strip counts performed by at least two different individuals were made for each sample. The strip count results were averaged for the determination of the number of organisms present per sample.

Using the appropriate figures for concentration factors and sample volumes selected, the number of organisms per 100 ml. were calculated from the raw counts using the following formula:

$$\text{Number/100ml.} = \text{Number counted} \times \text{vol. filtrate} \times \frac{10{,}000}{\text{vol. filtered}}$$

A scan of the entire Palmer cell was made following each strip count to separately identify and record organisms not encountered on the strip counts. This was done to add additional specimens to the organism baseline data as well as to determine possible mechanical damage to larger organisms.

Following the counting operation, the 10 ml. concentrated samples were preserved with 3 ml. of 40 percent formalin for permanent storage.

Sample Incubation

All samples to be incubated (intake and discharge samples for 24, 48, and 96 hours) were placed in specially designed chambers immediately following collection. The chambers were then fixed to a floating rack for incubation in the river.

The incubation chambers were constructed from pyrex glass tubing, 18.5 cm. long and 8.3 cm. in diameter. Total volume of the chamber was one liter. Each end of the chamber was covered by 40 micron mesh fiber glass pads, sandwiched between two layers of nylon plankton netting, number 25 mesh with 64 micron pore size.

The floating rack was designed so six chambers would incubate in the river at a depth of 0.5 meters. The rack was located upriver from the incurrent channel of the Danskammer plant at a point approximately 25 meters from the shoreline. A Ryan Model D recording thermometer was attached to the incubation platform to monitor incubation temperatures.

Operating Procedures

One liter incurrent and excurrent samples were returned five days per week (Monday - Friday) to the laboratory for analysis.

This set of samples produced the 0 hour data and was used for the chemical and physical laboratory tests.

Four times a week, a one liter sample from intake and discharge stations were incubated in the river chambers for 24 hours before they were returned to the laboratory for biological analysis.

Twice a week, one liter incurrent and excurrent samples were incubated in the river chambers for 48 hours before they were returned to the laboratory for biological analysis.

Once a week, one liter incurrent and excurrent samples were incubated in the river chambers for 96 hours before they were returned to the laboratory for biological analysis.

Chemical and physical data was taken on site and in the laboratory daily from 0 hour samples.

Data for gross megawatt output from each of Danskammer's four turbines were determined by plant engineers at the plant's control room. The megawatt data was recorded closely as possible to the time of sampling.

Air temperature was recorded daily at the sampling site using the Y.S.I. Model 54.

Daily precipitation data was provided by the Federal Aviation Administration at the Dutchess County Airport.

Tidal conditions during sampling were estimated visually at the site by the authors.

The Ryan recording thermometer operated seven days per week, during the study period, except during Tropical Storm Agnes, June 23-26. During the storm the equipment was removed from the river for its protection.

The entire procedure was tested for one week prior to the recording of data to acquaint research personnel with all the operational techniques in collection and analysis.

Statistical Analysis of Data

Data collected and recorded consisted of counts of all plankton samples collected on that day. Actual counts were converted to numbers of organisms per 100 ml. of water sampled and recorded on bench sheets and cumulative master sheets. Physical data taken each day were recorded in the same manner along with the gross megawatt output for the power plant. In addition to totals of organisms of each genera, other data were calculated from the counts and were recorded including total number of Cyanophyta, total numbers of Chlorophyta, total numbers of Chrysophyta, total numbers of Phytoplankton and total numbers of Zooplankton.

Data on populations and physical - chemical factors were maintained (as shown in tables elsewhere in this report) with corresponding intake and discharge samples in parallel. Thus, ready references could be made to compare populations of each type of organism prior to and after entrainment through the cooling coils of the power plant. Number of genera in each category of organisms were also counted and recorded. The percentage of all samples in which each genus appeared is recorded with the genus in the species list. (cf. Appendix I)

Analysis of the sample data, including correlations, graphs, statistical characteristics (population mean, median, mode, range, mean deviation and standard deviation) were done on an IBM Model 360-65 computer.

Tests of significant differences in the populations were done using the Wilcoxon's signed ranks tests by one of the principal investigators (Barnett). This test of signed ranks was chosen as the statistical instrument for determination of significant differences between incurrent and excurrent populations for several reasons. In addition to its simplicity, it is especially useful for comparing matched sets of measurements, as represented by the samples in this study. It is also especially well-adapted for use when some of the differences in the varieties are negative values. The test is reputed by Langley (1968) to produce results, when twelve or more pairs of variates are used, comparable to the Student's T- test.

Results were calculated and are given as p-values on the basis of a one-tailed test, since the investigators were primarily interested in determining potential detrimental effects of entrainment. In other words, primary concern was with reductions in populations as they pass through the high temperature zones during entrainment. Any positive differences from discharge values minus intake values must be attributed to random variation in sampling, since it would be impossible for actual population growth to occur during the four minute entrainment period.

RESULTS AND DISCUSSION

Physical and chemical data from intake and discharge stations fall within expected boundaries (cf. Data Table 1). It is reasonable to expect variations in both water temperature and turbidity of a river as large as the Hudson. However, it is apparent that both water temperature and turbidity were consistently increased as a result of entrainment. While the increase in water temperature at effluent points is easily explained, the increased turbidity (mean increase of 5.97 JTU) is still a matter of conjecture. It is possible that the steel collecting pipes at the discharge station did contribute significantly to the increased levels of turbidity.

Dissolved oxygen values show a range of two parts per million in the intake samples, but exhibit a wider range (four parts per million) in the discharge samples. Also, the mean value for discharge samples is 0.46 ppm lower than the mean value for intake samples. Apparently, the entrainment does cause minor reductions in dissolved oxygen values.

The pH values also show a greater range of values in the discharge samples, although the difference between the mean values is only 0.02.

Phosphate values do not show differences in levels between the intake and discharge samples.

DATA TABLE 1

Physical Parameters - Statistical Characteristics

0 Hour

Variable	Maximum	Minimum	Mean	Mean Dev.	Std. Dev.
Intake Water Temperature	26.1°C	18.3°C	23.12°C	2.19	2.53
Discharge Water Temperature	33.0°C	22.2°C	29.3°C	2.20	2.65
Intake Turbidity	54	16	36.74	5.84	7.96
Discharge Turbidity	65	20	41.71	6.76	9.27
Intake pH	8	6.8	7.47	.12	.19
Discharge pH	8.5	6.2	7.49	.11	.29
Intake D/O	8 ppm	6 ppm	7.24 ppm	.54	.65
Discharge D/O	9 ppm	5 ppm	6.88 ppm	.58	.81
Intake Phosphate	.5 ppm	.01 ppm	.23 ppm	.07	.10
Discharge Phosphate	.5 ppm	.001 ppm	.22 ppm	.07	.10

Sample size (N) = 34

Turbidity values in Jackson Turbidity Units

D/O = dissolved oxygen

Phosphate = PO_4^{---}

It is apparent algae of the division Chrysophyta comprise the major portion of Hudson River phytoplankton in the Danskammer area (cf. Data Table 2). It is also apparent that all major categories, either in combination or by Division show extensive fluctuations over a sampling period. This is quite consistent with the literature and has been demonstrated on the Hudson River by several studies including Howells and Feldman.

Coscinodiscus sp. was the most prevalent diatom collected during the sampling period (cf. Data Table 3). It is interesting to note the extreme range of that population, including samples lacking Coscinodiscus. Navicula sp. was the only genus collected in all samples. The large number of species in this genus may be the primary factor in determining its consistency in the samples. The Navicula populations seem less variable, again perhaps due to the large number of species in the genus.

As in the major categories, data demonstrates extensive variation in sample populations as well as a multi-modal distribution. Population variations of diatom populations has been widely cited by Patrick and others.

Following a 24 hour incubation period at ambient river conditions, all diatom populations increase by nearly one order of magnitude (cf. Data Table 4). Standard deviations of the samples show a similar increase in magnitude. The increase in numbers and in sample variability may have masked differences that may have been present.

It is possible that part of the increase in numbers of individuals could be related to a trapping potential of the incubation

DATA TABLE 2

Biological Populations - Statisitical Characteristics

0 Hour

Variable	Maximum P	Minimum P	Mean	Mean Dev.	Std. Dev.	# of Modes
:al Organisms :take	37750	185	6000	4000	7000	2
:al Organisms _charge	11325	1000	4000	1000	2000	4
:al Chlorophyta _ake	2250	750	600	300	400	3
:al Chlorophyta _charge	2700	100	700	300	500	1
:tal Chrysophyta :ake	11100	1125	3000	1000	2000	2
:tal Chrysophyta :charge	10375	1100	3000	1000	2000	1
:tal Zooplankton :take	850	0	100	100	100	1
:tal Zooplankton _scharge	400	0	100	100	100	1
_al Phytoplankton :take	25250	1425	5000	2000	4000	1
_al Phytoplankton _scharge	11275	860	4000	1000	2000	3

:mple size = 34

_a/ 100 ml. samples

DATA TABLE 3

Biological Populations - Statistical Characteristics

0 Hour

Variable	Maximum P	Minimum P	Mean	Mean Dev.	Std. Dev.	# of Modes
losira sp. ntake	1900	0	459	398	495	1
losira sp. scharge	1750	0	355	341	453	2
scinodiscus sp. take	8750	0	1590	1780	2320	1
scinodiscus sp. scharge	8000	0	1460	1600	2060	1
rosigma sp. take	700	0	205	148	181	1
yrosigma sp. scharge	750	0	189	112	145	4
urirella sp. ntake	1250	0	284	248	310	1
urirella sp. ischarge	1300	0	287	236	324	1
avicula sp. ntake	950	75	388	182	234	2
avicula sp. ischarge	3300	0	449	333	608	1

Sample size (N) = 34

ata/ 100 ml. samples

DATA TABLE 4

Biological Populations - Statistical Characteristics

24 Hour

Variable	Maximum P	Minimum P	Mean	Mean Dev.	Std. Dev.	# of Modes
Melosira sp. Intake	22500	150	5660	5830	7230	1
Melosira sp. Discharge	28850	75	4720	4370	5680	3
Coscinodiscus sp. Intake	72000	0	9580	11100	17210	1
Coscinodiscus sp. Discharge	38100	0	8180	7240	10240	1
Gyrosigma sp. Intake	2500	0	760	580	730	1
Gyrosigma sp. Discharge	4200	0	910	720	1020	2
Surirella sp. Intake	12000	0	1560	1690	2600	1
Surirella sp. Discharge	13230	0	1630	1650	2750	1
Navicula sp. Intake	23800	300	7220	5470	6640	1
Navicula sp. Discharge	26500	150	6670	5420	7330	1

Sample size (N) = 26

Data/ 100 ml. sample

chambers, rather than incubation effects. In spite of the efforts to keep river populations out of the chambers, the authors feel that smaller, motile diatoms and other organisms could penetrate the filter barriers.

There appears to be a slight trend toward the reduction in numbers of genera present in discharge samples when compared to numbers of genera appearing in intake samples (cf. Data Tables 5 and 6). While the trend is not significant, it does represent a potential area for further study. The zooplankton category seems to demonstrate this trend most clearly. It is possible that the presence of a cell wall in algal species would prevent severe damages during the entrainment period and that this protection is not available to zooplankton. With exception of loricate rotifers and crustaceans (not collected in high numbers), the zooplankton would be expected to be more fragile and more easily destroyed by heat or mechanical effects that are a part of the entrainment process. Zooplankter genera decreased in 19 of 34 discharge samples, while showing an increase in only 8 samples (no change in 7 samples). Number of genera of phytoplankton decreased the same number of times in discharge samples, but showed increases 12 times (no change in 3 samples).

The 24 hour data does not show the trend toward reduction in numbers of genera clearly (cf. Data Tables 7 and 8). Phytoplankton show a decrease in 13 samples, and increase in 10 samples and no change in 3 samples. Zooplankton show decreases in 11 samples, increases in 9 samples and no change in 6 samples. Either the populations have been replaced by the trapping effect or the sample

DATA TABLE 5

Number of Genera - 0 Hour Samples

Date	Chlorophyta		Chrysophyta		Phytoplankton		Zooplankton	
	Int.	Dis.	Int.	Dis.	Int.	Dis.	Int.	Dis.
6/26/72	6	10	8	11	15	21	4	4
6/27/72	8	5	11	9	22	14	5	6
6/28/72	6	4	11	8	17	13	2	1
6/29/72	3	6	11	10	15	17	3	3
6/30/72	4	4	13	8	18	12	7	5
7/03/72	7	4	11	8	20	12	9	3
7/05/72	6	4	9	13	15	20	8	4
7/06/72	10	13	10	11	21	26	4	5
7/07/72	6	16	10	9	20	17	0	1
7/10/72	11	9	14	14	27	26	4	6
7/11/72	7	8	10	10	20	20	3	3
7/12/72	6	12	12	12	20	20	0	5
7/13/72	7	9	12	13	22	25	1	8
7/14/72	9	6	12	14	23	26	8	1
7/17/72	7	10	11	13	20	26	6	3
7/18/72	8	7	13	11	22	20	3	3
7/19/72	8	7	13	13	23	22	5	4
7/20/72	13	10	11	11	27	24	4	4
7/21/72	9	7	11	11	23	21	5	4
7/24/72	6	4	9	8	17	13	6	5
7/25/72	7	7	8	9	17	19	6	4
7/26/72	11	4	9	10	22	15	6	2
7/27/72	7	10	11	13	21	24	5	4
7/28/72	9	6	10	10	20	18	4	4
7/31/72	9	5	10	11	20	18	3	1
8/01/72	10	10	12	10	26	20	4	1
8/02/72	10	11	13	10	27	23	11	3
8/03/72	8	9	9	10	18	19	3	3
8/04/72	7	12	12	10	21	24	3	4
8/07/72	14	12	10	10	27	24	8	2
8/08/72	10	12	12	10	23	23	4	1
8/09/72	12	14	9	11	23	26	4	1
8/10/72	15	15	11	9	30	26	3	4
8/11/72	13	12	9	12	27	27	7	3

DATA TABLE 6

Number of Genera - 0 Hour Samples

Date	Total Genera (all organisms) Intake	Discharge
6/26/72	19	27
6/27/72	27	18
6/28/72	19	14
6/29/72	18	20
6/30/72	25	17
7/03/72	29	15
7/05/72	23	24
7/06/72	25	31
7/07/72	20	18
7/10/72	31	32
7/11/72	23	23
7/12/72	20	32
7/13/72	23	33
7/14/72	31	22
7/17/72	26	29
7/18/72	25	23
7/19/72	28	28
7/20/72	31	28
7/21/72	28	25
7/24/72	23	18
7/25/72	23	23
7/26/72	28	17
7/27/72	27	28
7/28/72	24	22
7/31/72	23	19
8/01/72	30	21
8/02/72	38	26
8/03/72	21	22
8/04/72	24	28
8/07/72	35	26
8/08/72	27	24
8/09/72	27	27
8/10/72	33	30
8/11/72	34	30

DATA TABLE 7

NUMBER OF GENERA - 24 HOUR INCUBATED SAMPLES

Date	Chlorophyta		Chrysophyta		Phytoplankton		Zooplankton	
	Int.	Dis.	Int.	Dis.	Int.	Dis.	Int.	Dis.
6/27/72	2	2	9	7	13	9	1	2
6/28/72	5	4	8	11	13	17	2	1
6/29/72	4	9	12	18	16	29	4	2
6/30/72	5	6	9	12	14	21	5	4
7/06/72	4	5	8	17	12	23	0	8
7/07/72	5	4	13	11	19	16	3	6
7/11/72	1	2	8	11	10	14	2	1
7/12/72	5	3	12	8	20	12	6	0
7/13/72	3	4	12	12	16	18	4	1
7/14/72	1	5	10	12	12	18	0	0
7/18/72	3	2	11	11	16	15	2	2
7/19/72	4	10	9	14	14	27	0	3
7/20/72	4	7	14	9	20	17	1	1
7/21/72	8	6	11	14	22	22	2	1
7/25/72	6	2	12	13	19	17	0	4
7/26/72	8	3	10	11	20	15	5	3
7/27/72	3	1	10	10	14	12	2	3
7/28/72	8	5	13	9	23	15	3	3
8/01/72	7	5	8	10	17	15	2	4
8/02/72	1	2	8	14	10	18	3	1
8/03/72	3	2	11	9	15	12	2	2
8/04/72	4	5	12	11	17	17	2	2
8/08/72	4	11	13	10	18	24	1	3
8/09/72	10	9	10	10	22	22	1	4
8/10/72	15	6	8	11	24	18	4	2
8/11/72	14	9	12	10	28	20	8	5

DATA TABLE 8

NUMBER OF GENERA - 24 HOUR INCUBATED SAMPLES

Date	Total Genera (all organisms) Intake	Discharge
6/27/72	14	11
6/28/72	15	18
6/29/72	20	31
6/30/72	19	25
7/06/72	12	31
7/07/72	22	22
7/11/72	12	15
7/12/72	26	12
7/13/72	20	19
7/14/72	12	18
7/18/72	18	17
7/19/72	14	30
7/20/72	21	18
7/21/72	24	23
7/25/72	19	21
7/26/72	25	18
7/27/72	16	15
7/28/72	26	18
8/01/72	19	19
8/02/72	13	19
8/03/72	17	14
8/04/72	19	19
8/08/72	19	27
8/09/72	23	26
8/10/72	28	20
8/11/72	36	25

technique produces the change. However, the incubation time does not seem to have had an effect on the diversity of the genera present in either incurrent or excurrent samples.

Data is not presented on 48 or 96 hour samples due to problems encountered in the laboratory with heavy sedimentation. Large volumes of silt passed through the filter barriers causing severe difficulties in the sand filtration process. Volumes of filtration were changed and the procedure for filtration and counting was changed in an attempt to salvage some data. The change in procedure does introduce a variable in the counts that may detract from the more reliable data in the 0 and 24 hour samples.

The daily tables on the physical and chemical data are self-explanatory and were discussed previously under statistical characteristics of this data (cf. Data Tables 9-14). The tables serve as the basis for the statistical characteristics on Data Table 1. Trends or changes are expected and need not be discussed in further detail here.

The daily counts of the five most prevalent diatoms; Surirella sp., Navicula sp., Coscinodiscus sp., Melosira sp., and Gyrosigma sp. shows fluctuations of diatom populations (cf. Data Tables 15-19). The delta values (discharge minus intake) demonstrate the lack of significant population reductions. While changes are frequent, data shows nearly as many positive values as negative values. Melosira sp. shows most consistent reduction with 20 negative values in 34 samples. This data may suggest that Melosira may be the least tolerant genus in terms of entrainment effects.

DATA TABLE 9

Water Temperature °C.

Date	Intake	Discharge	Delta T (D-I)
6/26/72	18.5	27.0	8.5
6/27/72	18.5	27.0	8.5
6/28/72	19.0	26.0	7.0
6/29/72	18.5	27.5	9.0
6/30/72	18.3	25.6	7.3
7/03/72	20.0	24.4	4.4
7/05/72	21.1	24.4	3.3
7/06/72	21.1	27.8	6.7
7/07/72	21.1	22.2	1.1
7/10/72	22.2	27.8	5.6
7/11/72	21.7	28.9	7.2
7/12/72	22.2	30.0	7.8
7/13/72	22.2	28.9	6.7
7/14/72	23.3	28.3	5.0
7/17/72	23.9	30.0	6.1
7/18/72	26.1	31.7	5.6
7/19/72	25.0	31.1	6.1
7/20/72	25.0	31.1	6.1
7/21/72	24.4	31.1	6.7
7/24/72	25.6	31.1	5.5
7/25/72	26.1	31.1	5.0
7/26/72	25.6	31.1	5.5
7/27/72	24.0	31.7	7.7
7/28/72	25.0	33.0	8.0
7/31/72	25.0	33.0	8.0
8/01/72	25.0	27.0	2.0
8/02/72	25.0	32.0	7.0
8/03/72	25.5	31.0	5.5
8/04/72	25.3	30.5	5.2
8/07/72	25.0	30.0	5.0
8/08/72	25.0	31.0	6.0
8/09/72	25.0	31.0	6.0
8/10/72	25.0	31.0	6.0
8/11/72	22.0	31.0	9.0

Number of negative delta values in 34 samples = 0 mean $\underline{d}$ = 6.18°C

Number of 0 delta value = 0

DATA TABLE 10

Turbidity - Jackson Units

Date	Intake	Discharge	Delta Turbidity (D-I)
6/26/72	42	47	5
6/27/72	36	49	13
6/28/72	36	65	19
6/29/72	42	47	5
6/30/72	49	54	5
7/03/72	39	44	5
7/05/72	39	47	8
7/06/72	32	44	12
7/07/72	36	42	6
7/10/72	47	54	7
7/11/72	39	42	3
7/12/72	39	22	-17
7/13/72	30	36	6
7/14/72	39	44	5
7/17/72	36	42	6
7/18/72	36	44	8
7/19/72	22	30	8
7/20/72	16	20	4
7/21/72	32	39	7
7/24/72	42	36	-6
7/25/72	39	47	8
7/26/72	36	36	0
7/27/72	30	36	6
7/28/72	32	39	7
7/31/72	36	39	3
8/01/72	42	42	0
8/02/72	54	56	2
8/03/72	36	39	3
8/04/72	47	51	4
8/07/72	44	44	0
8/08/72	44	44	0
8/09/72	30	26	-4
8/10/72	20	32	12
8/11/72	30	39	9

Number of negative delta values in 34 samples = 3

Number of 0 delta value = 4

Mean delta value = 6.26 JTU

DATA TABLE 11

Dissolved Oxygen - PPM

Date	Intake	Discharge	Delta D/O (D-I)
6/26/72	6	7	1
6/27/72	7	7	0
6/28/72	8	8	0
6/29/72	8	7	-1
6/30/72	7	7	0
7/03/72	8	7	-1
7/05/72	8	7	-1
7/06/72	7	6	-1
7/07/72	8	8	0
7/10/72	7	7	0
7/11/72	6	5	-1
7/12/72	7	6	-1
7/13/72	8	6	-2
7/14/72	8	6	-2
7/17/72	7	7	0
7/18/72	8	6	-2
7/19/72	6	6	0
7/20/72	7	6	-1
7/21/72	7	7	0
7/24/72	8	7	-1
7/25/72	7	7	0
7/26/72	7	7	0
7/27/72	8	8	0
7/28/72	8	9	1
7/31/72	7	7	0
8/01/72	8	8	0
8/02/72	7	6	-1
8/03/72	7	7	0
8/04/72	6	7	1
8/07/72	7	7	0
8/08/72	7	8	1
8/09/72	7	7	0
8/10/72	7	6	-1
8/11/72	7	7	0

Number of negative delta values in 34 samples = 13

Number of 0 delta value = 16

Mean delta value = 0.59 ppm.

DATA TABLE 12

pH

Date	Intake	Discharge	Delta pH (D-I)
6/26/72	7.8	7.8	0.0
6/27/72	7.5	7.5	0.0
6/28/72	7.6	7.6	0.0
6/29/72	7.5	7.4	-0.1
6/30/72	7.5	8.5	1.0
7/03/72	7.5	7.5	0.0
7/05/72	8.0	7.5	-0.5
7/06/72	7.5	7.5	0.0
7/07/72	7.4	7.4	0.0
7/10/72	7.5	7.5	0.0
7/11/72	7.5	7.5	0.0
7/12/72	7.5	7.5	0.0
7/13/72	7.5	7.4	-0.1
7/14/72	7.4	7.4	0.0
7/17/72	7.5	7.5	0.0
7/18/72	7.5	7.5	0.0
7/19/72	7.5	7.5	0.0
7/20/72	7.5	7.5	0.0
7/21/72	7.5	7.5	0.0
7/24/72	7.5	7.5	0.0
7/25/72	7.5	7.5	0.0
7/26/72	7.5	7.5	0.0
7/27/72	7.5	7.5	0.0
7/28/72	7.5	7.5	0.0
7/31/72	7.5	7.5	0.0
8/01/72	7.5	7.5	0.0
8/02/72	7.5	7.5	0.0
8/03/72	7.5	7.5	0.0
8/04/72	7.3	7.5	0.2
8/07/72	7.3	7.5	0.2
8/08/72	7.5	7.5	0.0
8/09/72	7.0	7.5	0.5
8/10/72	6.8	6.2	-0.6
8/11/72	7.5	7.3	-0.2

Number of negative delta values in 34 samples = 5

Number of 0 delta values = 25

Mean delta value = 0.01

DATA TABLE 13

Daily Phosphate PPM

Date	Intake	Discharge	Delta Phosphate (D-I)
6/26/72	0.15	0.20	0.05
6/27/72	0.30	0.10	-0.20
6/28/72	0.25	0.10	-0.15
6/29/72	0.20	0.10	-0.10
6/30/72	0.30	0.25	-0.05
7/03/72	0.10	0.50	0.40
7/05/72	0.50	0.15	-0.35
7/06/72	0.40	0.20	-0.20
7/07/72	0.20	0.10	-0.10
7/10/72	0.20	0.20	0.00
7/11/72	0.10	0.20	0.10
7/12/72	0.10	0.20	0.10
7/13/72	0.10	0.20	0.10
7/14/72	0.20	0.20	0.00
7/17/72	0.30	0.20	-0.10
7/18/72	0.30	0.30	0.00
7/19/72	0.20	0.20	0.00
7/20/72	0.20	0.20	0.00
7/21/72	0.20	0.20	0.00
7/24/72	0.20	0.20	0.00
7/25/72	0.20	0.20	0.00
7/26/72	0.20	0.20	0.00
7/27/72	0.20	0.20	0.00
7/28/72	0.20	0.20	0.00
7/31/72	0.30	0.30	0.00
8/01/72	0.40	0.30	-0.10
8/02/72	0.30	0.30	0.00
8/03/72	0.20	0.20	0.00
8/04/72	0.30	0.40	0.10
8/07/72	0.01	0.00	-0.01
8/08/72	0.30	0.40	0.10
8/09/72	0.20	0.30	0.10
8/10/72	0.20	0.20	0.00
8/11/72	0.20	0.30	0.10

Number of negative delta values in 34 samples = 10

Number of 0 delta values = 15

Mean delta value = 0.07 ppm.

DATA TABLE 14

Daily Chlorine - PPM

Date	Intake	Discharge	Delta Chlorine (D-I)
6/26/72	0.005	0.005	0.000
6/27/72	0.000	0.001	0.001
6/28/72	0.000	0.000	0.000
6/29/72	0.010	0.010	0.000
6/30/72	0.050	0.010	-0.040
7/03/72	0.010	0.010	0.000
7/05/72	0.000	0.000	0.000
7/06/72	0.000	0.001	0.001
7/07/72	0.000	0.005	0.005
7/10/72	0.000	0.010	0.010
7/11/72	0.001	0.001	0.000
7/12/72	0.000	0.001	0.001
7/13/72	0.001	0.001	0.000
7/14/72	0.001	0.001	0.000
7/17/72	0.000	0.002	0.002
7/18/72	0.001	0.001	0.000
7/19/72	0.001	0.001	0.000
7/20/72	0.001	0.001	0.000
7/21/72	0.000	0.002	0.002
7/24/72	0.001	0.002	0.001
7/25/72	0.001	0.002	0.001
7/26/72	0.001	0.002	0.001
7/27/72	0.001	0.002	0.001
7/28/72	0.001	0.001	0.000
7/31/72	0.001	0.001	0.000
8/01/72	0.001	0.001	0.000
8/02/72	0.001	0.002	0.001
8/03/72	0.001	0.001	0.000
8/04/72	0.001	0.002	0.001
8/07/72	0.001	0.001	0.000
8/08/72	0.002	0.005	0.003
8/09/72	0.001	0.001	0.000
8/10/72	0.001	0.001	0.000
8/11/72	0.001	0.001	0.000

Number of negative delta values in 34 samples = 1

Number of 0 delta values = 19

Mean delta value = 0.002 ppm.

DATA TABLE 15

Daily Surirella sp. Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	350	400	50
6/27/72	750	200	-550
6/28/72	450	200	-250
6/29/72	675	1300	625
6/30/72	575	700	125
7/03/72	325	300	-25
7/05/72	325	600	275
7/06/72	400	475	75
7/07/72	850	350	-500
7/10/72	1250	1200	-50
7/11/72	500	550	50
7/12/72	700	900	200
7/13/72	250	250	0
7/14/72	750	300	-450
7/17/72	200	150	-50
7/18/72	175	375	200
7/19/72	100	125	25
7/20/72	175	200	25
7/21/72	50	100	50
7/24/72	25	100	75
7/25/72	50	50	0
7/26/72	0	75	75
7/27/72	75	25	-50
7/28/72	0	50	50
7/31/72	125	0	-125
8/01/72	25	50	25
8/02/72	50	100	50
8/03/72	50	75	25
8/04/72	50	125	75
8/07/72	50	50	0
8/08/72	50	200	150
8/09/72	250	50	-200
8/10/72	0	75	75
8/11/72	0	50	50

Number of negative delta values in 34 samples = 10

Number of 0 delta values = 3

DATA TABLE 16

Daily Navicula sp. Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	150	333	183
6/27/72	350	120	-230
6/28/72	125	200	75
6/29/72	225	400	175
6/30/72	425	0	-425
7/03/72	125	50	-75
7/05/72	75	200	125
7/06/72	125	50	-75
7/07/72	75	250	175
7/10/72	500	250	-250
7/11/72	450	900	450
7/12/72	800	1100	300
7/13/72	600	275	-325
7/14/72	750	325	-425
7/17/72	175	175	0
7/18/72	475	525	50
7/19/72	425	200	-225
7/20/72	225	250	25
7/21/72	250	500	250
7/24/72	400	300	-100
7/25/72	175	375	200
7/26/72	400	275	-125
7/27/72	400	75	-325
7/28/72	125	100	-25
7/31/72	375	333	-42
8/01/72	325	275	-50
8/02/72	450	400	-50
8/03/72	250	275	25
8/04/72	750	350	-400
8/07/72	350	400	50
8/08/72	950	750	-200
8/09/72	800	100	-700
8/10/72	400	450	50
8/11/72	700	1700	1000

Number of negative delta values in 34 samples = 18

Number of 0 delta values = 1

DATA TABLE 17

Daily Coscinodiscus sp. Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	50	67	17
6/27/72	0	0	0
6/28/72	0	0	0
6/29/72	0	50	50
6/30/72	50	50	0
7/03/72	400	300	-100
7/05/72	300	300	0
7/06/72	250	125	-125
7/07/72	125	300	175
7/10/72	600	350	-250
7/11/72	200	500	300
7/12/72	150	700	550
7/13/72	150	375	125
7/14/72	400	225	-175
7/17/72	375	125	-150
7/18/72	325	200	-125
7/19/72	375	100	-275
7/20/72	700	625	-75
7/21/72	650	800	150
7/24/72	500	167	-333
7/25/72	900	625	-275
7/26/72	1200	450	-750
7/27/72	125	900	775
7/28/72	625	575	-50
7/31/72	1275	2700	1425
8/01/72	1500	3225	1725
8/02/72	4150	4750	600
8/03/72	6250	3850	-2400
8/04/72	4900	3650	-1250
8/07/72	6100	6750	650
8/08/72	8750	8000	-750
8/09/72	6050	4700	-1250
8/10/72	4350	2100	-2250
8/11/72	2400	2100	-300

Number of negative delta values in 34 samples = 18

Number of 0 delta values = 4

DATA TABLE 18

Daily Melosira sp. Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	0	200	200
6/27/72	550	120	-430
6/28/72	125	100	-25
6/29/72	425	300	-125
6/30/72	475	175	-300
7/03/72	1175	350	-725
7/05/72	175	260	85
7/06/72	350	825	475
7/07/72	775	1750	975
7/10/72	1100	1100	0
7/11/72	1450	350	-1100
7/12/72	1300	1600	300
7/13/72	1150	700	-450
7/14/72	1900	750	-1150
7/17/72	875	475	-400
7/18/72	825	700	-125
7/19/72	700	975	275
7/20/72	400	475	75
7/21/72	100	250	150
7/24/72	0	67	67
7/25/72	50	25	-25
7/26/72	0	50	50
7/27/72	100	25	-75
7/28/72	0	0	0
7/31/72	75	33	-42
8/01/72	75	0	-75
8/02/72	50	50	0
8/03/72	200	50	-150
8/04/72	200	75	-125
8/07/72	200	0	-200
8/08/72	200	50	-150
8/09/72	50	100	50
8/10/72	200	0	-200
8/11/72	350	100	-250

Number of negative delta values in 34 samples = 20

Number of 0 delta values = 3

DATA TABLE 19

Daily Gyrosigma sp. Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	0	67	67
6/27/72	50	40	-10
6/28/72	100	50	-50
6/29/72	75	150	75
6/30/72	125	0	-125
7/03/72	75	25	-50
7/05/72	25	25	0
7/06/72	50	75	25
7/07/72	50	100	50
7/10/72	550	350	-200
7/11/72	200	350	150
7/12/72	50	300	250
7/13/72	450	275	-175
7/14/72	700	100	-600
7/17/72	75	50	-25
7/18/72	100	250	150
7/19/72	150	100	-50
7/20/72	125	150	25
7/21/72	100	300	175
7/24/72	250	267	17
7/25/72	150	100	-50
7/26/72	50	175	125
7/27/72	100	75	-25
7/28/72	125	125	0
7/31/72	25	67	42
8/01/72	275	125	-150
8/02/72	400	250	-150
8/03/72	250	150	-100
8/04/72	400	250	-150
8/07/72	300	350	50
8/08/72	500	750	250
8/09/72	550	300	-250
8/10/72	300	150	-150
8/11/72	250	300	50

Number of negative delta values in 34 samples = 17

Number of 0 delta values = 2

With the exception of Surirella sp., all diatom populations measured do show more negative values than positive values, however, it is necessary to note that there is not a significant difference between the number of negative and positive values of any of the diatom populations. Thus this data can only be a small indication that Surirella sp. may be more tolerant of entrainment effects.

Daily counts of major plankton categories do not indicate major shifts in populations as a result of entrainment (cf. Data Tables 20-24). The major categories include: Total Chrysophyta, Total Chlorophyta, Total Phytoplankton, Total Zooplankton and Total Organisms. The total phytoplankton show the largest number of negative values with 20 negative values in 34 samples.

Correlations were made between the five most prevalent diatoms in incurrent samples with five physical parameters of those samples, including water temperature, turbidity, pH, dissolved oxygen and phosphate levels (cf. Data Table 25).

Coscinodiscus shows a 0.47 positive correlation with water temperature, suggesting a tolerance to elevated temperatures, at least elevated to the extent found in this study. Surirella, on the other hand, shows a strong negative correlation (0.65) that suggests an intolerance to the elevated temperatures. However, this organism did not show extensive losses when intake and discharge populations were analyzed. The data sets seem to be contradictory at this point. It may suggest that factors other than temperature may exert pressures during entrainment or that Surirella is responsive to temperature related factors in ambient river water. It is interesting to note that Navicula shows a strong positive correlation (0.68) with Gyrosigma and that Melosira shows a o.61 positive correlation with Surirella.

DATA TABLE 20

Daily Total Chrysophyta Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	2400	2967	567
6/27/72	3100	3600	500
6/28/72	1450	1275	-175
6/29/72	2175	2950	775
6/30/72	2500	1375	-1125
7/03/72	2875	1400	-1475
7/05/72	1425	5900	4475
7/06/72	1850	2400	550
7/07/72	3450	3600	150
7/10/72	7200	5300	-1900
7/11/72	3625	3600	25
7/12/72	5150	6550	400
7/13/72	3425	3000	-425
7/14/72	6600	2825	-3775
7/17/72	2650	1675	-975
7/18/72	3000	2475	-525
7/19/72	2225	2450	225
7/20/72	2050	2450	400
7/21/72	2575	2700	125
7/24/72	1575	1100	-475
7/25/72	1450	1425	-25
7/26/72	2250	1350	-900
7/27/72	2200	1400	-800
7/28/72	1125	1100	-25
7/31/72	2300	3500	1200
8/01/72	2425	4025	1600
8/02/72	5475	6100	625
8/03/72	7200	4600	-2600
8/04/72	7000	5025	-1975
8/07/72	7500	7800	300
8/08/72	11100	10375	-725
8/09/72	7850	5650	-2200
8/10/72	5550	2975	-2575
8/11/72	3850	5000	1150

Number of negative delta values in 34 samples = 19

Number of 0 delta values = 0

DATA TABLE 21

Daily Total Chlorophyta Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	800	533	-267
6/27/72	550	100	-450
6/28/72	275	275	0
6/29/72	75	450	375
6/30/72	200	100	-100
7/03/72	425	270	-155
7/05/72	425	550	125
7/06/72	500	800	300
7/07/72	875	200	-675
7/10/72	450	750	300
7/11/72	850	650	-200
7/12/72	1600	1850	250
7/13/72	850	825	-25
7/14/72	1350	400	-950
7/17/72	450	1050	600
7/18/72	500	425	-75
7/19/72	375	475	100
7/20/72	700	800	100
7/21/72	900	700	-200
7/24/72	525	267	-258
7/25/72	275	425	150
7/26/72	650	525	-125
7/27/72	525	525	0
7/28/72	275	600	325
7/31/72	250	433	183
8/01/72	250	375	125
8/02/72	525	650	125
8/03/72	550	325	-225
8/04/72	500	275	-225
8/07/72	1150	1200	50
8/08/72	750	800	50
8/09/72	1150	1800	650
8/10/72	1400	2700	1300
8/11/72	2250	1850	-400

Number of negative delta values in 34 samples = 15

Number of 0 delta values = 2

DATA TABLE 22

Daily Total Phytoplankton Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	3225	3500	275
6/27/72	4000	860	-3140
6/28/72	1725	1600	-125
6/29/72	2275	3500	1225
6/30/72	2525	1225	-1300
7/03/72	3600	1725	-1875
7/05/72	1850	6950	5100
7/06/72	2550	3325	775
7/07/72	4400	4200	-200
7/10/72	9050	6500	-2550
7/11/72	4875	4850	-25
7/12/72	7550	10650	2100
7/13/72	5375	4750	-625
7/14/72	9950	4025	-5925
7/17/72	4125	3625	-500
7/18/72	4725	4125	-600
7/19/72	3825	4425	600
7/20/72	3950	4125	175
7/21/72	4625	4500	-125
7/24/72	2150	1400	-750
7/25/72	1725	1950	225
7/26/72	3000	1875	-1125
7/27/72	2725	1950	-775
7/28/72	1425	1750	325
7/31/72	2500	4033	1533
8/01/72	2750	4400	1750
8/02/72	6100	6800	700
8/03/72	7800	4925	-2875
8/04/72	7850	5550	-2300
8/07/72	8800	9050	250
8/08/72	11850	11275	-575
8/09/72	9200	7500	-1700
8/10/72	7150	5775	-1375
8/11/72	6650	7100	450

Number of negative delta values in 34 samples = 20

Number of 0 delta values = 0

DATA TABLE 23

Daily Total Zooplankton Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	525	267	-258
6/27/72	275	140	-135
6/28/72	125	75	-50
6/29/72	0	250	250
6/30/72	400	100	-300
7/03/72	175	150	-25
7/05/72	250	150	-100
7/06/72	150	25	-125
7/07/72	0	300	300
7/10/72	250	400	150
7/11/72	50	350	300
7/12/72	0	350	350
7/13/72	0	200	200
7/14/72	25	25	0
7/17/72	25	75	50
7/18/72	75	50	-25
7/19/72	200	75	-125
7/20/72	150	150	0
7/21/72	200	350	150
7/24/72	125	200	75
7/25/72	75	75	0
7/26/72	150	50	-100
7/27/72	50	175	125
7/28/72	50	50	0
7/31/72	25	0	-25
8/01/72	0	25	25
8/02/72	150	100	-50
8/03/72	250	50	-200
8/04/72	0	50	50
8/07/72	50	250	200
8/08/72	250	50	-200
8/09/72	100	50	-50
8/10/72	400	100	-300
8/11/72	850	350	-500

Number of negative delta values in 34 samples = 17

Number of 0 delta values = 4

DATA TABLE 24

Daily Total Organism Count / 100 ml.

Date	Intake	Discharge	Delta P (D-I)
6/26/72	3750	3700	-50
6/27/72	4275	1000	-3275
6/28/72	1850	1675	-175
6/29/72	2275	3750	1475
6/30/72	2565	1575	-990
7/03/72	3775	1875	-1900
7/05/72	2100	7100	5000
7/06/72	2700	3350	650
7/07/72	4400	4500	100
7/10/72	9500	6900	-2600
7/11/72	4925	5200	275
7/12/72	7550	11000	3450
7/13/72	5375	4950	-425
7/14/72	10200	4050	-6150
7/17/72	4150	3700	-450
7/18/72	4800	4175	-625
7/19/72	4025	4500	475
7/20/72	4100	4275	175
7/21/72	4825	4850	25
7/24/72	2275	1800	-475
7/25/72	1850	2025	175
7/26/72	3150	1925	-1225
7/27/72	2775	2125	-650
7/28/72	1475	1800	325
7/31/72	2600	4033	1433
8/01/72	2750	4425	1675
8/02/72	6250	6900	650
8/03/72	7950	4975	-2975
8/04/72	7850	5600	-2250
8/07/72	8050	9200	1150
8/08/72	12000	11325	-675
8/09/72	9300	7550	-1750
8/10/72	7550	5875	-1675
8/11/72	7450	7450	0

Number of negative delta values in 34 samples = 18

Number of 0 delta values = 1

DATA TABLE 25

Intake Diatoms - Intake Physical Parameter Correlations

	HOH Temperature	Turbidity	pH	Dissolved Oxygen	Phosphate	Coscinodiscus	Melosira	Navicula	Surirella	Gyrosigma
HOH Temperature	1	-.20	-.36	-.08	-.02	.47	-.26	.27	-.65	.32
Turbidity	-.20	1	.28	-.01	.14	.14	.01	.13	.25	.19
pH	-.36	.28	1	.13	.30	-.47	.00	-.37	.14	-.44
Dissolved Oxygen	-.08	-.01	.13	1	.14	-.28	.07	-.23	.10	-.02
Phosphate	-.02	.14	.30	.14	1	-.04	-.31	-.15	-.06	-.13
Coscinodiscus	.47	.14	-.47	-.28	-.04	1	-.35	.47	-.42	.53
Melosira	-.26	.01	.00	.07	-.31	-.35	1	.26	.61	.25
Navicula	.27	.13	-.37	-.23	-.15	.47	.26	1	-.01	.68
Surirella	-.65	.25	.14	.10	-.06	-.42	.61	-.01	1	.06
Gyrosigma	.32	.19	-.43	-.02	-.13	.53	.25	.68	.06	1

Discharge diatom populations were also correlated with the discharge physical parameters mentioned in the previous table (cf. Data Table 26). Results were inconclusive. Again, Surirella shows a 0.46 negative correlation with water temperature in line with the incurrent correlation, although not as strong. The strong correlation between Navicula and Gyrosigma at intake stations becomes a minor or weak correlation at the discharge station.

Correlations of intake and discharge diatom populations produces some interesting results (cf. Data Table 27). The correlations suggest which populations differ greatly following entrainment or which ones seem to be less changed by passage. Coscinodiscus (0.94) seems least changed by passage through the power plant. Surirella (+0.77), Melosira (+0.66) and Gyrosigma (+0.50) show decreasing positive correlations, indicating a potential effect of the entrainment process. Navicula (+0.25) shows a very low correlation, suggesting that this organism is affected by passage through the condensers.

Correlations of the 0 hour delta values do not show unexpected results (cf. Data Tables 28 & 29). It may be said that the correlations may be somewhat lower than expected.

Tables were prepared for the daily total organism count and the daily Coscinodiscus count for the 24 hour samples (cf. Data Tables 30 & 31). These tables do show the increase in populations counts over the 0 hour data (cf. Data Tables 17 & 24). As stated previously the counts are one order of magnitude higher than the 0 hour counts, suggesting the trapping potential of the river incubators. Experiments on the trapping potential could be determined by inoculating the chambers with sterile samples of water and allowing them to incubate for a 24 hour period.

DATA TABLE 26

Discharge Diatoms - Discharge Physical Parameter Correlations

	HOH Temperature	Turbidity	pH	Dissolved Oxygen	Phosphate	Coscinodiscus	Melosira	Navicula	Surirella	Gyrosigma
HOH Temperature	1	-.42	-.24	-.12	.18	.35	-.36	.35	-.46	.29
Turbidity	.42	1	.32	.2-	-.04	-.02	-.21	-.14	.21	-.12
pH	-.24	.32	1	.18	.05	-.12	.01	-.12	.20	-.14
Dissolved Oxygen	-.12	.25	.18	1	-.01	.17	-.28	-.11	-.21	-.06
Phosphate	.17	-.04	.05	-.01	1	.27	-.18	.19	-.19	.19
Coscinodiscus	.35	-.02	-.12	.17	.27	1	-.39	.20	-.36	.62
Melosira	-.36	-.21	.01	-.28	-.18	-.39	1	-.06	.50	-.02
Navicula	.35	-.14	-.12	-.11	.19	.20	-.06	1	-.10	.16
Surirella	-.46	.21	.21	-.21	-.19	-.36	.50	-.10	1	.08
Gyrosigma	.29	-.12	-.14	-.06	.19	.62	-.02	.16	.08	1

DATA TABLE 27

Correlations - 0 Hour Incurrent - Excurrent Diatoms

	Coscinodiscus Inc.	Melosira Inc.	Navicula Inc.	Surirella Inc.	Gyrosigma Inc.	Coscinodiscus Exc.	Melosira Exc.	Navicula Exc.	Surirella Exc.	Gyrosigma Exc.
Coscinodiscus Inc.	1	-.35	.47	-.42	.53	.94	-.39	.08	-.36	.59
Melosira Inc.	-.35	1	.26	.61	.25	-.35	.66	-.03	.44	.01
Navicula Inc.	.47	.26	1	-.01	.68	.47	.05	.25	-.01	.62
Surirella Inc.	-.42	.61	-.01	1	.06	-.42	.64	-.13	.77	-.12
Gyrosigma Inc.	.53	.25	.68	.06	1	.49	-.05	-.10	-.06	.50
Coscinodiscus Exc.	.94	-.35	.47	-.42	.49	1	-.39	.20	-.36	.62
Melosira Exc.	-.39	.66	.05	.64	-.05	-.39	1	-.06	.50	-.02
Navicula Exc.	.08	-.03	.25	-.13	-.10	.20	-.06	1	-.10	.16
Surirella Exc.	-.36	.44	-.01	.77	-.06	-.36	.50	-.10	1	.08
Gyrosigma Exc.	.59	.01	.62	-.12	.50	.62	-.02	.16	.08	1

DATA TABLE 28

Correlations - 0 Hour Delta Values

	HOH Temperature	Dissolved Oxygen	Turbidity	Total Chlorophyta	Total Chrysophyta	Total Organisms	Total Phytoplankton	Total Zooplankton
HOH Temperature	1	.09	.09	.14	.04	.08	-.09	-.21
Dissolved Oxygen	.09	1	.05	.03	.01	.07	-.06	-.25
Turbidity	.09	.05	1	-.01	-.02	-.03	-.06	-.33
Total Chlorophyta	.14	.03	-.01	1	.02	.17	.19	-.05
Total Chrysophyta	.04	.01	-.02	.02	1	.39	.47	.08
Total Organisms	.08	.07	-.03	.17	.39	1	.63	.21
Total Phytoplankton	-.09	-.06	-.06	.19	.47	.63	1	.29
Total Zooplankton	-.21	-.25	-.33	-.05	.08	.21	.29	1

DATA TABLE 29

Correlations - 0 Hour Delta Values

	HOH Temperature	Dissolved Oxygen	Turbidity	Coscinodiscus	Gyrosigma	Melosira	Navicula	Pediastrum	Scenedesmus	Surirella
HOH Temperature	1	.09	.09	.03	.15	-.18	.25	-.05	.12	.23
Dissolved Oxygen	.09	1	.05	-.09	.18	.32	.06	-.15	-.19	-.10
Turbidity	.09	.05	1	-.1	-.15	-.06	-.001	-.23	.03	-.26
Coscinodiscus	.03	-.09	-.1	1	.18	.04	.37	.24	-.01	-.04
Gyrosigma	.15	.18	-.15	.18	1	.37	.33	.19	.07	.45
Melosira	-.18	.32	-.06	.04	.37	1	.07	.03	.1	.08
Navicula	.25	.06	-.001	.37	.33	.07	1	.08	.21	.04
Pediastrum	-.05	-.15	-.23	.24	.19	.03	.08	1	.42	.25
Scenedesmus	.12	-.19	.03	-.01	.07	.1	.21	.42	1	.3
Surirella	.23	-.10	-.26	-.04	.45	.08	.04	.25	.3	1

DATA TABLE 30

Coscinodiscus Counts - 24 Hour Samples / 100 ml.

Date	Incurrent	Excurrent	Delta P (E-I)
6/27/72	100	200	100
6/28/72	0	300	300
6/29/72	150	325	175
6/30/72	600	100	-500
7/06/72	0	10100	10100
7/07/72	1600	1650	50
7/11/72	0	7200	7200
7/12/72	1333	0	-1333
7/13/72	2100	3100	1000
7/14/72	2700	2450	-250
7/18/72	500	5000	4500
7/19/72	0	600	600
7/20/72	100	0	-100
7/21/72	1500	4250	2750
7/25/72	250	550	300
7/26/72	5400	4000	-1400
7/27/72	10500	13500	3000
7/28/72	10700	9000	-1700
8/01/72	5850	9225	3375
8/02/72	23000	36500	13500
8/03/72	6000	7400	1400
8/04/72	10900	7950	-2950
8/08/72	12607	16000	3393
8/09/72	31500	16550	-14950
8/10/72	49600	38100	-11500
8/11/72	72000	18750	-53250

Number of negative values in 24 samples = 10

Number of 0 delta values = 0

DATA TABLE 31

Total Organism Count - 24 Hour Samples / 100 ml.

Date	Incurrent	Excurrent	Delta P (E-I)
6/27/72	2100	1950	-150
6/28/72	8100	11400	3300
6/29/72	3275	8225	4950
6/30/72	5650	10300	4650
7/06/72	8050	38600	30550
7/07/72	38200	24350	-13850
7/11/72	67200	100350	33150
7/12/72	1023433	11425	-1012008
7/13/72	54250	38500	-15750
7/14/72	72025	72800	775
7/18/72	37250	46500	9250
7/19/72	62650	19050	-43600
7/20/72	12200	5350	-6850
7/21/72	39750	61250	21500
7/25/72	6600	7150	550
7/26/72	32200	31500	-700
7/27/72	32500	26750	-5750
7/28/72	51500	29000	-22500
8/01/72	9350	12675	3325
8/02/72	41950	61500	19550
8/03/72	10200	15300	5100
8/04/72	20600	27025	6425
8/08/72	18133	22100	3967
8/09/72	48900	25100	-23800
8/10/72	64000	47100	-15900
8/11/72	15250	33000	17750

Number of negative delta values in 24 samples = 11

Number of 0 delta values = 0

Some of the higher correlations of the delta values deserve further discussion (cf. Data Table 32). Some of the higher values show rather obvious relationships, while others are not obvious to the casual observer. Coscinodiscus, the most prevalent diatom, should and does show a high positive correlation with the total Chrysophyta, since it comprises the major portion of that category. Scenedesmus, a major contributor to the green algae or Division Chlorophyta, would also be expected to show a high positive correlation. The 0.54 positive correlation between total phytoplankton and the total number of organisms is also expected as phytoplankton comprise the bulk of the total organisms sample.

It is worth noting that Gyrosigma, not the most prevalent diatom, has a 0.64 positive correlation with the total Chrysophyta. This may suggest that under the study conditions, Gyrosigma may respond to a similar range of tolerances that is exhibited by the division and therefore, could serve as an indicator species to demonstrate conditions that favor diatom growth in general.

Some correlations at the 0.4 - 0.5 level merit some additional comment, since it may indicate potential relationships. Total zooplankton and Coscinodiscus correlate at a 0.41 level. This seems remarkable because Coscinodiscus is the most common organism of any type in the samples, while zooplankton comprise the smallest category. Whether a causative relationship exists or not could be a problem for further consideration.

The 0.42 positive correlation between Pediastrum and Scenedesmus may indicated a similarity in tolerance ranges for these green algae.

The 0.42 positive correlation between Surirella, a diatom, and the total number of Chlorophyta is another interesting figure. While it may be coincidence, it may suggest similarities in tolerance ranges of the desmids in the Division Chlorophyta and the apparently sensitive, Surirella.

Correlations with values between 0.3 and 0.4 are presented in the table, but are not discussed. It would be stretching the values of correlations to discuss such low values.

DATA TABLE 32

CORRELATIONS OF DELTA VALUES

Gyrosigma / Total number Chrysophyta	+0.64
Total Phytoplankton / Total Organisms	+0.63
Coscinodiscus / Total Chrysophyta	+0.59
Scenedesmus / Total Chlorophyta	+0.54
Total Chrysophyta / Total phytoplankton	+0.47
Total Chlorophyta / *Pediastrum*	+0.47
Gyrosigma / *Surirella*	+0.46
Total Chlorophyta / *Pediastrum*	+0.46
Total Organisms / *Melosira*	+0.42
Navicula / *Pedisatrum*	+0.42
Scenedesmus / *Pediastrum*	+0.42
Surirella / Total Chlorophyta	+0.42
Melosira / Total Chlorophyta	+0.42
Total Zooplankton / *Coscinodiscus*	+0.41
Navicula / Total Chrysophyta	+0.40
Total Chrysophyta / Total organisms	+0.40
Melosira / Total Chrysophyta	+0.38
Gyrosigma / Total phytoplankton	+0.37
Gyrosigma / *Melosira*	+0.37
Coscinodiscus / *Melosira*	+0.37
Navicula / *Coscinodiscus*	+0.37

Correlations with Delta values only.

All organism identified to genus were listed in taxonomic categories (division or phyla) and these are listed in Appendix I. The number of incurrent and excurrent samples and the percentage of samples in which each genus occurred is listed in this table.

A total of 153 genera were encountered with the greatest variety occurring in the Division Chlorophyta. Within this taxon, the Desmids predominated in numbers and the numbers of different types. Overall, the Division Chrysophyta had the greatest number of organisms.

Cyclotella and Navicula were the only genera to occur in all collections taken at the intake sampling point.

The most frequently occuring genera in the major groups were:

		Intake	Discharge
CYANOPHYTA	Anabaena	56%	53%
	Oscillatoria	79%	62%
CHLOROPHYTA	Scenedesmus	91%	94%
	Pediastrum	94%	94%
CHRYSOPHYTA	Navicula	100%	97%
	Cyclotella	100%	91%
PROTOZOA	Codonella	38%	29%
	Euglena	44%	35%
ASCHELMINTHES	Keratella	62%	68%
	Polyarthra	24%	21%
CRUSTACEA	Cyclops	21%	12%

Tests of Significant Differences

The tests of significant differences as determined by Wilcoxon's signed ranks test are shown in Data Table 33. The results are shown in p values (probability of observed variations in samples being due to no more than random sample variability, or the probability that the sample sets compared actually represent the same population). Selected results are shown in the table to illustrate the pattern of the p values. With few exceptions, the p values do not show significant differences. As stated previously, the p values indicate a one-tailed test which is concerned with showing potential significance of population reductions as a result of entrainment.

Genera of Chlorophyta showed a p value of 0.064, while not significant, it does suggest the possibility that entrainment may reduce viability since the value is recorded in the 24 hour sample as compared to a 0.031 p value in the 0 hour samples.

Comparison of incurrent and excurrent samples for all genera of phytoplankton gives a p value of 0.078 after 24 hour incubation. Again, the figure is not significant, but suggests a reduction in population viability following entrainment.

The effects of entrainment may not be immediately observed, since it is nearly impossible to distinguish viable cells from non-viable cells with an ordinary light microscope. Unless the cell wall is obviously disrupted, viability can only be determined easily through the use of a fluorescent microscope.

Genera of zooplankton in the 0 hour data showed a definite reduction in discharge samples which is significant at the 1 percent

level (p = 0.008). The lack of a protective wall, except in the loricate rotifers and crustaceans probably accounts for their sensitivity to events in the entrainment process. Zooplankton may serve a potential indicators of entrainment effects.

The 24 hour samples seem to have recovered (p = 0.398) during the incubation period. This rapid recovery suggests to the authors that the incubation chambers may well have trapped motile organisms. An alternative suggestion is that the zooplankton populations have the capability to recover following severe population losses.

Counts of all organisms in the 0 hour samples show a significant reduction in the number of genera present in the discharge samples (p = 0.047), while no significant difference is demonstrated in the 24 hour samples.

There does not seem to be a clearly defined pattern between the 0 hour and 24 hour samples. From the tests, it appears that simple counts of population diversity, rather than numbers, may be an effective bioassay of entrainment effects. This may be especially true of the more sensitive zooplankton populations.

DATA TABLE 33

TESTS OF SIGNIFICANT DIFFERENCES
(AS DETERMINED BY WILCOXON'S SIGNED RANKS TEST)

Comparison of Excurrent - Incurrent Populations: in p values

Test	0 hour	24 hour
Genera of Chlorophyta	0.301	0.064
Numbers of Chlorophyta	0.370	0.302
Genera of Chrysophyta	0.316	0.125
Numbers of Chrysophyta	0.137	0.299
Genera of Phytoplankton	0.444	0.078
Numbers - Phytoplankton	0.103	0.237
Genera of Zooplankton	0.008	0.398
Numbers - Zooplankton	0.348	0.355
Genera of all Organisms	0.047	0.319
Numbers - all Organisms	0.264	0.444

CONCLUSIONS

It is impossible to make conclusive statements as a result of a seven week survey of any ecosystem, much less one as complex as the Hudson River. The conclusions, therefore, are tentative and suggestive, rather than definitive as they must be limited as to time and scope within the confines of the present study period and design.

With the exception of water temperature and turbidity, no significant differences in physical and chemical characteristics of cooling waters were noted. Both water temperature and turbidity were increased as a result of passage through the Danskammer plant.

No significant differences of diversity or viability in the plankton populations were noted with the exception of zooplankton populations. The Danskammer facility may produce changes in populations of phytoplankton as a result of entrainment, but not at significant levels.

During the study period, zooplankton populations were significantly reduced in the discharge samples, but recovered after 24 hours of incubation. Zooplankton diversity is the best immediate indicator of entrainment effects.

Multi-modal distribution in most populations suggest that plankton populations sampled in this study do not fit a normal distribution.

Navicula sp. was encountered in more samples than any other diatom.

Coscinodiscus sp. occurred in the samples in the greatest numbers of any organism found in the study period.

Surirella appeared to be the most temperature-sensitive diatom, showing population reductions as ambient river temperatures increased.

The division Chrysophyta comprises the bulk of the plankton found in waters entering the Danskammer plant.

Coscinodiscus sp. appears to be most tolerant of all diatoms to elevated ambient temperatures. The diatom also does not show effects of entrainment.

Pediastrum sp. and Scenedesmus sp. were the most commonly encountered genera of Chlorophyta in the samples. They show similar responses to changing conditions in the samples taken.

ADDITIONAL STUDIES

Additional studies should be made on entrainment effects in order to secure more data and to refine techniques. There is a need to be able to identify viable plankton more readily. A fluorescent microscope may be a necessity for identifying the viable plankton forms.

Collection techniques need to be refined. The avoidance reactions of larger zooplanktors is well documented. Large zooplanktors were not present in large numbers in the present study, perhaps as a result of a deficiency in the sampling devices.

Incubation devices need to be refined. It was apparent that finer mesh filters may be necessary to restrict the inflow of silt. Perhaps incubation can best be accomplished in laboratory situations.

Continued research in the Danskammer area would be very productive in assessing the possibility of a threshold effect. The present temperatures at discharge could be elevated to threshold levels if incurrent temperatures are increased. The possibility of elevated

incurrent temperatures is very real with the proposed increased construciton of electric generating facilities upriver from the Danskammer facility.

The Hudson River is a valuable resource at the present and we are obliged to preserve its character so that it may serve as a valuable resource for future generations.

APPENDIX I

ORGANISMS COLLECTED IN WATER SAMPLES

Hudson River Roseton Study-Phase II, Summer, 1972

PHYTOPLANKTON (73 genera)

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
CYANOPHYTA (7 genera)				
Anabaena	19	56	18	53
Anacystis	11	32	14	41
Gonphosphaeria	1	3	1	3
Merismodoedia	1	3	1	3
Oscillatoria	27	79	21	62
Polycystis	1	3	0	0
Aphanocapsa	1	3	0	0
CHLOROPHYTA (40 genera)				
Actinastrum	22	65	18	53
Ankistrodesmus	12	35	13	38
Asterococcus	8	23.5	6	18
Bumillaria	1	3	1	3
Chlamydomonas	5	15	3	9
Chlorococcum	6	18	8	23.5
Chroococcus	2	6	2	6
Closterium	16	47	17	50
Cosmarium	0	0	1	3
Crucigenia	1	3	1	3
Chlorosarcina	1	3	0	0
Dimorphococcus	1	3	0	0

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
Chlorophyta (cont'd)				
Dictosphaerium	10	29	9	26
Errerella	7	21	8	23.5
Eudorina	9	26	8	23.5
Gloeocystis	10	0	1	3
Gomphosphaeria	0	0	1	3
Kirchneriella	3	9	2	6
Micractinium	10	29	6	18
Microspora	0	0	1	3
Nephryocytium	2	6	2	6
Oocystis	7	21	7	21
Palmella	1	3	0	0
Palmellococcus	4	12	4	12
Pandorina	8	23.5	6	18
Planktosphaeria	1	3	1	3
Pleodorina	9	26	4	12
Pediastrum	32	94	32	94
Quadrigula	2	6	1	3
Protococcus	22	65	27	79
Scenedesmus	31	91	32	94
Selenastrum	2	6	2	6
Sphaerocystis	8	23.5	2	6
Staurastrum	7	21	4	12
Synura	1	3	0	0
Tetraedron	2	6	0	0
Tetraspora	4	12	0	0

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
Chlorophyta (cont'd)				
Ulothrix	15	44	11	32
Volvox	1	3	2	6
Zygnema	1	3	1	6
Chrysophyta (24 genera)				
Amphipleura	0	0	2	6
Amphora	1	3	0	0
Asterionella	20	59	18	53
Bacillaria	1	3	1	3
Campylodiscus	1	3	0	0
Cocconeis	23	68	25	74
Coscinodiscus	31	91	31	91
Cyclotella	34	100	31	91
Cymbella	8	23.5	7	21
Diatoma	12	35	13	38
Fragillaria	31	91	23	68
Frustulina	0	0	1	3
Gomphonema	7	21	8	23.5
Gyrosigma	33	97	32	94
Melosira	30	88	31	91
Meridion	1	3	0	0
Navicula	34	100	33	97
Nitzchia	24	71	21	62
Pinnularia	1	3	1	3
Stauroneis	3	9	2	6
Stephanodiscus	13	38	16	47

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
Chrysophyta (cont'd)				
Surirella	31	91	33	97
Synedra	3	9	3	9
Tabellaria	16	47	15	44
ZOOPLANKTON (total 61)				
Protozoa (28 genera)				
Acanthocystis	0	0	1	3
Acineta	1	3	1	3
Actinophrys	2	6	0	0
Amoeba	0	0	1	3
Amphimonas	2	6	0	0
Asterameoba	1	3	0	0
Carteria	1	3	3	9
Ceratium	4	12	4	12
Codonella	13	38	10	29
Didinium	1	3	0	0
Difflugia	2	6	3	9
Epalxis	1	3	0	0
Epistylis	4	12	2	6
Euglena	15	44	12	35
Glenodinium	2	6	2	6
Holophyra	1	3	0	0
Lepocynclis	1	3	0	0
Mallomonas	2	6	1	3
Peridinium	2	6	1	3
Phacus	6	18	7	21

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
Protozoa (cont'd)				
Spathidium	2	6	1	3
Stokesia	1	3	0	0
Tetrahymena	0	0	1	3
Trachelomonas	7	21	3	9
Trachelophyllum	1	3	0	0
Uronema	0	0	1	3
Vorticella	1	3	2	6
Xanthidium	1	3	0	0
Aschelminthes (20 genera)				
Brachionus	0	0	1	3
Cephalodella	1	3	2	6
Chaetonotus (Gastrotricha)	1	3	1	3
Chromogaster	1	3	0	3
Collotheca	1	3	0	0
Conochilus	3	9	0	0
Filinia	1	3	1	3
Hexarthra	1	3	0	0
Ichthyridium (Gastrotricha)	5	15	2	6
Kellicottia	1	3	0	0
Keratella	21	62	23	68
Lepadella	1	3	0	0
Monostyla	1	3	0	0
Panagrolaimus (Nematode)	1	3	2	6

Type	Intake No. Occ.	Intake % Occ.	Discharge No. Occ.	Discharge % Occ.
Aschelminthes (cont'd)				
Philodina	0	0	2	6
Polyarthra	8	23.5	7	21
Rhabdolaimus (Nematode)	1	3	0	0
Sinantherina	1	3	0	0
Synchaeta	2	6	2	6
Trichocerca	3	9	1	3
Nemerta (1 genera)				
Prostoma	1	3	0	0
Crustacea (7 genera)				
Bosmina	2	6	1	3
Cyclops	7	21	4	12
Daphnia	1	3	0	0
Diaphanosoma	1	3	1	3
Gammarus	0	0	1	3
Limnocalanus	2	6	0	0
Nauplius larvae (Copepod)	11	32	7	21

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VOLUME II

PLANKTON, BENTHOS AND FISH LARVAE

CHAPTERS III, IV AND V

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TABLE OF CONTENTS

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME II

TABLE OF CONTENTS

Chapter		Page
III.	PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON	
A.	Introduction and Study Objectives..	III-1
B.	Selected Water Quality Data...	3
C.	Phytoplankton..	5
	1. Materials and Methods	5
	(a) Sampling...	5
	(b) Laboratory Analysis..	6
	(c) Statistical Analysis.	6
	(d) Discussion of Sampling and Laboratory Analysis ...	7
	2. Results	8
	(a) Species Inventory	8
	(b) Seasonal Patterns of Abundance.	8
	(c) Comparisons	10
	(i) Between Sampling Dates	10
	(ii) Between Stations	10
	(iii) Between Whole Water and Fractionated Samples..	11
	(iv) Between Roseton/Danskammer Point 1971-1972 and 1973...	11
	(v) Between Weekly and Monthly	12
	3. Discussion.	12
	(a) Seasonal Patterns of Abundance.	12
	(b) Nuisance Algae..	13
	(c) Differences Between Stations...	15
	(d) Differences Between Whole Water and Fractionated Samples	15
	(e) Weekly-Monthly Abundance Comparison.	16
	(f) Differences Between 1971-1972 and 1973...	16
	4. Conclusions	16
D.	Microzooplankton	17
	1. Material and Methods	17
	(a) Sampling...	17
	(b) Laboratory Analysis..	18
	(c) Statistical Analysis.	18
	(d) Discussion of Sampling and Laboratory Analysis ...	19
	2. Results	19
	(a) Species Inventory	19
	(b) Seasonal Patterns of Abundance.	20
	(c) Comparisons	22
	(i) Between Sampling Dates...	22
	(ii) Between Collecting Depths	22
	(iii) Between Stations	23
	(iv) Between 1971-1972 and 1973	23

VOLUME II

TABLE OF CONTENTS
(Continued)

CHAPTER III
(Continued)

Chapter		Page
	3. Discussion	24
	(a) Seasonal Variation in Abundance	24
	(b) Differences Between Collecting Dates	26
	(c) Differences Between Depths	26
	(d) Differences Between Stations...	26
	(e) Differences Between 1971-1972 and 1973... ...	26
	4. Conclusions	27
E.	Macrozooplankton	28
	1. Materials and Methods	28
	(a) Sampling...	28
	(b) Laboratory Analysis..	29
	(c) Statistical Analysis.	30
	(d) Discussion of Field and Laboratory Procedures.	31
	2. Results	31
	(a) Species Inventory	31
	(b) Diel Migration..	31
	(c) Seasonal Variation...	32
	(d) Differences Between Stations...	33
	(e) Intake and Discharge Comparisons	33
	(i) Between One-Meter Nets and One-Half Meter Nets.	33
	(ii) Between Intake and Discharge Abundance...	33
	(f) River and Intake Comparisons...	33
	3. Discussion	34
	(a) Diel Migration..	34
	(b) Seasonal Variations..	35
	(c) Intake and Discharge Abundance and Viability Comparisons	36
	(d) Differences Between Stations...	37
	4. Conclusions	37
	References Cited	39

VOLUME II

TABLE OF CONTENTS
(Continued)

Chapter		Page
	CHAPTER IV	
IV	BENTHOS	
	A. Introduction...	IV-1
	B. Materials and Methods	3
	1. Collection Procedures	3
	(a) Sampling Locations...	3
	(b) Sampling Procedure...	4
	(c) Sampling Frequency...	5
	2. Laboratory Procedures	5
	3. Data Analysis...	7
	C. Results and Discussion...	10
	1. Group Diversity Based on Class Abundance.	13
	2. Abundance and Distribution	16
	3. Comparison of Monthly and Bimonthly Samples...	20
	4. Biomass Distribution Per Class.	21
	5. Fish Support Potential	23
	6. Salinity Influence...	28
	7. Littoral Survey	30
	D. Conclusions	30
	References Cited	36
	CHAPTER V	
V.	FISH LARVAE	
	A. Introduction...	V-1
	B. Materials and Methods	5
	1. Field Procedures	5
	(a) River Sampling..	5
	(b) Plant Sampling..	6
	(i) Danskammer Point	7
	(ii) Roseton	8
	(iii)Field Analysis..	8
	2. Laboratory Procedures	9

VOLUME II

TABLE OF CONTENTS
(Continued)

Chapter — Page

CHAPTER V
(Continued)

C. Results and Discussion... 11
1. River Sampling.. 11
(a) General Larval Distribution 11
(b) Species Occurrence... 14
(i) Striped Bass (Morone saxatilis) 15
(ii) White Perch (Morone americana) 17
(iii) Alosa spp. 20
(c) Vertical Distribution 24
(i) Surface, Mid-Depth and Bottom Larvae Concentrations 25
(ii) Diurnal Migration... 25
2. Plant Sampling 26
(a) Danskammer Point 26
(i) Concentration of Larvae... 26
(ii) Time of Day and Depth Patterns of Larvae in the Intake 29
(iii) Length Frequency of Entrained Fish Larvae 31
(b) Roseton 34
(i) Concentration Of Larvae... 34
(ii) Length Frequency 35
(c) Viability Studies 36
3. Fish Egg Entrainment 39
4. Special Study: Comparison of Catch Between One-Half and One Meter Nets. 40

D. Effect of Roseton Plant Operation on the Hudson River Striped Bass Population.. 44
1. Introduction 44
(a) Clark Model 48
(b) Goodyear Approach 49
(c) QLM Model.. 50
(d) Comparison of Model Results 53
2. Application of LMS Striped Bass Model for Roseton Plant Operation and Multi-Plant Operation.. ... 55
(a) Input Parameters 56
(i) River Parameters 56
(ii) Fish Life Cycle Parameters 57
(iii) Plant Impact Parameters... 57
(iv) Results and Discussion 63

VOLUME II

TABLE OF CONTENTS
(Continued)

	Page
CHAPTER V (Continued)	
E. Conclusions	69
References Cited	74

LIST OF FIGURES

VOLUME II

LIST OF FIGURES

Figure No.		Preceding Page No.
	CHAPTER III	
III-1	Plankton Sampling Stations	III-5
III-2	Phytoplankton Abundance - Net Sample	III-8
III-3	Phytoplankton Composition - Net Sample	III-8
III-4	Phytoplankton Abundance - Filtrate Sample	III-8
III-5	Phytoplankton Composition - Filtrate Sample	III-8
III-6	Weekly Whole Water Phytoplankton Abundance	III-12
III-7	Microzooplankton Abundance: 0-10 ft. Tow	III-19
III-8	Microzooplankton Composition: 0-10 ft. Tows	III-19
III-9	Microzooplankton Abundance: 0-10 ft. Dominant Representatives	III-21
III-10	Microzooplankton Composition: 0-10 ft. Dominant Representatives	III-21
	CHAPTER IV	
IV-1	Benthos Sampling Stations, 1973	IV-3
IV-2	Benthos Total Diversity Based on Abundance by Season and Transect	IV-13
IV-3	Benthos Total Diversity Based on Abundance by Season and Transect	IV-13
IV-4	Benthos Diversity Values Based on Abundance by Season, Transect and Depth	IV-13
IV-5	Benthos Diversity Values Based on Abundance by Season, Transect and Depth	IV-13
IV-6	Benthos Affinity Index - 1971 Fall	IV-15
IV-7	Benthos Affinity Index - 1971 Winter	IV-15

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER IV (Continued)	Preceding Page No.
IV-8	Benthos Affinity Index - 1972 Spring	IV-15
IV-9	Benthos Affinity Index - 1972 Summer	IV-15
IV-10	Benthos Affinity Index - 1972 Fall	IV-15
IV-11	Benthos Affinity Index - 1973 Winter	IV-15
IV-12	Benthos Affinity Index - 1973 Spring	IV-15
IV-13	Benthos Affinity Index - 1973 Summer	IV-15
IV-14	Benthos Affinity Index - 1973 Fall	IV-15
IV-15	Benthos Affinity Index - 1973 Winter	IV-15
IV-16	Benthos Percent Abundance Composition of North Control Transect Benthos By Depth	IV-17
IV-17	Benthos Percent Abundance Composition of Maximum ΔT Transect Benthos By Depth	IV-17
IV-18	Benthos Percent Abundance Composition of 75 Maximum ΔT Transect Benthos By Depth	IV-17
IV-19	Benthos Percent Abundance Composition of South Control Transect Benthos By Depth	IV-17
IV-20	Benthos: Total Abundance By Season and Transect 1971-1973	IV-17
IV-21	Benthos: Total Abundance By Season and Transect 1971-1973	IV-17
IV-22	Benthos: Total Abundance By Season, Transect and Depth, 1971-1973	IV-17
IV-23	Benthos: Total Abundance By Season, Transect and Depth, 1971-1973	IV-17
IV-24	Monthly and Seasonal Trends in Benthos Abundance at the 30-foot Depth at the South Control Transect	IV-20
IV-25	Monthly and Seasonal Trends in Benthos Abundance at the 30-Foot Depth of Max ΔT Transect	IV-20

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER IV (Continued)	Preceding Page No.
IV-26	Benthos: Total Biomass by Season, Transect and Depth, 1971-1973	IV-21
IV-27	Benthos: Total Biomass by Season, Transect and Depth, 1971-1973	IV-21
IV-28	Benthos: Number of Classes Present According to Season Depth and Transect, 1971-1973	IV-21
IV-29	Roseton/Danskammer Point Littoral Survey Areas	IV-30
	CHAPTER V	
V-1	Fish Larvae Sampling Stations	V-5
V-2	Hudson River Fish Larvae Abundance: 1972-1973 Species: All Larvae	V-11
V-3	Hudson River Fish Larvae Abundance: 1972-1973 Species: Striped Bass Larvae	V-15
V-4	Striped Bass Larval Length Distribution	V-16
V-5	Hudson River Fish Larvae Abundance: 1972-1973 Species: White Perch Larvae	V-18
V-6	White Perch Larval Length Distribution	V-20
V-7	Hudson River Fish Larvae Abundance: 1972-1973 Species: Alosa Larvae	V-21
V-8	Alosa Larval Length Distribution	V-22
V-9	Average Larval Abundance: 1973 Danskammer Point Intake and Discharge	V-26
V-10	Larval Abundance: Day/Night - 1973 Danskammer Point Intake	V-29
V-11	Larvae Length Distribution: Striped Bass - 1973 Hudson River, Danskammer Point Intake and Discharge	V-31

LIST OF FIGURES
(Continued)

Figure No.		Preceding Page No.
	CHAPTER V (Continued)	
V-12	Larval Length Distribution: White Perch 1973, Hudson River, Danskammer Point Intake and Discharge	V-31
V-13	Larval Length Distribution: Alosa spp. - 1973 Hudson River, Danskammer Point Intake and Discharge	V-31
V-14	Average Larval Abundance: 1973 Roseton Intake and Discharge	V-34
V-15	Larval Length Distribution: Striped Bass, White Perch and Alosa spp. - 1973 Roseton Intake and Discharge	V-35
V-16	Hudson River Striped Bass Transport Model Parameters	V-56

LIST OF TABLES

VOLUME II

LIST OF TABLES

Table No.		Preceding Page No.
	CHAPTER III	
III-1	Phytoplankton Collecting Dates: 1973	III-5
III-2	Phytoplankton Species Inventory: 1973	III-8
III-3	Phytoplankton: One-Way Analysis of Variance Between Dates, Total Algal Abundance	III-10
III-4	Phytoplankton: One-Way Analysis of Variance Between Stations	III-10
III-5	Phytoplankton: Student-Newman-Keuls Ranking Test of Station on Dates of Significant Differences Between Stations	III-10
III-6	Tests for Significant Differences in Phytoplankton Abundance Whole Water Samples and Net Plus Filtrate Samples	III-11
III-7	Pollution-Tolerant Algae Identified in Roseton/Danskammer Point Vicinity 1973	III-14
III-7a	Pollution-Tolerant Algae Identified at the Roseton Intake, 1973, Roseton/Danskammer Point Vicinity	III-14
III-8	Microzooplankton Collection Dates, 1973	III-18
III-9	Microzooplankton Species Inventory - 1973	III-20
III-10	Microzooplankton: Three-Way Analysis of Variance	III-22
III-10a	Microzooplankton: One-Way Analysis of Variance Between Dates, Roseton/Danskammer Point Vicinity	III-22
III-11	Student-Newman-Keuls Ranking Test for Microzooplankton	III-22
III-11a	Microzooplankton: One-Way Analysis of Variance Between Depths, 1973, Roseton/Danskammer Point Vicinity	III-23

LIST OF TABLES
(Continued)

Table No.		Preceding Page No.
	CHAPTER III (Continued)	
III-12	Macrozooplankton Sampling Locations: 1973	III-28
III-13	Inventory of Major Macrozooplankton: 1973	III-31
III-14	Vertical Distribution of Amphipods, RDECH on June 7 and 8, 1973	III-32
III-15	Comparison of Day and Night Macrozooplankton Surface Samples in the Roseton/Danskammer Point Vicinity, 1973	III-32
III-15a	Macrozooplankton Abundance, May 22-23, 1973 Roseton/Danskammer Point Vicinity	III-32
III-15b	Macrozooplankton Abundance, July 31-August 1, 1973, Roseton/Danskammer Point Vicinity	III-32
III-15c	Macrozooplankton Abundance By Sampling Date at RDE, 1973, Roseton/Danskammer Point Vicinity	III-32
III-16	Macrozooplankton: Two-Way Analysis of Variance Between Stations and Dates	III-33
III-17	Macrozooplankton: One-Meter and One-Half Meter Net Comparison for Danskammer Point Intake	III-33
III-18	Macrozooplankton Comparison of Abundance in Danskammer Point Intake and Discharge	III-33
III-19	Macrozooplankton: One-Way Analysis of Variance Between Stations	III-34

LIST OF TABLES
(Continued)

CHAPTER IV

Table No.		Preceding Page No.
IV-1	Roseton Benthos 1973 Species List	IV-10
IV-2	Benthos Diversity Values Based on Class Abundance by Season, Transect and Depth, 1971-1973	IV-13
IV-3	Sample Locations where Community Abundance Structure is Dominated by One Class Based On Numerical Abundance	IV-15
IV-4	Three-Way Analysis of Variance of Seasonal, Total Benthos Abundance from Fall 1971 through Winter 1973.	IV-18
IV-5	Student-Newman-Keuls Procedure for Determining The Source of Significant Main Effects	IV-18
IV-6	Three-Way Analysis of Variance of Seasonal, Oligochaete Abundance from Fall 1971 through Winter 1973	IV-18
IV-7	Student-Newman-Keuls Procedure for Determining the Source of Significant Main Effects	IV-18
IV-8	A. Three-Way Analysis of Variance of Seasonal Dipteran Abundance from Fall 1971 through Winter 1973 B. Student-Newman-Keuls Procedure for Determining the Source of Significant Main Effects	IV-19
IV-9	Three-Way Analysis of Variance of Seasonal Mollusca Abundance from Fall 1971 through Winter 1973	IV-19
IV-10	Mollusca Abundance Student-Newman-Keuls Procedure for Determining the Source of Significant Main Effects	IV-19
IV-11	Calculated Fish Support Potential of Oligochaetes Per m^2	IV-26
IV-12	Calculated Fish Support Potential of Insects Per m^2	IV-26
IV-13	Calculated Fish Support Potential of Crustaceans Per m^2	IV-26
IV-14	Roseton/Danskammer Point Littoral Survey Species Inventory	IV-31

LIST OF TABLES
(Continued)

Table No.	CHAPTER V	Preceding Page No.
V-1	Average Concentration of Total Larvae	V-11
V-2	Total Larvae Depth Distribution by Month	V-14
V-3	Average Concentration of Striped Bass Larvae 1973	V-15
V-4	Striped Bass Depth Distribution by Transect and Month, 1973	V-17
V-5	Average Concentration of White Perch Larvae 1973	V-18
V-6	White Perch Depth Distribution by Transect and Month 1973	V-19
V-7	Average Concentration of Alosa spp. Larvae 1973	V-21
V-8	Alosa spp. Depth Distribution by Date and Transect, 1973	V-23
V-9	Statistical Test Results: Catch Variation with Depth, 1973	V-25
V-10	Statistical Test Results: Catch Variation with Day/Night	V-26
V-11	Average Larval Concentration for Total Larvae and for Dominant Species at Danskammer Point Intake and Discharge, 1973, Roseton/Danskammer Point Vicinity	V-26
V-12	Average Larval Concentration by Time Periods for Each Sampling Date, Danskammer Point Intake Channel, 1973	V-30
V-13	Average Larval Concentration by Day and Night at Danskammer Point Intake Channel, 1973	V-31
V-14	Total Larval Comparisons for Day and Night Danksammer Point Intake, 1973	V-31
V-15	Average Concentration of Dominant Fish Larvae Species and Total Larvae at Roseton Intake and Discharge, 1973	V-34

LIST OF TABLES
(Continued)

Table No.		Preceding Page No.
	CHAPTER V (Continued)	
V-16	Danskammer Point Viability Collection, 1973 Roseton/Danskammer Point Vicinity	V-37
V-17	Roseton Viability Collection, 1973 Roseton/Danskammer Point Vicinity	V-37
V-18	Total Larval Abundance Net Comparisons, 1973 Roseton/Danskammer Point Vicinity	V-43
V-19	Simultaneous Net Collection Comparisons Total Larvae and Dominant Species, Roseton/Danskammer Point Vicinity	V-43
V-20	Potential Effect of Operation of Indian Point Units 1 and 2 on Hudson River Striped Bass Population - Lawler's Position	V-53
V-21	Percentage Reduction in Striped Bass Population Resulting from Two-Unit Operation at Indian Point - Based on Lawler's Model	V-53
V-22	Percentage Reduction in Striped Bass Population Resulting from Two-Unit Operation at Indian Point - Based on Goodyear's Model	V-53
V-23	Percentage Reduction in Striped Bass Population Resulting from Two-Unit Operation At Indian Point - Based on Clark's Calculation	V-53
V-24	Segmentation of the Hudson River Used in the Striped Bass Transport	V-56
V-25	Plant Circulating Water Flow Rates (Full Flow)	V-57
V-26	Roseton 1973 Striped Bass Larval Stage Composite "f" Factor	V-60
V-27	Roseton 1973 Striped Bass Juvenile I Stage Composite "f" Factor	V-60
V-29	Effect of Roseton, Cornwall, Indian Point and Bowline Plant Operation on Hudson River Striped Bass Population	V-64

CHAPTER III

III. PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

A. INTRODUCTION AND STUDY OBJECTIVES

The results of phytoplankton, microzooplankton and macrozooplankton abundance studies conducted during 1973 in the Roseton/Danskammer Point vicinity of the Hudson River and the Roseton/Danskammer power plants are presented in this Chapter. In addition, an in-depth discussion of the role planktonic organisms play in the aquatic ecology of a waterbody is presented.

The interrelationships of phytoplankton and zooplankton populations are varied and complex. It is possible to identify some general principles about these relationships by cursory examination of two broad topics: grazing and seasonality.

Many zooplankters are either obligate herbivores or obligate carnivores, eating only plants or animal material, respectively; others are omnivores, combining both modes of nutrition. Some herbivores become rapitorial feeders on animal material when phytoplanktonic rations fall below a certain level (Adams and Steel, 1966). The effect of grazing (ingestion of phytoplankton cells) on phytoplankton populations is probably a function of the standing stock, age groups, species present and species structure of the feeding zooplankton populations and the standing stock, rate of production, and size range of the available phytoplankton population.

Most zooplanktonic herbivores ingest algae of very specific size ranges. Several investigators have shown that although many copepods filter-feed on a non-selective basis, the size of the algal cells ingested depends on the filtering apparatus of the organism under consideration (Gauld, 1958; Jørgensen, 1966). In general, the size of the zooplankter parallels the size of the cell it can ingest most efficiently; microzooplankters feed on nanoplankton and macrozooplankters feed on the larger net plankton.

Detritus particles may form a large part of the food supply of filter feeding zooplankters although preliminary experiments also indicate that some copepods do not feed heavily on detritus particles (Strickland, 1970). It has been shown (Raymont, 1963) that detritus may form an important component of the diet of estuarine copepods. It has also been shown that the filtering rate of a freshwater cladoceran was inhibited by high concentrations of suspended particulates (Burnes and Rigler, 1967; Crowley, 1973); this phenomenon may be of importance in the feeding of Hudson River populations.

The seasonality of zooplankton and phytoplankton in temperate waters is well-known (Sverdrup, 1953; Holland, 1969; Harris, 1973). Under the influence of increasing temperature and light intensity, phytoplankters grow and divide rapidly in the spring, sometimes reaching bloom concentrations within two weeks. The increase in zooplankton populations lags behind but is closely correlated with the rise in phytoplankton numbers (Menzel and Ryther, 1961). After low level production in the summer, a burst of growth occurs in the fall, followed by overwintering conditions (Riley, 1967).

Any organism in an aquatic environment is affected at all times by physical, chemical and biological parameters. Since each species has a different set of nutritional requirements and a different range of tolerances, it follows that as environmental parameters change, population numbers and structure will also change. Due to the interconnections of the food web, a change in a single parameter could be followed by changes throughout the ecosystem.

The in-plant studies were initiated in 1973 to begin investigations of the following subject areas:

(a) Comparison of species abundance and occurrence between intake, discharge and river samples;

(b) estimation of effects (both short and long-term) resulting from discharge of heated condenser cooling water and condenser cooling water chlorination practices, and

(c) development of procedures to be used in evaluating long-term, e.g., 10 years, effects resulting from simultaneous operation of the Roseton and Danskammer Point plants.

B. SELECTED WATER QUALITY DATA

Water quality data collected at the intake (surface sample) of the Danskammer Point plant and a station (surface sample) approximately 1-1/2 miles north of Danskammer Point (designated as Roseton North Control) were selected for

comparison with the results of the plankton studies (See Chapter VII).

Surface temperature was consistent within 2°F for both areas, increasing from 56°F in late May to a high of 81°F in late August. In early October the temperature was approximately 72°F and declined to approximately 48°F by late November.

Salinity at the Danskammer Point intake was usually higher than the salinity at the river stations, rising from approximately 0.16 ppt in May to a high of 0.29 ppt in late October, after which salinity decreased to 0.19 ppt in late November. At the control area the range was 0.10 to 0.39 ppt, with a decrease to 0.13 ppt in late November.

Total phosphorus values ranged from 0.02 mg/l at the North Control area on May 29 to 0.11 mg/l on August 22, then fell to levels of 0.06-0.07 mg/l during October and November. Data from the Danskammer Point intake show a similar trend.

The concentration of nitrate-nitrogen for Danskammer Point intake showed peaks of 0.76 and 0.73 mg/l on June 19 and November 27, respectively; nitrate-nitrogen varied from 0.27 to 0.47 mg/l in other months. The nitrate-nitrogen data for the North Control area showed similar concentrations.

Ammonia-nitrogen at the intake and control were measured at 0.25 and 0.07 mg/l and 0.22 and 0.15 mg/l, respectively, on May 29 and June 19. Thereafter no ammonia-nitrogen was detected at either site for the duration of the sampling period, with the exception of a 0.06 mg/l concentration at the intake on August 22.

C. PHYTOPLANKTON

1. Materials and Methods

(a) Sampling. Phytoplankton samples were collected by pouring 18.9 liters of surface water through an 18μ mesh Wisconsin-type plankton net. In order to obtain nanoplankton, approximately 900 milliliters of the water passing through the net was taken as a "filtrate" sample (approximately 300 ml. of the filtrate sample was collected at the beginning, 300 ml. in the middle and 300 ml. at the end of the pouring process). These aliquots were combined to make up the nanoplankton sample. The net was washed from the outside, and the cod-end bucket was rinsed into a collection bottle labelled "net" samples. Two 900 milliliter "whole water" samples were also taken from the surface waters with a Van Dorn water bottle. All the phytoplankton samples were preserved with 2-4% formalin solution.

The sampling sites, Roseton North Control East = RNCE, Roseton North Control West = RNCW, Roseton South Control East = RSCE, Roseton South Control West = RSCW, Roseton Intake = RI, and Roseton/Danskammer East = RDE, are shown in Figure III-1. The samples collected on each sampling date are shown in Table III-1.

In addition, whole water phytoplankton samples were collected weekly from the Danskammer Point intake channel in the manner described for monthly samples (above). These samples were used to obtain baseline data for comparison with monthly samples.

FIGURE III-1

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
ROSETON/DANSKAMMER POINT GENERATING STATIONS

PLANKTON SAMPLING STATIONS

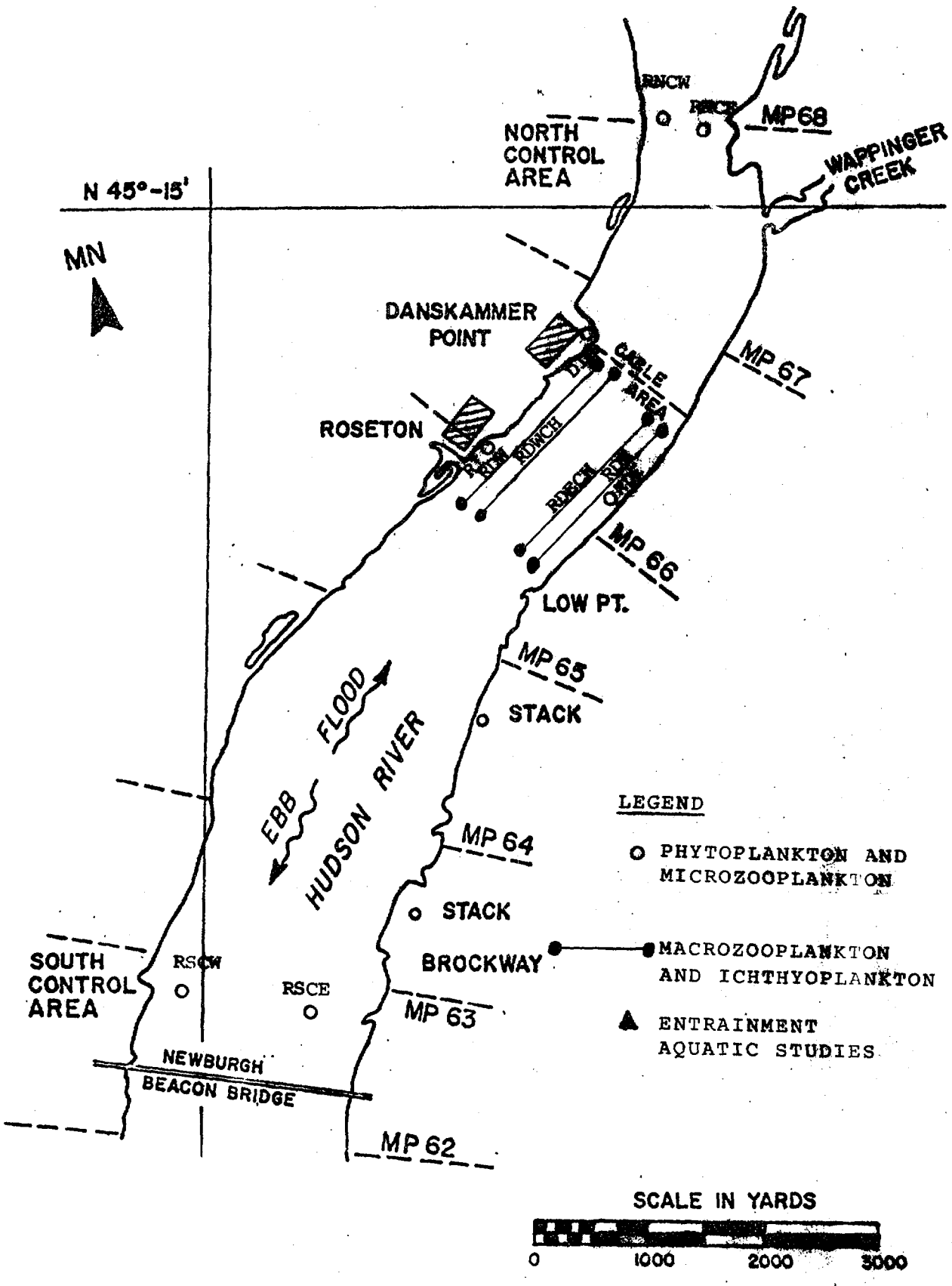


TABLE III-1

PHYTOPLANKTON COLLECTING DATES - 1973
ROSETON/DANSKAMMER POINT VICINITY

Date	STATION						
	RNCW	RNCE	RSCW	RSCE	RDE	RI	DI
A. Net Phytoplankton							
May 31	x	x	x	x		x	x
June 26	x	x	x	x			
July 24	x	x	x	x	x	x	
August 21	x	x	x	x		x	
September 18	x	x	x	x	x	x	
October 16	x	x	x	x	x	x	x
November 12	x	x	x	x	x	x	x
December 12	x	x	x	x	x	x	x
B. Filtrate Phytoplankton							
May 31	x	x		x		x	x
June 26	x	x	x	x			
July 24	x	x	x	x	x	x	
August 21	x	x	x	x		x	
September 18	x	x	x	x	x	x	
October 16	x	x	x	x	x	x	x
November 12	x	x	x	x	x	x	x
December 12	x	x	x	x	x	x	x
C. Whole Water Phytoplankton							
May 31							
June 26	x	x		x			
July 24	x	x	x	x	x	x	
August 21	x	x	x	x		x	
September 18	x	x	x	x	x	x	x
October 16	x	x	x	x	x	x	x
November 12	x	x	x	x	x	x	x
December 12	x	x	x	x	x	x	x

Note: Sampling stations locations are shown in Figure III-1.

The purpose of collecting whole water, net and filtrate samples was to provide comparative data prior to the projected change to collecting only whole water samples during 1974. Only net phytoplankton samples were collected in the Roseton/Danskammer Point area during the 1971-1972 programs.

(b) Laboratory Analysis. The methods and procedures used in 1973 were approximately the same as those used in 1971 and 1972 (Quirk, Lawler & Matusky Engineers, 1973). Three aliquots representing known percentages of a homogeneously mixed concentrated sample were counted at 200 x in a Palmer cell. Duplicate samples of each aliquot were counted. The counts of the aliquots were averaged and the number of algal cells (of each taxon) per milliliter was utilized to calculate the number of cells per liter (see American Public Health Association, 1971).

(c) Statistical Analysis. Analysis of variance (ANOVA) was used to ascertain significant differences in mean numbers of organisms with respect to a given variable. Analyses were conducted as follows (Sokal and Rohlf, 1969):

1. For net, filtrate and whole water samples, tests for significant differences for each date between stations were conducted.
2. For net, filtrate and whole water samples, tests for significant differences for each station between dates were conducted.
3. To locate the significant variable within a source of variance, Student-Newman-Keuls ranking tests were applied where significant differences between stations were found.

A paired-t test or a Wilcoxon test for large samples was used to determine whether or not there were significant differences in abundance between whole water river samples and net plus filtrate river samples.

(d) Discussion of Sampling and Laboratory Analysis. The collection and analysis of net, filtrate and whole water phytoplankton samples provided a quantitative estimate of the surface phytoplankton population at a given station. The high concentrations of particulate matter in the Hudson River might have caused clogging of the small phytoplankton mesh size, and therefore, some estimates of abundance from net samples may be lower than natural populations. Although absolute numbers of phytoplankton might have been underestimated during periods of high production, the seasonal trends of the phytoplankton populations were established.

Many phytoplankters exist as individual cells; others, such as Asterionella or Oscillatoria, tend to form filaments, colonies or clumps; phytoplankton samples in 1973 were enumerated as both clumps and cells. Since cells comprise the basic unit of algal structure, cell counts provide a more absolute measure of standing crop than the enumeration of clumps; the emphasis in the results and discussion sections, therefore, has been placed on estimates expressed as cells/liter.

The results are presented as 'net' and 'filtrate' samples because these samples express size ranges within the populations of primary producers. The results of whole water analyses are presented in comparative form, i.e. major similarities and dissimilarities with net and filtrate samples are noted.

2. Results

(a) Species Inventory. A species inventory is presented in Table III-2. Abundance data for each sampling site on each sampling date are presented in Appendix III-A; the data are presented as net, filtrate, and whole water samples expressed as algal cells/liter.

(b) Seasonal Patterns of Abundance. The abundance of diatoms, green algae, and blue-green algae collected in net samples at each of the four sampling sites was graphed for the entire sampling period and is presented in Figure III-2. The percent composition of these groups and all other net phytoplankters is presented in Figure III-3. Similar graphs were generated for those algae which passed through the net (filtrate samples); these two graphs of abundance and percent composition are presented in Figures III-4 and III-5, respectively.

Diatoms exhibited a typical bimodal seasonal distribution with intermediate fluctuations during the summer months at the four sampling sites. The late spring peak, composed of Melosira sp., Cyclotella sp., Asterionella sp., and Navicula sp., contained less than 10^6 cells/liter for filtrate samples and less than 10^5 cells/liter for net samples.

The early winter peak was higher than the early spring peak of abundance for both collection techniques, with net diatom abundance reaching 2.9×10^5 cells/liter and filtrate diatom abundance reaching 1.2×10^6 cells/liter. The month of highest diatom count was December and the station with the highest value was RSCW. The seasonal pattern of diatom abundance in whole water samples approx-

TABLE III-2

PHYTOPLANKTON SPECIES INVENTORY: 1973
ROSETON/DANSKAMMER POINT VICINITY

A. DIATOMS

Achnanthes sp.
Amphiprora sp.
Amphora sp.
Asterionella formosa
Attheya zachariasi
Ceratoneis sp.
Chaetoceros sp.
Chaetoceros sp.A.
Cocconeis sp.
Coscinodiscus sp.
Cyclotella sp.
Cymbella sp.
Diatoma sp.
Diploneis sp.
Eunotia sp.
Fragilaria sp.
Fragilaria crotonensis
Gomphonema sp.
Gyrosigma sp.
Hantzschia sp.
Melosira sp.
M. granulata
Meridion circulare
Navicula sp.
Navicula sp.A.
Nitzschia sp.
N. sigma
Pinnularia sp.
Rhoicosphenia curvata
Stephanodiscus sp.
Surirella sp.
S. patella
Synedra sp.
S. ulna
Tabellaria sp.
T. flocculosa
T. fenestrata
UID centric
UID pennate
UID spined-centric

B. EUGLENOIDS

Euglena sp.
Phacus sp.
Trachelomonas sp.
UID euglenoids

C. GREEN ALGA

Actinastrum sp.
A. gracillimum
A. hantzschii
Ankistrodesmus sp.
Asterococcus sp.
Chlamydomonas sp.
Chlorella sp.
Chlorococcum sp.
Chodatella sp.
C. longiseta
C. microporum
C. subsalsa
C. quadrata
Closteriopsis sp.
Closterium sp.
Coelastrum sp.
Cosmarium sp.
Crucigenia sp.
Dictyosphaerium sp.
Echinosphaerella sp.
Elakatothrix sp.
Euastrum sp.
Eudorina sp.
E. elegans
Franceia sp.
Golenkinia radiata
Kirchneriella sp.
Micractinium pusillum
Micrasterias sp.
Mougeotia sp.
Oocystis sp.
Pandorina sp.
P. charkowiensis
Pediastrum biradiatum
P. duplex
P. glanduliferum

TABLE III-2 (continued)

C. GREEN ALGA CONT.

P. simplex
P. tetras
Platydorina caudata
Polyedriopsis sp.
Protococcus sp.
Scenedesmus sp.
S. abundans
S. acuminatus
S. arcuatus
S. bijuga
S. dimorphus
S. denticulatus
S. obliquus
S. quadricauda
Schroedria sp.
Schroederia setigera
Selenastrum sp.
Sphaerocystis sp.
Spirogyra sp.
Staurastrum sp.
Staurastrum aspinosa
Stigeoclonium sp.
Tetradesmus sp.
Tetraedron sp.
Tetraedron trigonum
Tetrastrum sp.
Ulothrix sp.
UID colonial
UID desmid
UID flagellate
UID filamentous
UID four-spined
UID Gonium-like
UID unicellular
Volvox sp.

D. YELLOW-BROWN ALGAE (DINOFLAGELLATES)

Dinobryon sp.
Glenodinium sp.
Peridinium sp.
Synura sp.
UID dinoflagellate

E. BLUE-GREEN ALGA

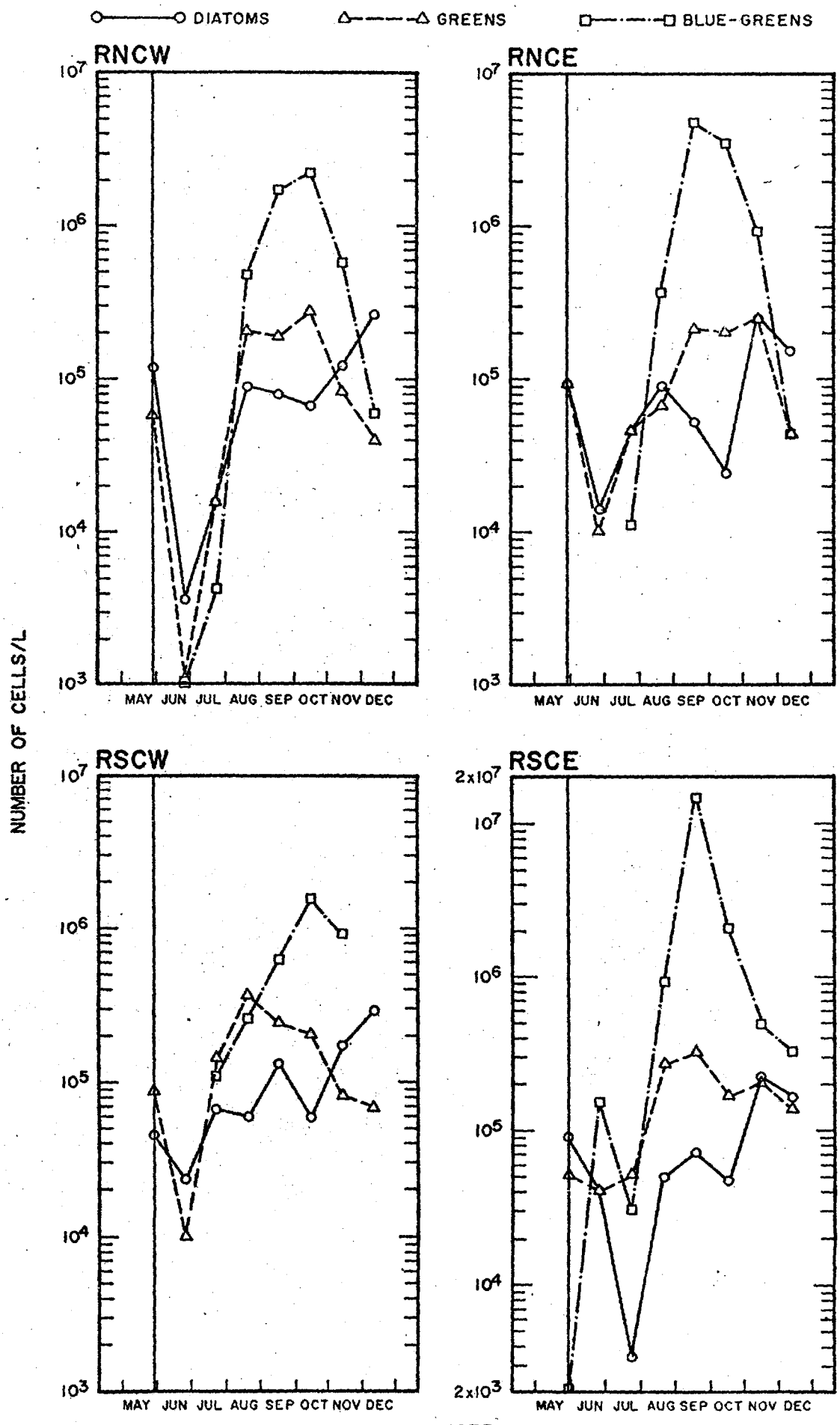
Anabaena sp.
A. flos-aquae
A. spiroides
Aphanizomenon sp.
Aphanocapsa sp.
Aphanothece sp.
Chroococcus sp.
Cylindrospermum sp.
Dactylococcopsis sp.
Gleocapsa sp.
Gleothece sp.
Gomphosphaeria sp.
Lyngbya sp.
Merismopedia sp.
M. glauca
M. major
Microcystis sp.
M. aeruginosa
Nostoc sp.
Oscillatoria sp.
Phormidium sp.
Spirulina sp.
Synechococcus sp.
UID Aphanothece-like
UID branched filamentous
UID colonial
UID filamentous
UID Gleocapsa-like
UID long cell
UID sheathed cell
UID two-celled colonial
UID unicellular

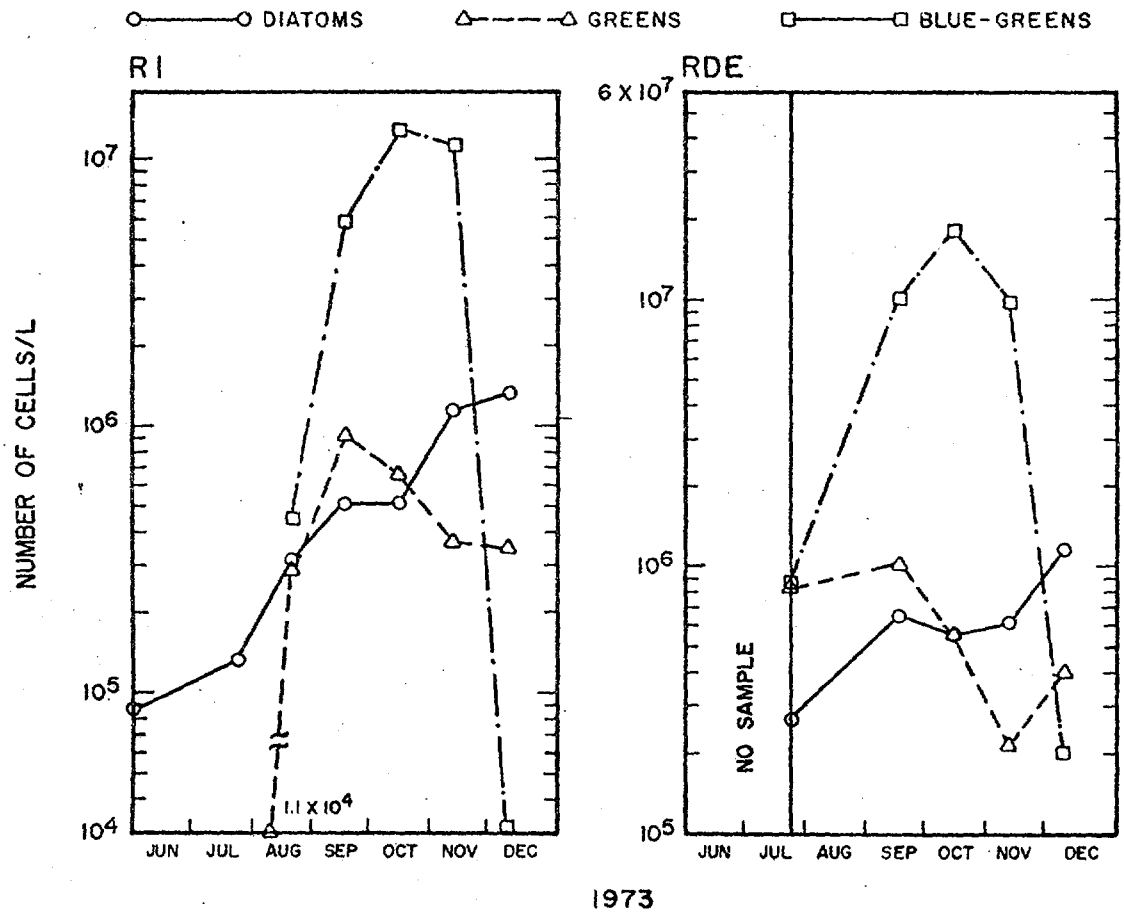
F. OTHER ALGA

UID flagellate

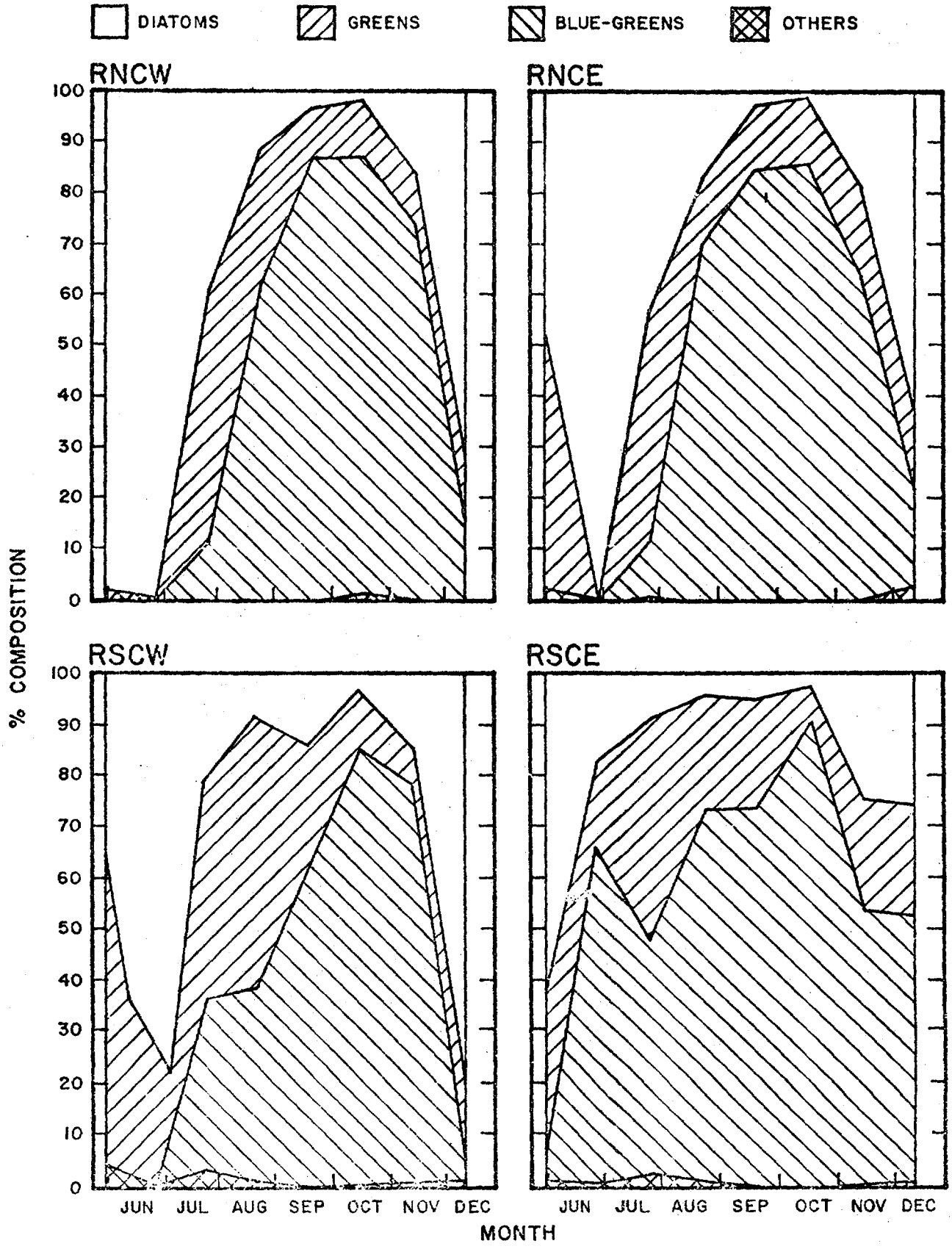
Phytoplankton Abundance - Net Sample
Roseton/Danskammer Point Vicinity, 1973

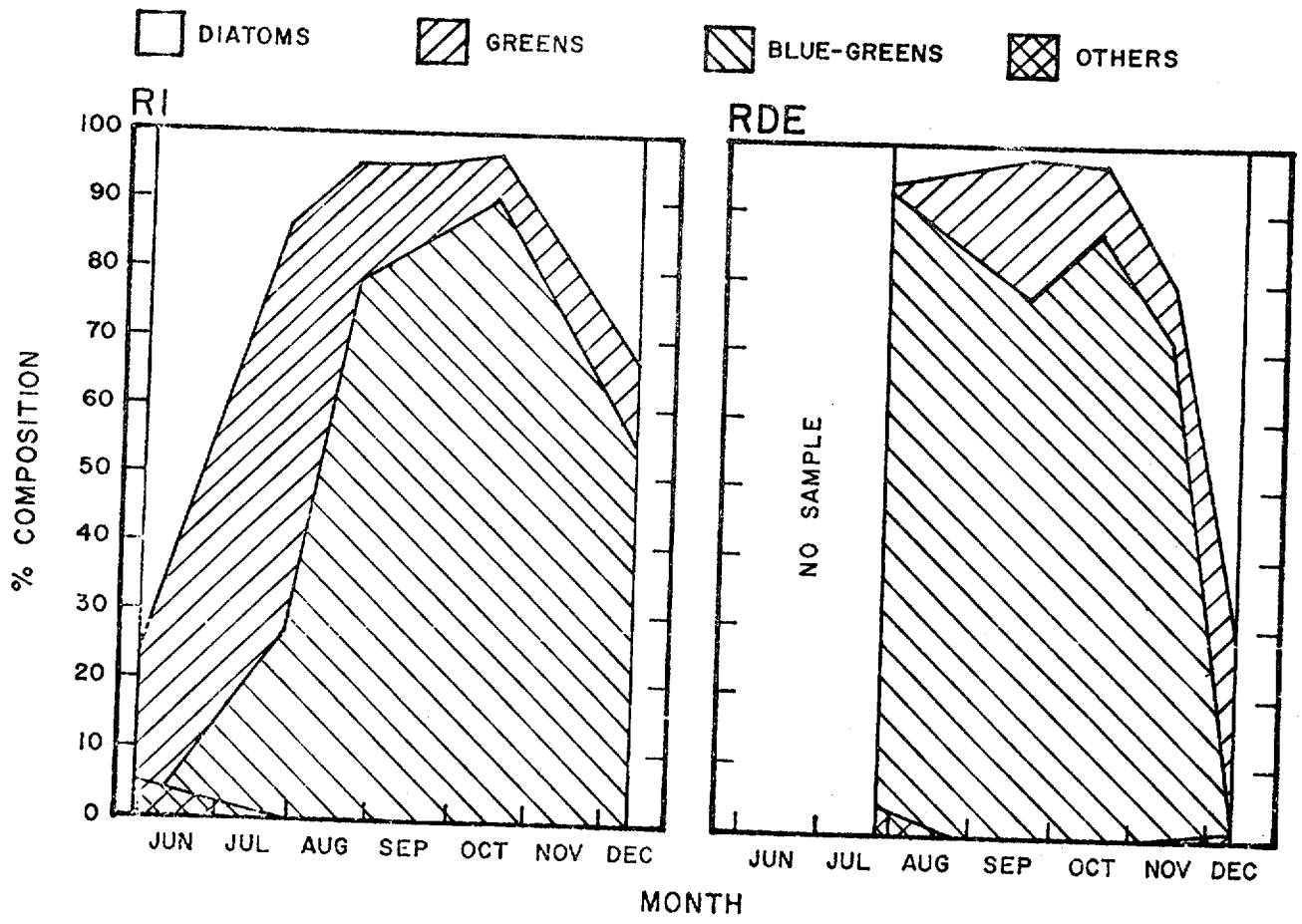
FIGURE III-2
net cells/l
Sheet 1 of 2




DIATOMS
GREENS
BLUE-GREENS
R1
RDE
NUMBER OF CELLS/L
10^7
10^6
10^5
10^4
6×10^7
1.1×10^4
NO SAMPLE
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1973

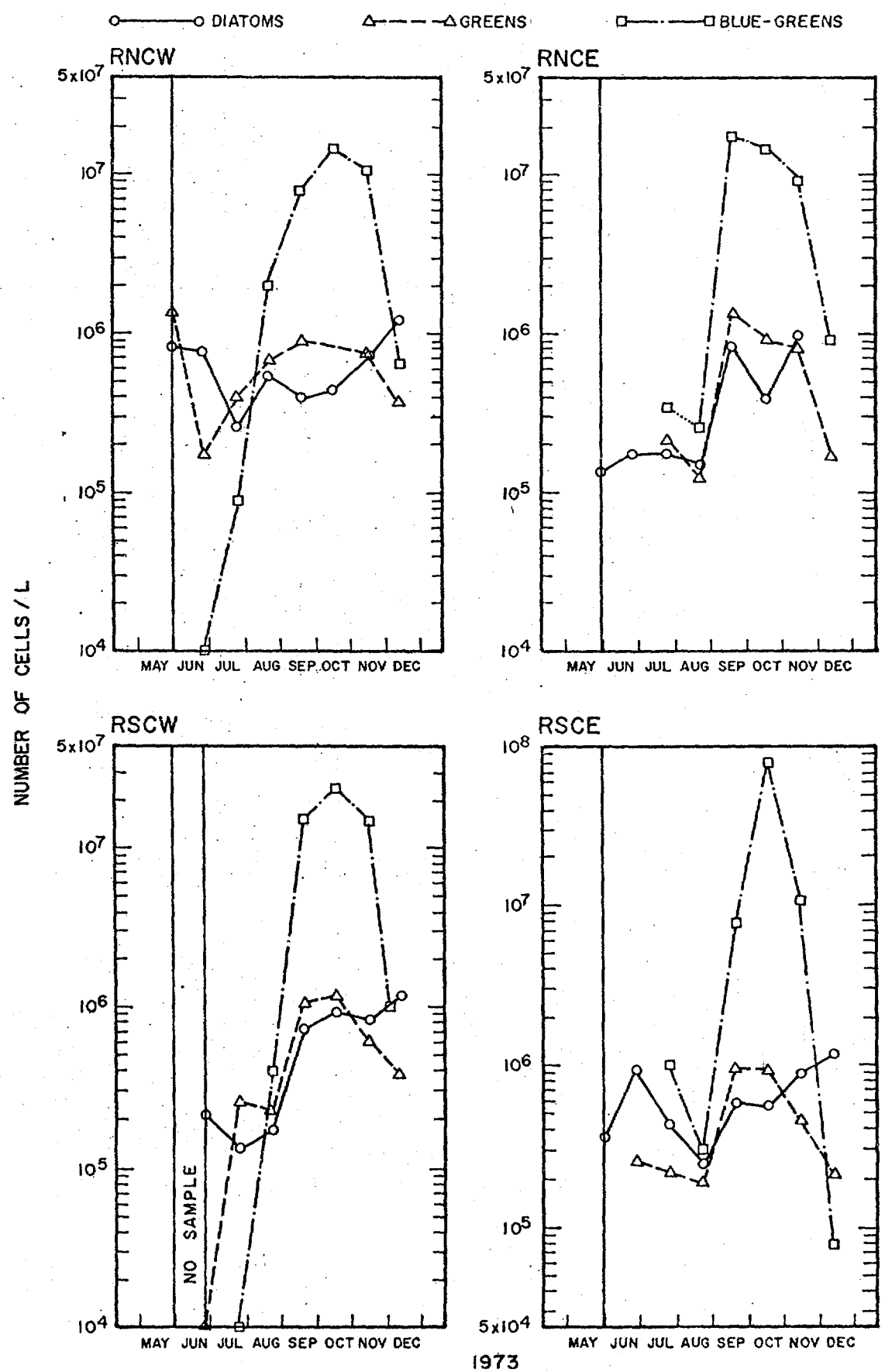
Phytoplankton Composition - Net Sample
Roseton/Danskammer Point Vicinity
Based on Net Sample




DIATOMS
GREENS
BLUE-GREENS
OTHERS
RI
RDE
% COMPOSITION
100
90
80
70
60
50
40
30
20
10
0
NO SAMPLE
JUN JUL AUG SEP OCT NOV DEC
JUN JUL AUG SEP OCT NOV DEC
MONTH

Phytoplankton Abundance - Filtrate Sample
Roseton/Danskammer Point Vicinity

FIGURE III-4
Sheet 1 of 2



1973

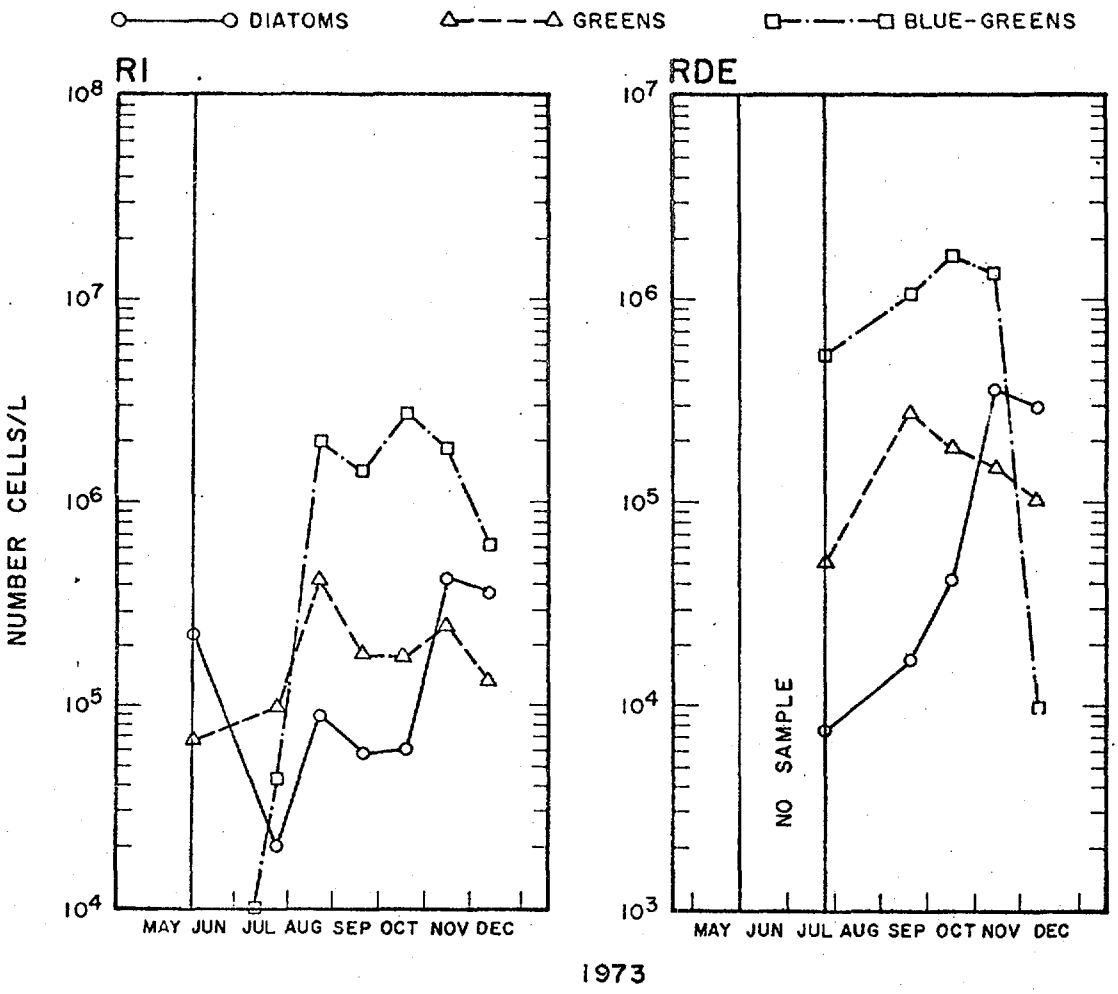
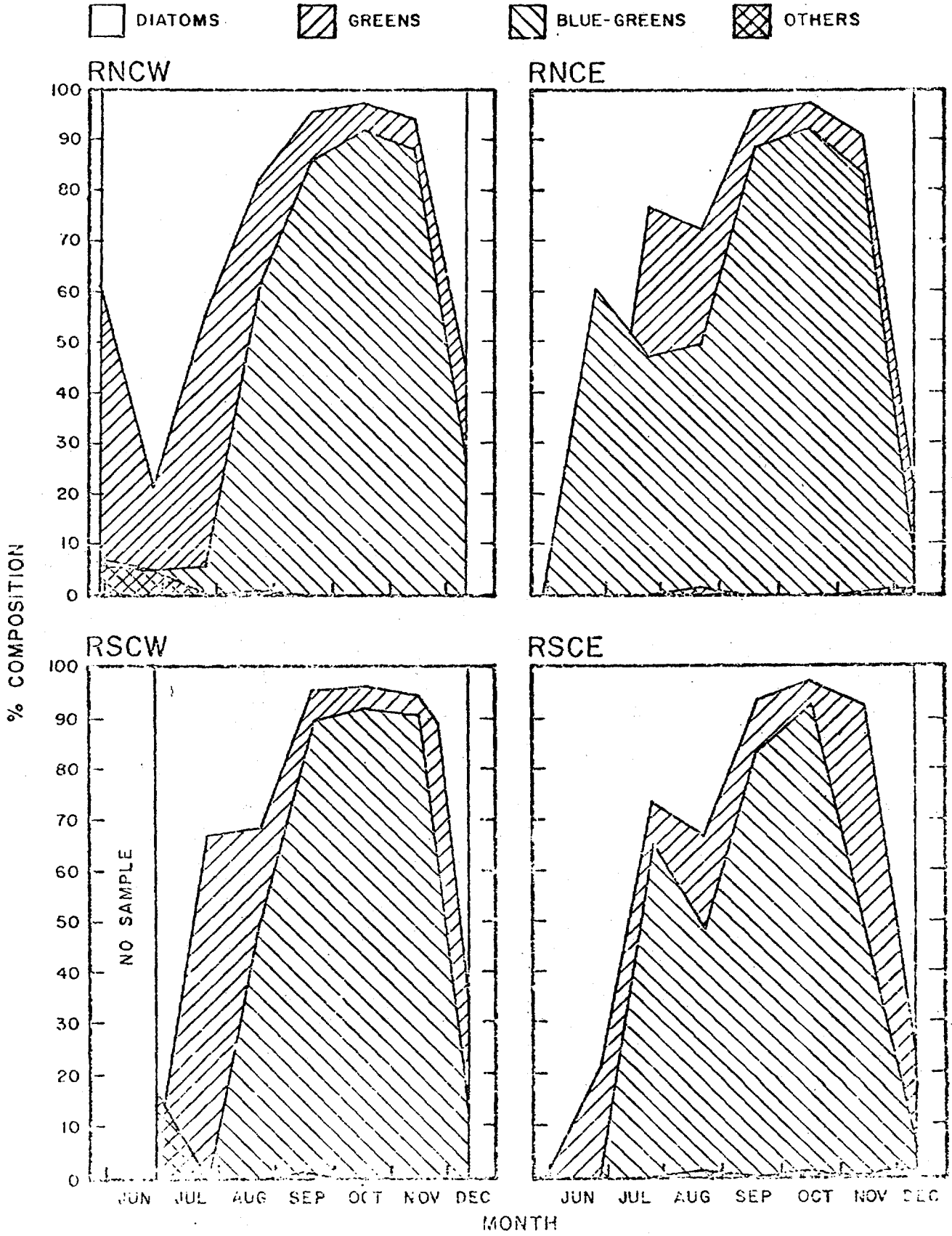
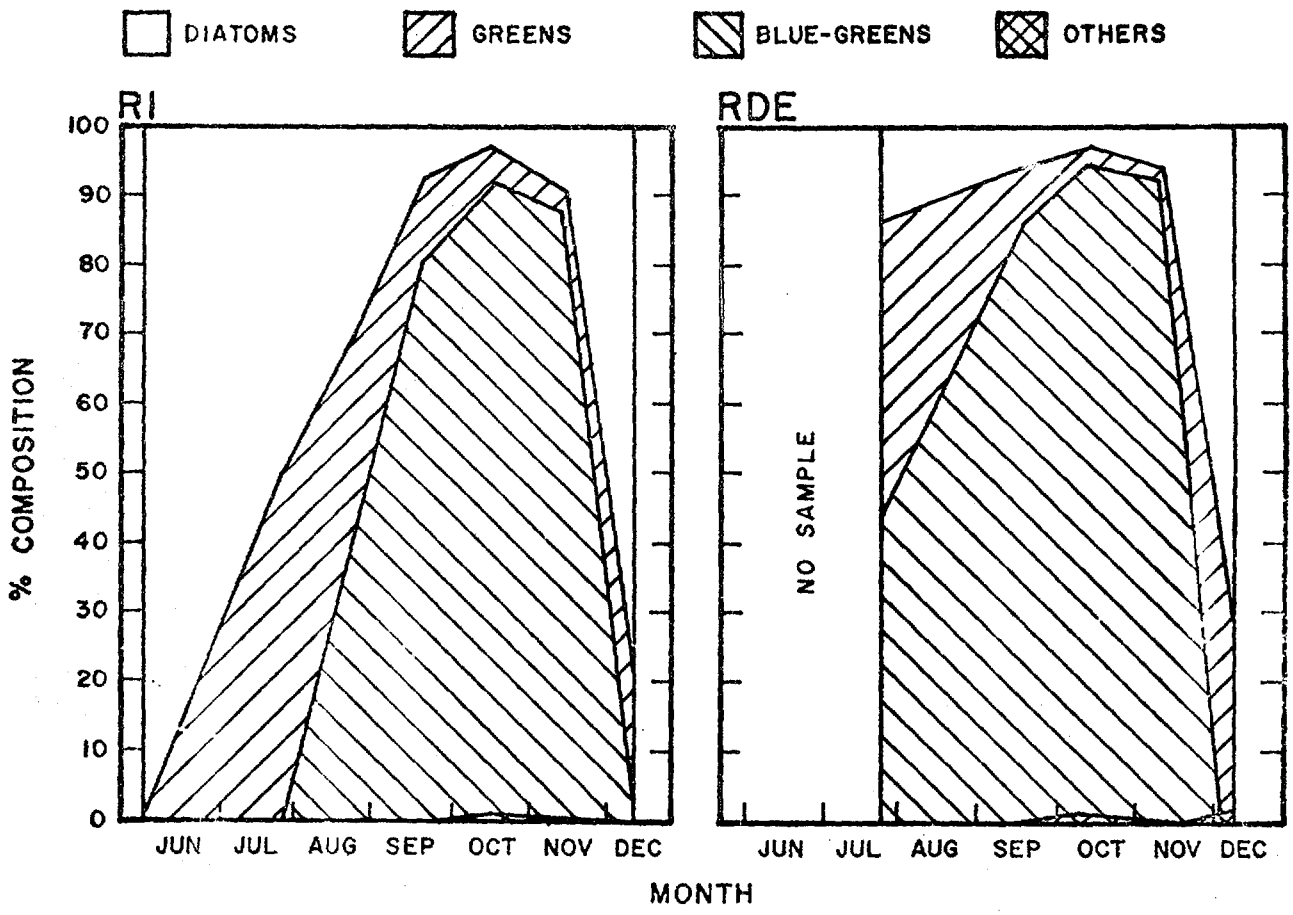

DIATOMS
GREENS
BLUE-GREENS
RI
RDE
NUMBER CELLS/L
10^8
10^7
10^6
10^5
10^4
10^3
NO SAMPLE
MAY JUN JUL AUG SEP OCT NOV DEC
MAY JUN JUL AUG SEP OCT NOV DEC
1973

Figure III-5
Sheet 1 of 2

Phytoplankton Composition - Filtrate Sample
Roseton/Danskammer Point Vicinity 1973




DIATOMS
GREENS
BLUE-GREENS
OTHERS
RI
RDE
NO SAMPLE
% COMPOSITION
100
90
80
70
60
50
40
30
20
10
0
JUN JUL AUG SEP OCT NOV DEC
JUN JUL AUG SEP OCT NOV DEC
MONTH

imated the patterns found in filtrate samples; species composition was also similar, but diatom abundance was generally higher in whole water samples than in either filtrate or net samples.

By August and September the green algae, especially Scenedesmus and Tetrastrum, increased in the filtrate samples. In the net samples Mougeotia, Ankistrodesmus, and two species of Pediastrum dominated the increase. Panadorina and Eudorina also contributed to net collection pulses in concentrations. Actinastrum hantzchii, Coelastrum sp., Mougeotia sp., Panadorina sp., Pediastrum spp., Scenedesmus quadricauda and Ulothrix sp. were the dominant green algae in the whole water samples at that time. The dominant phytoplankters were more abundant in whole water samples than in filtrate samples, and were more abundant in filtrate samples thanin net samples.

Blue-green algal blooms were extant from August through October. The numbers of Oscillatoria ranged from approximately 6.2×10^5 cells/liter at RNCE to 1.5×10^6 cells/liter at RNCW during October in the net samples (see Figure III-2). Filtrate samples contained higher numbers of Oscillatoria, varying from 6.4×10^6 cells/liter at RSCE to 1.5×10^7 cells/liter at RNCE (see Figure III-4). In addition to Oscillatoria, bloom proportions of Lyngbya and Merismopedia existed in both filtrate and net samples. The same genera were dominant in the whole water samples, but abundance was higher in the whole water samples, ranging from 2.2×10^6 Oscillatoria cells/liter at RNCE to almost 1.1×10^7 Oscillatoria cells/liter at RSCW on September 18.

(c) Comparisons

(i) Between Sampling Dates

The results of analyses to determine whether there were significant differences in total algal abundance between dates at each station are presented in Table III-3. There were significant differences in algal abundance in filtrate samples between dates at all river stations, but not at the Roseton or Danskammer Point intakes. This pattern was not found within phytoplankton populations in the net samples; rather, significant differences between dates were noted only at RNCE and RSCE in net samples. Significant differences in abundance between dates were found at stations RNCE, RSCW, and RSCE, and at Roseton intake for whole water samples.

(ii) Between Stations

Significant differences in algal abundance between stations were found on June 26 for net samples, on August 21 for filtrate samples, and on July 24 and August 21 for whole water samples (Table III-4). Since the differences in algal abundance between dates reflected the seasonal changes described previously, no further analyses were conducted to refine the location of significant differences. However, a Student-Newman-Keuls ranking test was applied where there were significant differences in algal abundance between stations. The results of these analyses are presented in Table III-5. On June 26 phytoplankton abundance at RNCW and RSCE was least similar while abundance in filtrate samples were least similar between RNCW and RSCW on August 21. As determined in whole water samples, algal abundance at RSCW and at

TABLE III-3

PHYTOPLANKTON: ONE-WAY ANALYSIS OF VARIANCE BETWEEN DATES
ROSETON/DANSKAMMER POINT VICINITY
1973

	Station	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
A. Filtrate Sample	DI	Date	7	0.937	1.940
		Error	85	0.483	
		Total	92		
	RI	Date	7	0.424	0.820
		Error	152	0.517	
		Total	159		
	RDE	Date	7	1.505	3.252*
		Error	97	0.463	
		Total	104		
	RNCW	Date	7	1.928	4.146*
		Error	172	0.465	
		Total	179		
	RNCE	Date	7	2.501	3.890*
		Error	162	0.643	
		Total	169		
	RSCW	Date	7	3.895	7.217*
		Error	163	0.540	
		Total	170		
	RSCE	Date	7	2.378	4.892*
		Error	152	0.486	
		Total	159		

*Significant differences at $\alpha = 0.05$

TABLE III-3 (Continued)

B. Net Samples

Station	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
DI	Date	7	1.230	2.275*
	Error	79	0.541	
	Total	86		
RI	Date	7	1.598	2.592*
	Error	159	0.616	
	Total	166		
RDE	Date	7	1.388	2.283*
	Error	109	0.608	
	Total	116		
RNCW	Date	7	1.022	1.664
	Error	149	0.615	
	Total	156		
RNCE	Date	7	2.415	4.902*
	Error	277	0.493	
	Total	284		
RSCW	Date	7	1.096	2.044
	Error	163	0.536	
	Total	170		
RSCE	Date	7	1.223	2.110*
	Error	154	0.579	
	Total	161		

*Significant difference at $\alpha = 0.05$

TABLE III-3 (Continued)

	Station	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
C. Whole Water Samples	DI	Date	3	0.470	0.777
		Error	124	0.606	
		Total	127		
	RI	Date	5	1.786	3.749*
		Error	174	0.476	
		Total	179		
	RDE	Date	4	1.235	2.175
		Error	155	0.568	
		Total	159		
	RNCW	Date	6	1.087	2.005
		Error	227	0.542	
		Total	233		
	RNCE	Date	6	1.777	3.681*
		Error	206	0.483	
		Total	212		
	RSCW	Date	5	6.821	13.226*
		Error	199	0.516	
		Total	204		
	RSCE	Date	6	1.647	3.190*
		Error	216	0.516	
		Total	222		

*Significant Difference at $\alpha = 0.05$

TABLE III-4

Phytoplankton: One-way Analysis of Variance
Between Stations
ROSETON/DANSKAMMER POINT VICINITY 1973

A. Net Samples

DATE	SOURCE OF VARIANCE	DEGREES OF FREEDOM	MEAN SQUARE	F RATIO CALCULATED
5/31	Station	5	0.17	0.57
	Error	94	0.29	
	Total	99		
6/26	Station	3	1.249	3.93*
	Error	20	0.318	
	Total	23		
7/24	Station	5	0.20	0.579
	Error	91	0.347	
	Total	96		
8/21	Station	4	0.325	0.644
	Error	110	0.505	
	Total	114		
9/18	Station	5	0.775	0.978
	Error	112	0.792	
	Total	117		
10/16	Station	6	0.75	0.920
	Error	161	0.81	
	Total	167		
11/12	Station	6	0.452	0.594
	Error	190	0.761	
	Total	196		
12/12	Station	6	0.723	1.763
	Error	191	0.410	
	Total	197		

*significant differences at $\alpha = 0.05$

TABLE III-4 (con't)

B. Filtrate Samples

DATE	SOURCE OF VARIANCE	DEGREES OF FREEDOM	MEAN SQUARE	CALCULATED F RATIO
5/31	Station	4	0.19	1.31
	Error	19	0.15	
	Total	23		
6/26	Station	3	0.062	0.479
	Error	19	0.130	
	Total	22		
7/24	Station	5	0.133	1.005
	Error	33	0.132	
	Total	38		
8/21	Station	4	2.632	5.607*
	Error	191	0.470	
	Total	195		
9/18	Station	5	0.360	0.728
	Error	190	0.494	
	Total	195		
10/16	Station	6	0.16	0.24
	Error	181	0.66	
	Total	187		
11/12	Station	6	0.384	0.684
	Error	179	0.561	
	Total	185		
12/12	Station	6	0.95	0.280
	Error	166	0.341	
	Total	172		

TABLE III-4 (con't)

C. Whole Water Samples

DATE	SOURCE OF VARIANCE	DEGREES OF FREEDOM	MEAN SQUARE	CALCULATED F RATIO
6/26	Station	2	0.240	0.621
	Error	77	0.386	
	Total	79		
7/24	Station	3	4.361	10.869*
	Error	106	0.401	
	Total	109		
8/21	Station	3	2.740	5.771*
	Error	154	0.475	
	Total	157		
9/18	Station	3	0.582	1.075
	Error	121	0.542	
	Total	124		
10/16	Station	3	0.011	0.018
	Error	130	0.653	
	Total	133		
11/12	Station	3	0.619	0.898
	Error	140	0.689	
	Total	143		
12/12	Station	3	0.123	0.331
	Error	120	0.371	
	Total	123		

TABLE III-5

PHYTOPLANKTON: STUDENT-NEWMAN-KEULS RANKING TEST
ON DATES OF SIGNIFICANT DIFFERENCE BETWEEN STATIONS
1973
ROSETON/DANSKAMMER POINT VICINITY

1. Net Phytoplankton, June 26, 1973	Rank	1	2	3	4		
	Station	RNCW	RNCE	RSCW	RSCE		
2. Filtrate Phytoplankton, August 21, 1973	Rank	1	2	3	4	5	
	Station	RNCE	RSCW	RSCE	RI	RNCW	
3. Whole Water Phytoplankton, July 24, 1973	Rank	1	2	3	4	5	6
	Station	RSCW	RI	RSCE	RDE	RNCE	RNCW
4. Whole Water Phytoplankton, August 21, 1973	Rank	1	2	3	4	5	
	Station	RNCW	RI	RNCE	RSCW	RSCE	

Note: Underscoring denotes similarity.

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RNCW was least similar to the other three stations on July 24 and August 21, respectively. Although the trend emerging from these results indicated that one of the two west stations was generally different from the remaining three stations, there were not enough instances of significant differences between stations to form a definite east-west pattern.

(iii) Between Whole Water and Fractionated Samples

As shown in Table III-6, abundance of diatoms and green algae were significantly greater when calculated from whole water samples than from the combination of net and filtrate samples.

(iv) Between Roseton/Danskammer Point 1971-1972 and 1973

In 1971-1972 none of the major phytoplankton taxa were found above 2×10^5 algal cells/liter; during 1973 the major phytoplankton taxa were at least an order of magnitude more abundant. A shift of the composition from Cyclotella, Melosira and Conscinodiscus to Cyclotella, Melosira and Navicula occurred in the Hudson River between 1971-1972 and 1973. The plant intake sample showed a Melosira, Cyclotella, Fragilaria, and Asterionella abundance. Peaking of Asterionella formosa was recorded in May and December of 1973 while 1972 river results showed no similar peaks.

Blue-green algae, especially Oscillatoria, contributed to bloom conditions

TABLE III-6

TESTS FOR SIGNIFICANT DIFFERENCES
IN PHYTOPLANKTON ABUNDANCE
WHOLE WATER SAMPLES AND NET PLUS FILTRATE SAMPLES
ROSETON/DANSKAMMER POINT VICINITY, 1973

PAIRED-t TEST

GROUP	DEGREES OF FREEDOM	TEST STATISTIC	*CRITICAL VALUE
Blue-green algae	24	t = -0.513	2.064
†Diatoms	26	t = -2.801	2.056
Euglenoids	26	t = -0.904	2.056
Yellow-brown algae	26	t = -2.032	2.056
Total phytoplankton	26	t = -2.037	2.056

WILCOXON SIGNED RANK TEST

†Green algae	n = 27	z = 2.366	1.96

* critical values at $\alpha = 0.05$

† significant difference at $\alpha = 0.05$

in August-October 1973, whereas they were far less abundant during 1971-1972 except for a pulse of Aphanizomenon in August 1971.

Although no problem algae occurred at "trouble" levels in 1971-1972, the blue-greens, Oscillatoria, Anabaena, Microcystis, Merismopedia and Lyngbya, and the diatom Cyclotella exceeded 5×10^5 cells/liter in 1973. At the plant intake, the diatom Melosira also reached bloom proportions.

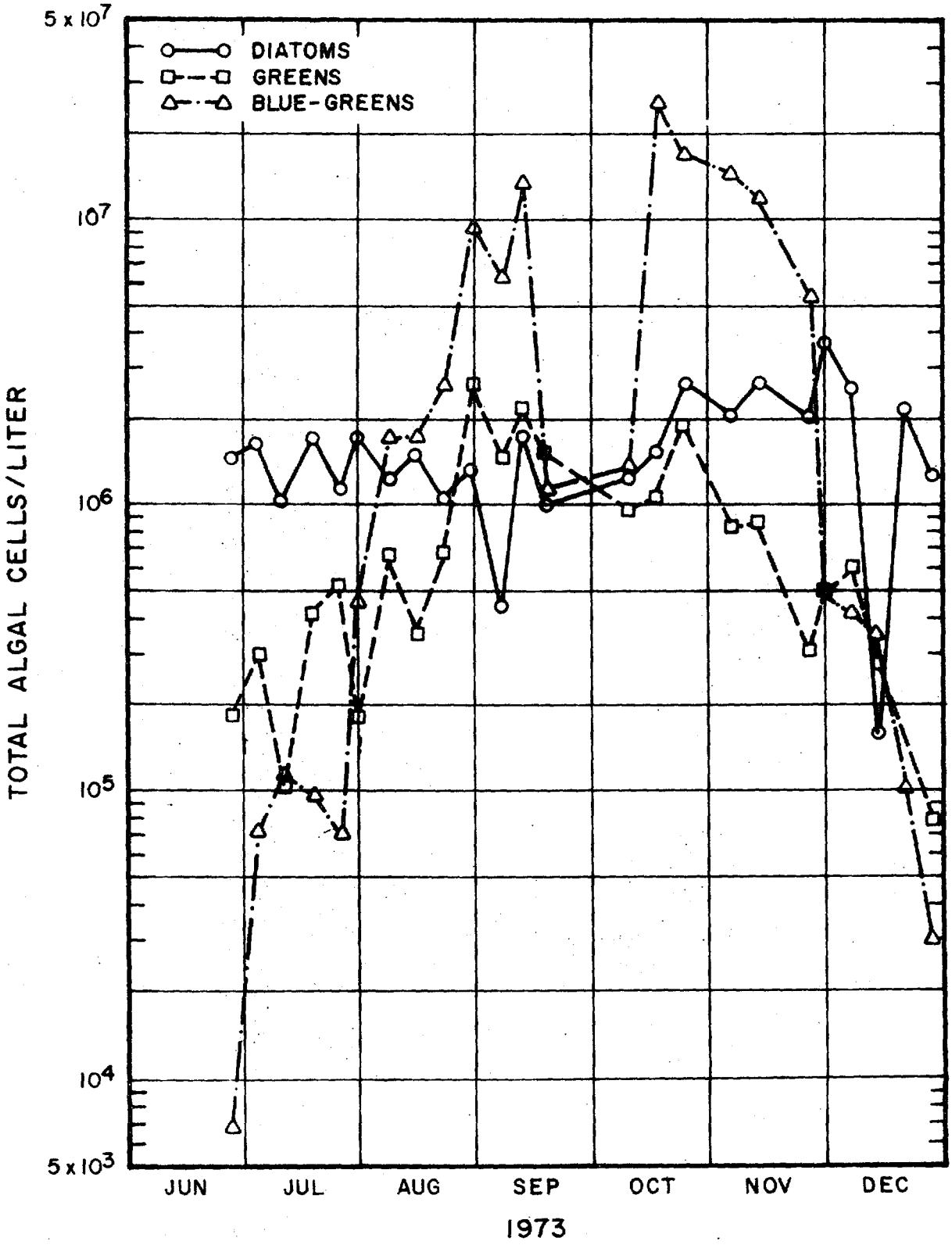
(v) Between Weekly and Monthly

Figure III-6 shows the seasonal patterns of diatoms, green algae; and blue-green algae based on whole water samples taken weekly at the Danskammer Point intake. By comparing the trends depicted in this figure it can be seen that a clearer idea of seasonal patterns is obtained from weekly samples. The pattern of diatom abundance in particular was considerably different from the pattern based on monthly samples.

3. Discussion

(a) Seasonal Patterns of Abundance. In the Roseton/Danskammer Point vicinity of the Hudson River there were diatom pulses in May-June and again in December. Similar biomodal peaks of diatom occurrence have also been found in New England Coastal Waters (Riley, 1947), in Chesapeake Bay (Patten et al., 1963) and in Narragansett Bay (Pratt, 1965).

WEEKLY WHOLE WATER PHYTOPLANKTON ABUNDANCE
DANSKAMMER POINT INTAKE
ROSETON-DANSKAMMER, 1973



Several environmental parameters, especially light and temperature, have been reported to influence diatom communities (Patrick, 1967). During May and November, the average temperature in the Roseton/Danskammer Point area was relatively low (50-60°F; see Chapter VII), and growth of cold water diatoms was favored. As the river warmed the phytoplankton population composition changed to green algae, dominated by Scenedesmus, Tetradesmus, Pediastrum spp., and Mougeotia. This diatom-green algal succession in the Hudson River was noted earlier by Lauer (1972) and in Haverstraw Bay (Quirk, Lawler & Matusky Engineers, 1974).

Blue-green algae, generally considered "nuisance algae" because of their abundance and dominance in eutrophic environments, reached bloom concentrations in the Roseton-Danskammer Point vicinity from August through October 1973. Oscillatoria and Lyngbya reached bloom proportions (75×10^5 cells/liter) at the river stations; Oscillatoria and Anabaena were found in equally high numbers at both the Roseton and the Danskammer Point intakes during the early fall months.

Fogg et al. (1973) suggested that nitrogen fixation should be considered a factor in blue-green succession and abundance. Nitrate, as well as phosphate, was present in the Hudson River in quantities (Chapter VII) sufficient to support the bloom populations (Figure III-6). Other hypotheses to explain the blue-green algal blooms could include increase pH (Shapiro, 1973), bicarbonate addition from an unknown source (Dickman, 1973) or increased temperature.

(b) Nuisance Algae. Algae which can create problems in water supplies

have been reviewed by MacKenthun (1969). The type of problem depends upon the composition of the phytoplankton population, as well as the quantity of organisms present. Palmer (1969) compiled a list of genera and species of pollution-tolerant forms, based on the published investigations of 165 authorities. His compilation basically represented the potential problem algae described in earlier reports. Therefore, the term "pollution-tolerant algae" is to be considered synonymous with potential problem (nuisance) algae. Table III-7 lists algal genera found in the phytoplankton at Roseton/Danskammer point which Palmer (1969) classified as pollution-tolerant algae.

Table III-7a lists the pollution-tolerant algae found in Roseton intake samples (a similar list for Danskammer intake was not compiled because August and/or September samples were not taken at that location). Comparison of these two tables shows that Acnanthes, Gomphonema, Euglena, Phacus and Trachelomonas were found at the river stations, but not at the intake, and that Spirulina and Pinnularia were found at the intake, but not at the river stations. The dominant nuisance algae occurred at all collecting sites.

Whipple et al. (1948) formulated an algal density criterion pertaining to water quality; counts greater than 5×10^5 cells/l for a particular algae may be indicative of a problem, whereas serious trouble may exist if greater than 3×10^6 cells/liter are present. In the study area, Oscillatoria sp., Lyngbya sp., Merismopedia sp., Microcystis sp., Cyclotella sp., and Anabaena sp. occurred at more than 5×10^5 algal

TABLE III-7

IDENTIFIED POLLUTION-TOLERANT ALGAE
1973
ROSETON/DANSKAMMER POINT VICINITY

DIATOMS	GREENS	BLUE-GREENS	OTHERS
Achnanthes	*Actinastrum*	*Anabaena*	*Trachelomonas*
Asterionella	*Ankistrodesmus*	*Lyngbya*	
Coccoenis	*Chlorella*	*Merismopedia*	
Cyclotella	*Closterium*	*Microsystis*	
Cymbella	*Coelastrum*	*Oscillatoria*	
Diatoma	*Cosmarium*		
Fragilaria	*Crucigenia*		
Gomphonema	*Dictyosphaerium*		
Melosira	*Eudorina*		
Navicula	*Euglena*		
Nitzschia	*Golenkinia*		
Stephanodiscus	*Micractinium*		
Surirella	*Oocystis*		
Synedra	*Pandorina*		
	Pediastrum		
	Phacus		
	Scenedesmus		
	Selenastrum		
	Ulothrix		

Note: Based on Palmer (1969).

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TABLE III-7a

POLLUTION-TOLERANT ALGAE IDENTIFIED AT THE ROSETON INTAKE
1973
ROSETON/DANSKAMMER POINT VICINITY

DIATOMS	GREENS	BLUE-GREENS
Asterionella	*Actinastrum*	*Anabaena*
Cocconeis	*Ankistrodesmus*	*Lyngbya*
Cyclotella	*Chlorella*	*Merimopedia*
Cymbella	*Closterium*	*Oscillatoria*
Diatoma	*Coelastrum*	*Spirulina*
Fragilaria	*Cosmarium*	
Melosira	*Crucigenia*	
Navicula	*Dictyosphaerium*	
Nitzshia	*Eudorina*	
Pinnularia	*Golenkinia*	
Stephanodiscus	*Micractinium*	
Surirella	*Oocystis*	
Synedra	*Pandorina*	
	Pediastrum	
	Scenedesmus	
	Selenastrum	
	Ulothrix	

Note: Based on Palmer (1969).

cells/liter at least once during the course of the sampling program. More than 3 x 10^6 cells/liter of Oscillatoria were found on a single collecting date (September 18) at RNCW, RSCE and RSCW. Odum (1971) defined bloom conditions somewhat qualitatively as rapid growth over a short time duration; by this definition blooms of Asterionella formosa, Oscillatoria sp., Lyngbya sp., and Microcystis sp. occurred during 1973. In general, blue-green algae increased by two orders of magnitude between late June and late October. Thus, according to several criteria, a bloom of blue-green algae, dominated by Oscillatoria sp., Lyngbya sp. and Merismopedia sp., occurred in October.

(c) Differences Between Stations. Significant differences in algal abundance between stations occurred on only three sampling dates. It is possible that some naturally occurring but unknown environmental factors such as current patterns may have caused these differences.

(d) Differences Between Whole Water and Fractionated Samples. Differences in the size and form of algae influence the differences in concentration of algae between the net and filtrate samples. Many diatoms tend to form small, single-cell colonies that are easily broken apart, and are thus likely to be more abundant in filtrate samples than in net samples. The four green algae generally dominating the summer pulse of abundance in the net samples tend to be larger in size than the two green algal genera dominant in the filtrate collections. In addition, some

genera have a gelatinous sheath that could help to retain individuals in the net.

Statistical analyses indicated that more algal cells were found in whole water samples than net plus filtrate samples. In theory, there should have been no significant difference in abundance, but it is surmised that phytoplankters adhered to the mesh and cod-end bucket of the fractionating net, thus reducing the number of cells in the preserved sample used for laboratory analysis.

(e) Weekly-Monthly Abundance Comparison. With the exception of patterns of diatom abundance, monthly samples provided adequate data for the delineation of seasonal trends in phytoplankton abundance. Significant short term changes in algal abundance were clearly distinguishable in weekly samples.

(f) Differences Between 1971-1972 and 1973. The results showed that an increase in the abundance of all phytoplankters in net samples occurred between 1971-1972 and 1973. It is also notable that microzooplankton were more abundant in 1973 than in 1971-1972, which precludes the possibility that differences in zooplankton grazing may have caused the differences in phytoplankton abundance between years.

4. Conclusions

(a) Seasonal patterns of phytoplankton abundance and species composition were observed.

(b) Blue-green algae were found above nuisance levels of abundance (5×10^5 algal cells/liter) during the fall.

(c) Although both species composition and algal abundance indicated eutrophic environmental conditions, healthy phytoplankton production levels provide a solid base for the consumers (zooplankton, fish larvae, fish, etc.) of the aquatic food web.

(d) Comparison of the abundance of algal cells in whole water samples and in net plus filtrate samples showed that significantly more algae were collected using the whole water method than using the net plus filtrate method. Since net clogging may be a factor in underestimating algal abundance, it is recommended that whole water samples be used in future studies.

D. MICROZOOPLANKTON

1. Materials and Methods

(a) Sampling. Microzooplankton samples were taken on the same dates as were phytoplankton samples by towing an 11.4 cm diameter Wisconsin-type plankton net (#20 mesh; 76μ) vertically through the water column. Immediately after each tow, the samples were washed from the cod-end bucket and preserved in 5-10% formalin (final concentration) for laboratory analysis.

Three tows were made at each station: 10'-0', 20'-0', and 30'-0' to obtain data on the depth distribution of microzooplankton. Four river stations (the same stations at which phytoplankton was sampled) were sampled once a month from May through December. Three additional stations representing Roseton and Danskammer Point intakes and the

opposite side of the river were sampled from September through December and at selected times prior to September, as shown in Table III-8. During 1971, microzooplankton samples were collected from August through December at RNCW and RSCW; during 1972, samples were collected from May through December at the same stations as in 1973. Collection methods during the 1971 and 1972 studies were the same as the methods used during 1973 except that in 1971 and 1972 vertical tows were made only from a depth of thirty feet to the surface.

(b) Laboratory Analysis. The methods and procedures used in 1973 were the same as those used in 1972 (Quirk, Lawler and Matusky Engineers, 1973). Three aliquots representing known percentages of a homogeneously mixed sample were counted in a Sedgewick-Rafter cell. The counts of the three aliquots were averaged and the number of organisms per milliliter was used to calculate the number of organisms per cubic meter (given the total sample volume, length of tow, and mouth area of the net).

The most abundant cladocerans and rotifers were identified to genus. Copepods were identified by age class (nauplii, copepodites, and adults) and (calanoid, cyclopoid, and harpaticoid) within the adult age class.

(c) Statistical Analysis. Analysis of variance (ANOVA) (Sokal and Rohlf, 1969) was conducted for total microzooplankton abundance among dates, depths, and stations to determine whether there were significant differences due to any of these three sources of variance. When significant differences were noted, a Student-Newman-Keuls ranking test was conducted to locate similarities within a source of variance.

TABLE III-8

MICROZOOPLANKTON COLLECTION DATES
1973
ROSETON/DANSKAMMER POINT VICINITY

DATE	DI	RI	RDE	FOUR RIVER STATIONS
May 31	x	x		x
June 26				x
July 24		x	x	x
August 21		x		x
September 18		x	x	x
October 16	x	x	x	x
November 12	x	x	x	x
December 12	x	x	x	x

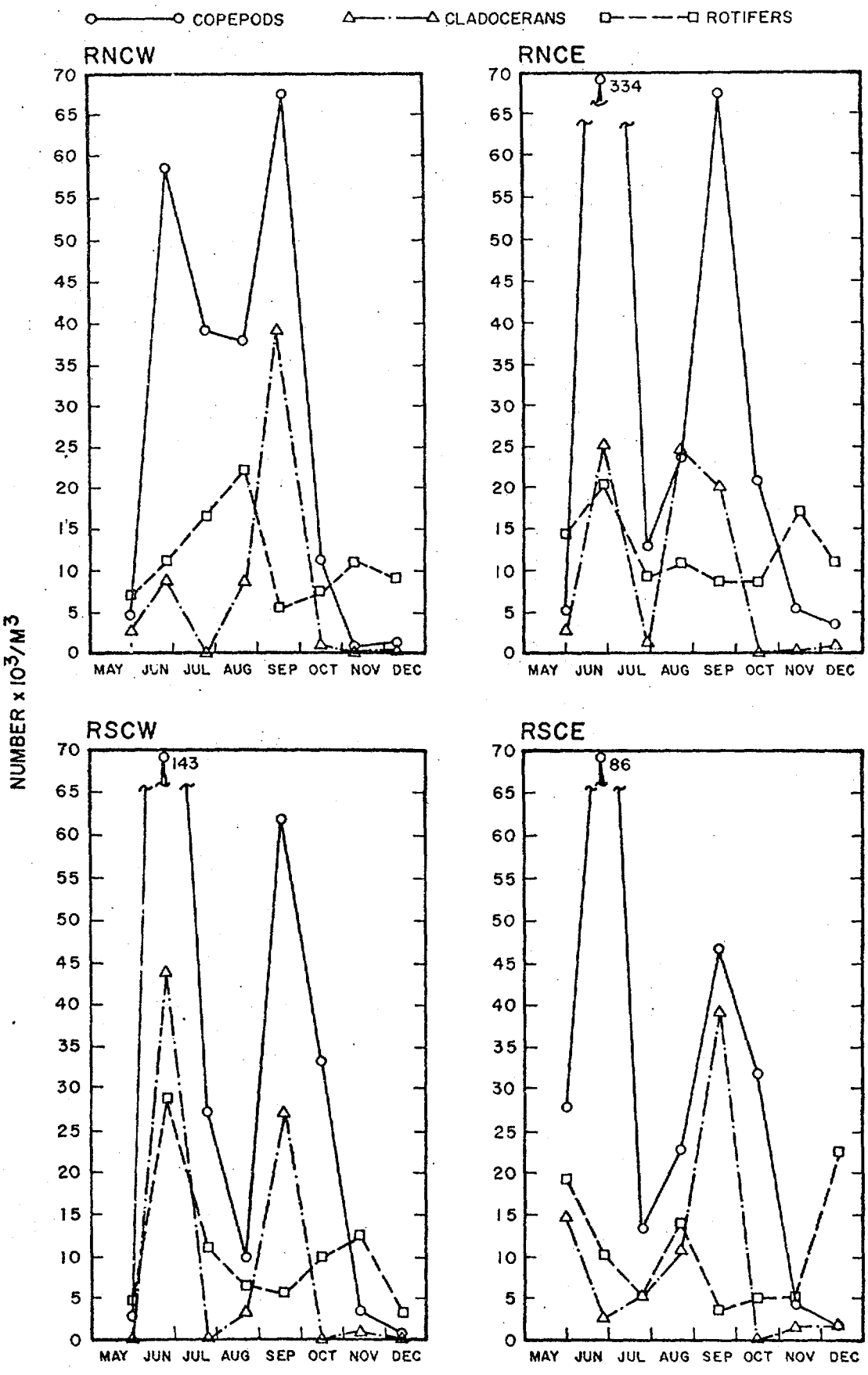
Note: Sampling station locations are shown in Figure II-1

(d) Discussion of Sampling and Laboratory Analysis. The use of an 11.4 cm mouth diameter Wisconsin type net in a water column containing high concentrations of particulate matter may at times preclude accurate determination of the number of organisms/m^3. The larger (>200μ) microzooplankters may avoid an oncoming net and clogging of the meshes may result in non-quantitative samples. Although the absolute numbers of microzooplankters may have been underestimated due to possible net clogging during peak periods of abundance, the data reflect seasonal variations and the relationships between populations found in the River. The estimates of abundance of microzooplankton for the 10' - 0' tows are likely to be less affected by clogging than the deeper tows (Tonolli, 1971) and are therefore used more extensively in discussions concerning river populations and entrainment. Since Roseton Intake was sampled more frequently than Danskammer Point Intake and Roseton/Danskammer Point East, the data acquired at that location has been used for comparison with the river control stations as representative of "typical" intake water populations.

2. Results

(a) Species Inventory. A tabulation of microzooplankton abundance and composition data collected at the Roseton and Danskammer Point intakes is presented in Appendix III-B. The results of the Roseton Intake surface samples are presented graphically in Figures III-7 and III-8. Fourteen genera of rotifers, four genera of cladocerans, and three sub-orders of copepods were identified and are listed in

Microzooplankton Abundance: 0 - 10 ft. tow
Roseton/Danskammer Point Vicinity, 1973



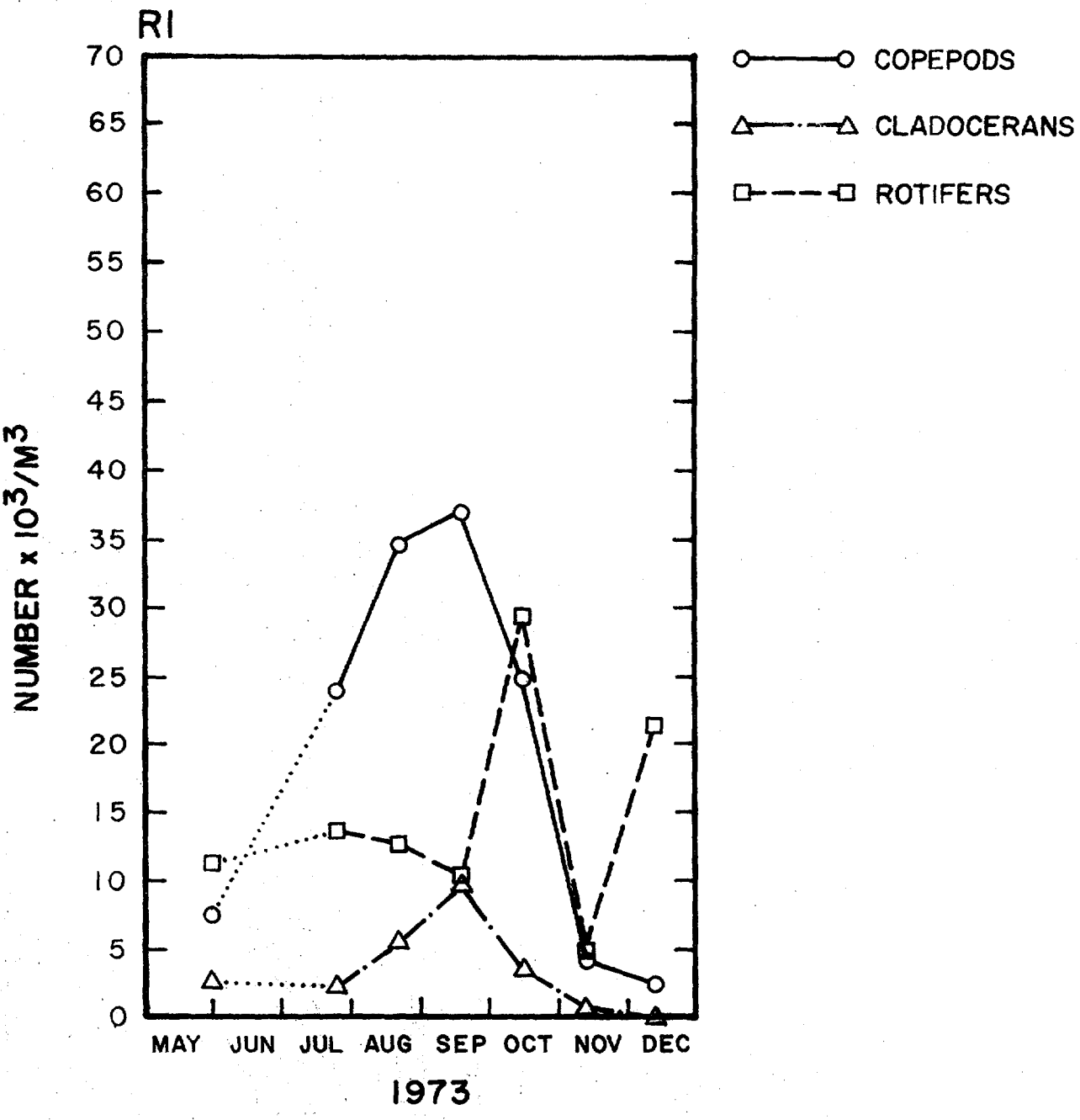
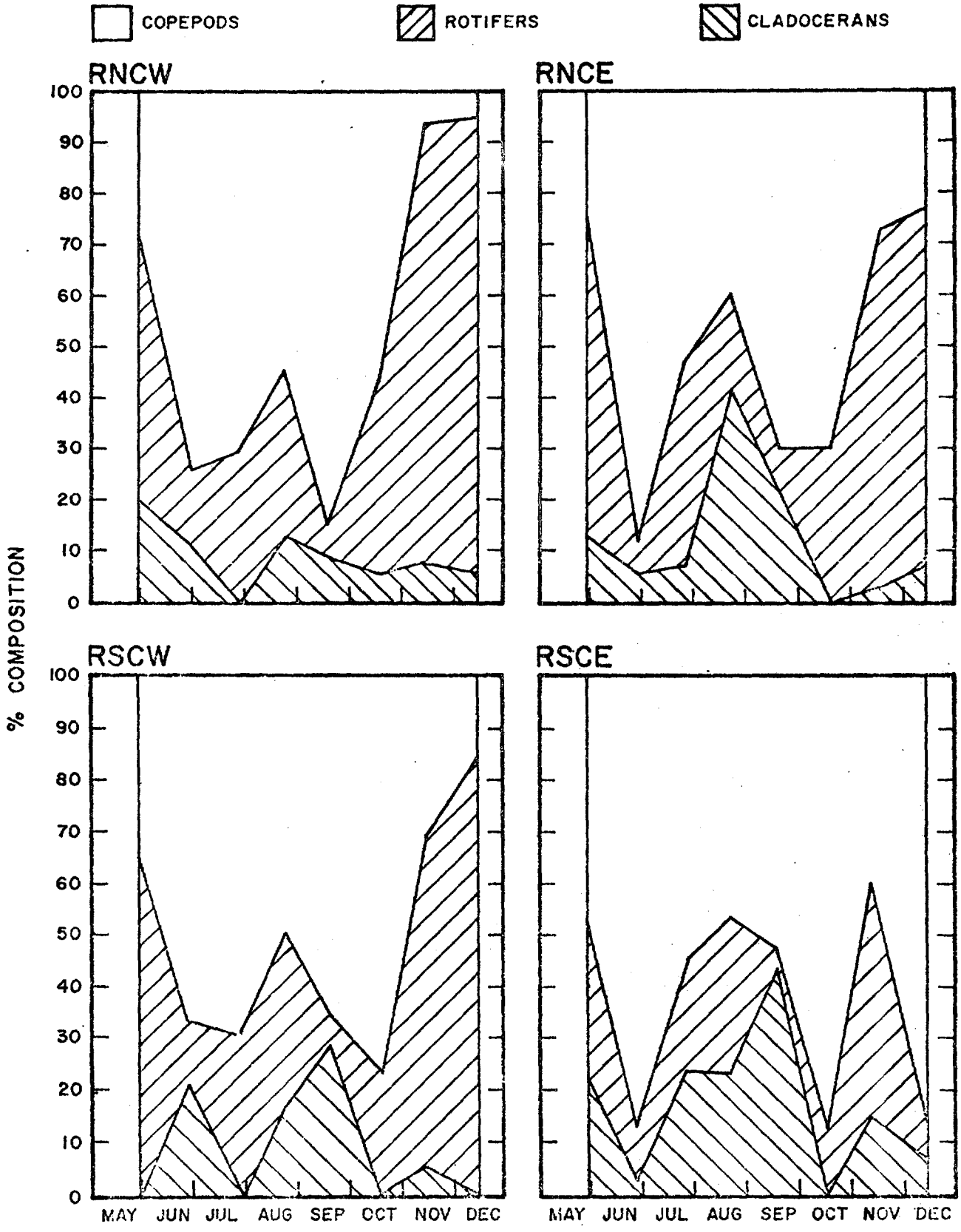

RI
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
NUMBER x $10^3/M^3$
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1973
COPEPODS
CLADOCERANS
ROTIFERS

FIGURE III-8
Sheet 1 of 2

Microzooplankton Composition: 0-10 ft. tows
Roseton/Danskammer Point Vicinity, 1973



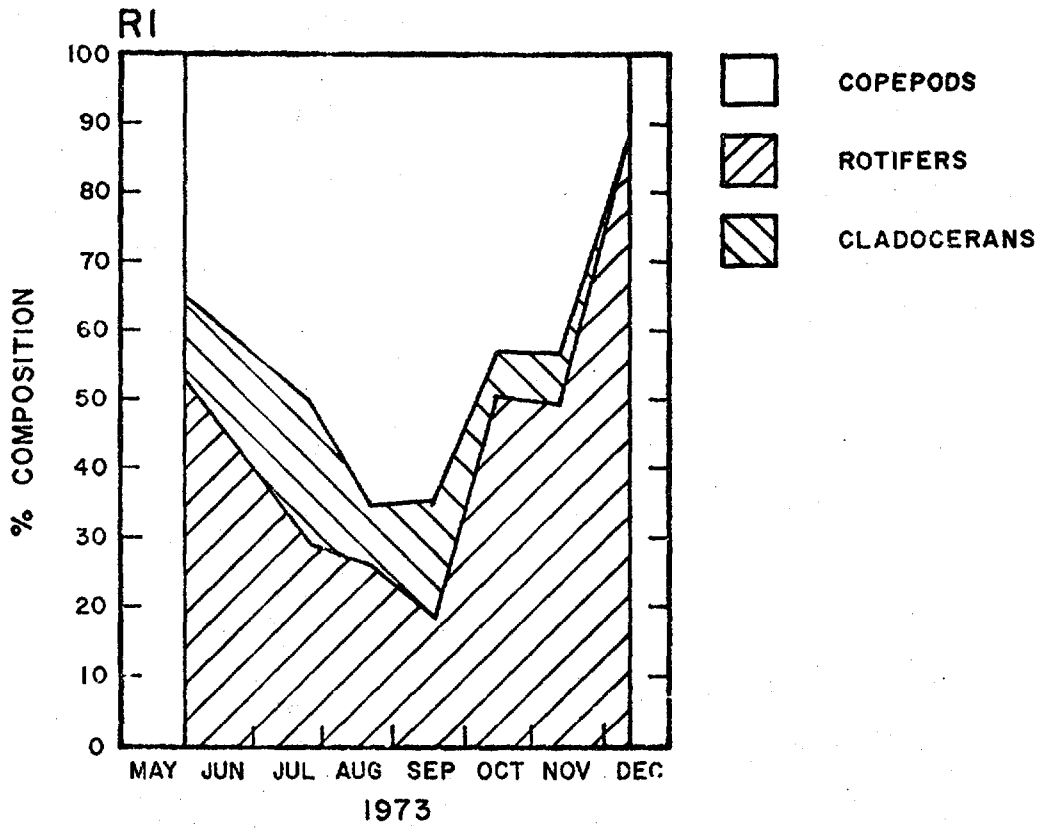

RI
100
90
80
70
60
50
40
30
20
10
0
% COMPOSITION
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1973
COPEPODS
ROTIFERS
CLADOCERANS

Table III-9. With the exception of an unidentified bdelloidian rotifer, which was a significant contributor to the total rotifer population, unidentified organisms within the copepod, cladoceran and rotifer groups were a small fraction of the total.

(b) Seasonal Patterns of Abundance. The microzooplankton populations in the Roseton/Danskammer Point area were characterized by two peaks of abundance: one in early summer and one in early fall. The early summer peak was caused by an increase in all three major groups (Figure III-7). The early fall peak was caused by an increase in cladocerans and copepods with a subsequent rotifer increase in November (Figures III-7 and III-8). At most stations, rotifers were the most abundant group in May and in November and December. Copepods, usually followed by cladocerans, were the most abundant group from June through September. October appeared to be a transition month, during which rotifers increased and copepods and cladocerans decreased from the previous month (Figures III-7 and III-8).

The seasonal pattern of abundance at the Roseton intake shown in Figure III-7 was similar to the patterns found at the river stations. The absence of the June peak of abundance at the Roseton intake was due to the lack of sampling during that month, and it is probable that such a peak did occur. The rotifer population at the Roseton intake was approximately the same as the river population especially in October when rotifers reached almost 30×10^3 organisms/$1000m^3$ at the Roseton intake.

TABLE III-9

MICROZOOPLANKTON SPECIES INVENTORY - 1973
ROSETON/DANSKAMMER POINT VICINITY

A. COPEPODS

Calanoids
Cyclopoids
Harpacticoids
UID Copepods

B. CLADOCERANS

Bosmina sp.
Daphnia sp.
Leptodora sp.
Pleuroxus sp.
UID Cladocerans

C. ROTIFERS

Branchionus sp.
Cephalodella sp.
Diplois sp.
Elosa sp.
Filinia sp.
Kellekotia sp.
Keratella sp.
Lecane sp.
Nothulca sp.
Ploesoma sp.
Polyarthra sp.
Proalides sp.
Trichocerca sp.
Trichotria sp.
UID Bdelloides
UID in capsule

More than 90% of total copepod abundance at all four stations was due to high numbers of nauplii during the early summer peak. Slightly less than 90% of the total copepods were accounted for by nauplii during the early fall peak at both the river stations and Roseton intake (Figures III-9 and III-10). Although copepod adults increased in number both during and after naupliar peaks, their maximum numbers ranged from 7 x $10^3/m^3$ to 1.5 x $10^4/m^3$ as compared to a range of 5.5 x $10^4/m^3$ to 3.2 x $10^5/m^3$ for copepod nauplii (Figure III-8).

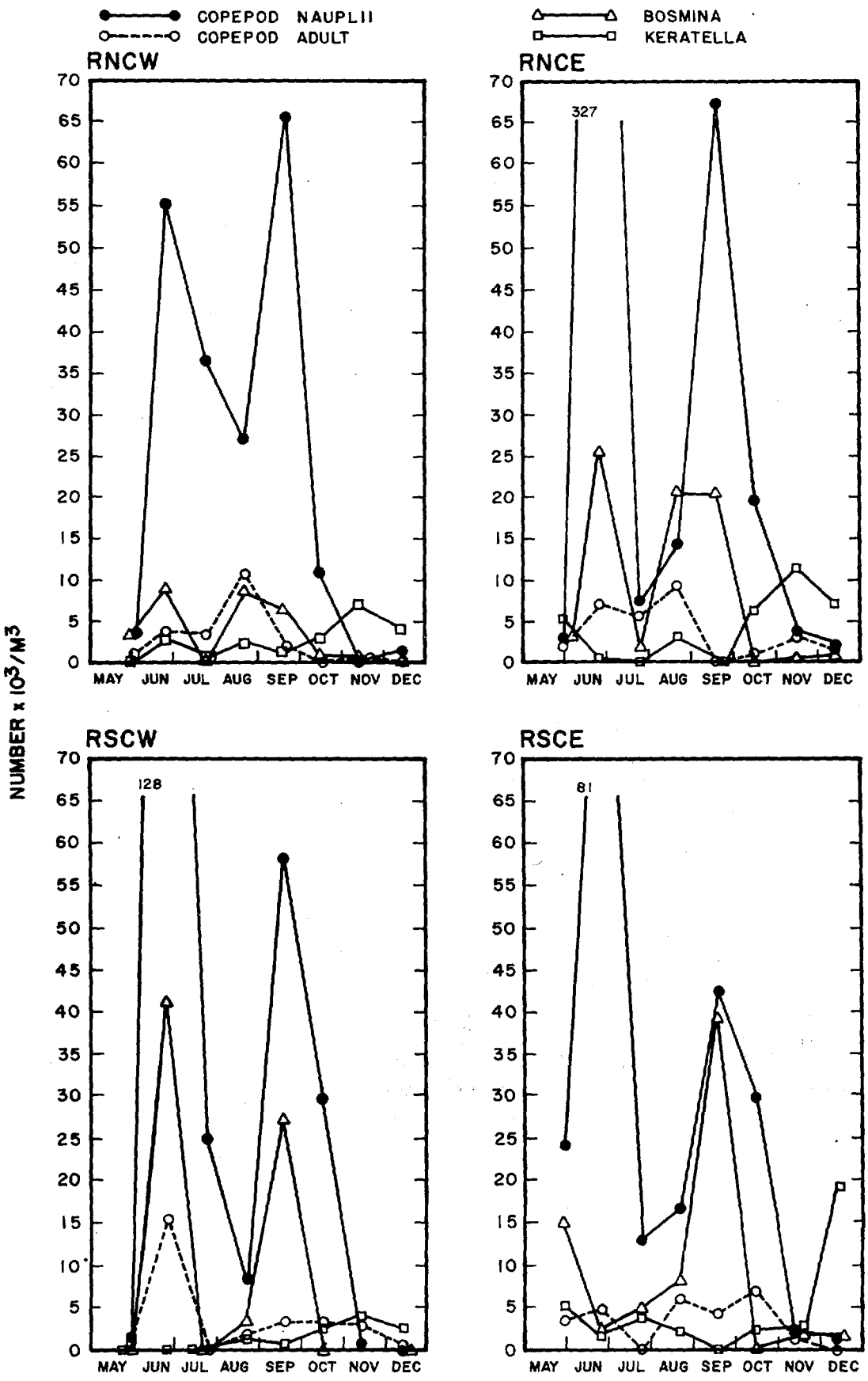
Seasonal trends in the cladoceran population were due primarily to changes in the Bosmina population (Figures III-7 and III-9) which ranged from $0/m^3$ to 4 x $10^4/m^3$. Daphnia and Leptodora contributed significantly (approximate maximum of 4.3 x 10^3 organisms/m^3) to the total cladoceran population in the early summer and early fall.

The density of rotifers was more variable from month to month than corresponding copepod or cladoceran densities. Although Keratella followed the general trend of the rotifer populations (Figures III-7 and III-9) at most times, Ploesoma, Polyarthra, Nothulca, and unidentified bdelloidians contributed significantly (from 1 x 10^3 to 1 x 10^4 organisms/m^3) to the total rotifer population. The total rotifer population ranged from about 3 x 10^3 to 2.7 x 10^4 rotifers/m^3.

It is possible that "overwintering" populations (Riley, 1967) of approximately equal numbers of copepod adults and nauplii were sampled in November and December. Keratella appeared to be the dominant overwintering rotifer, and Bosmina appeared to be the dominant overwintering cladoceran.

FIGURE III- 9
Sheet 1 of 2

Microzooplankton Abundance: 0-10 ft. Dominant Representatives
Roseton/Danskammer Point Vicinity, 1973



1973

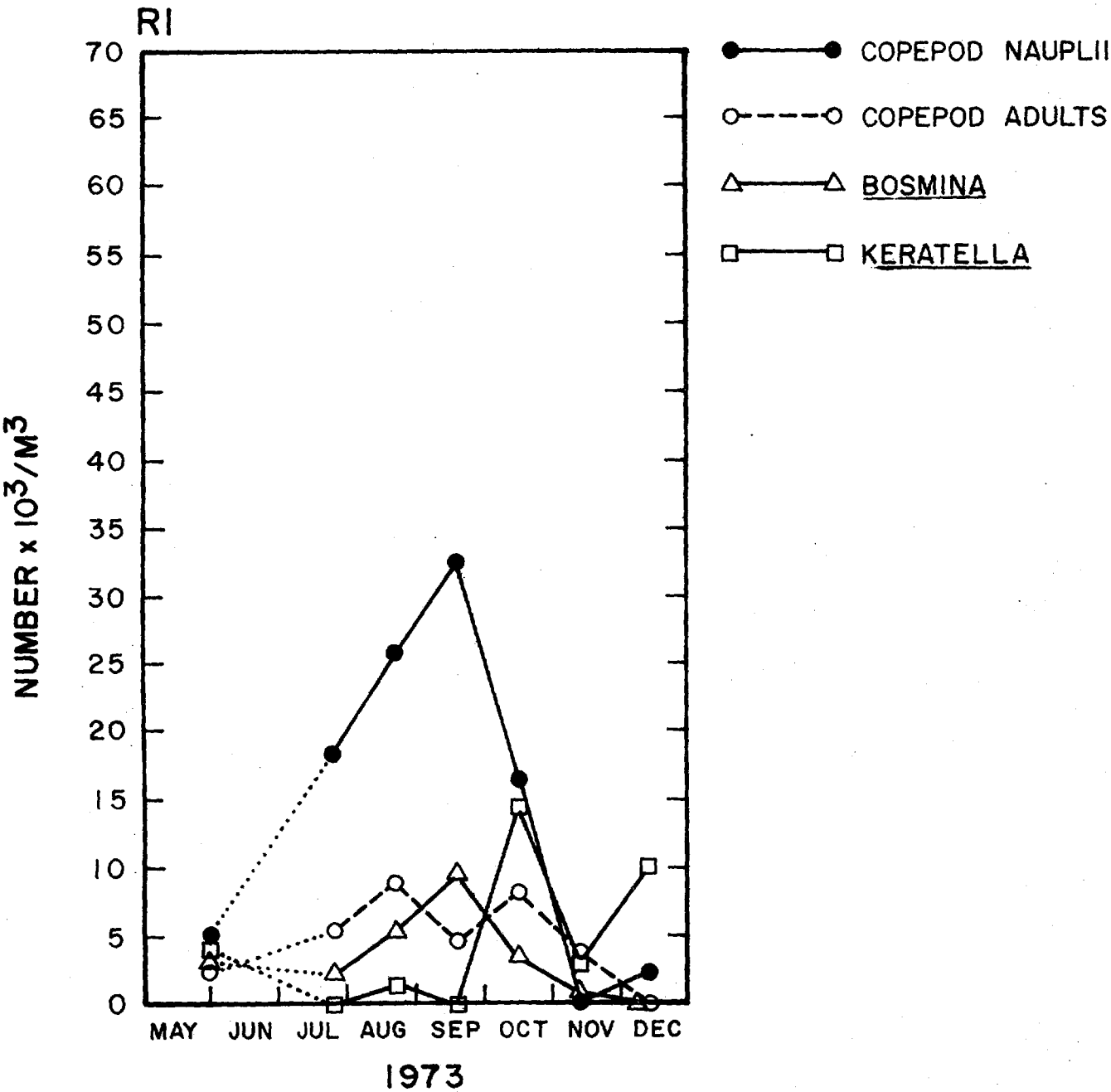
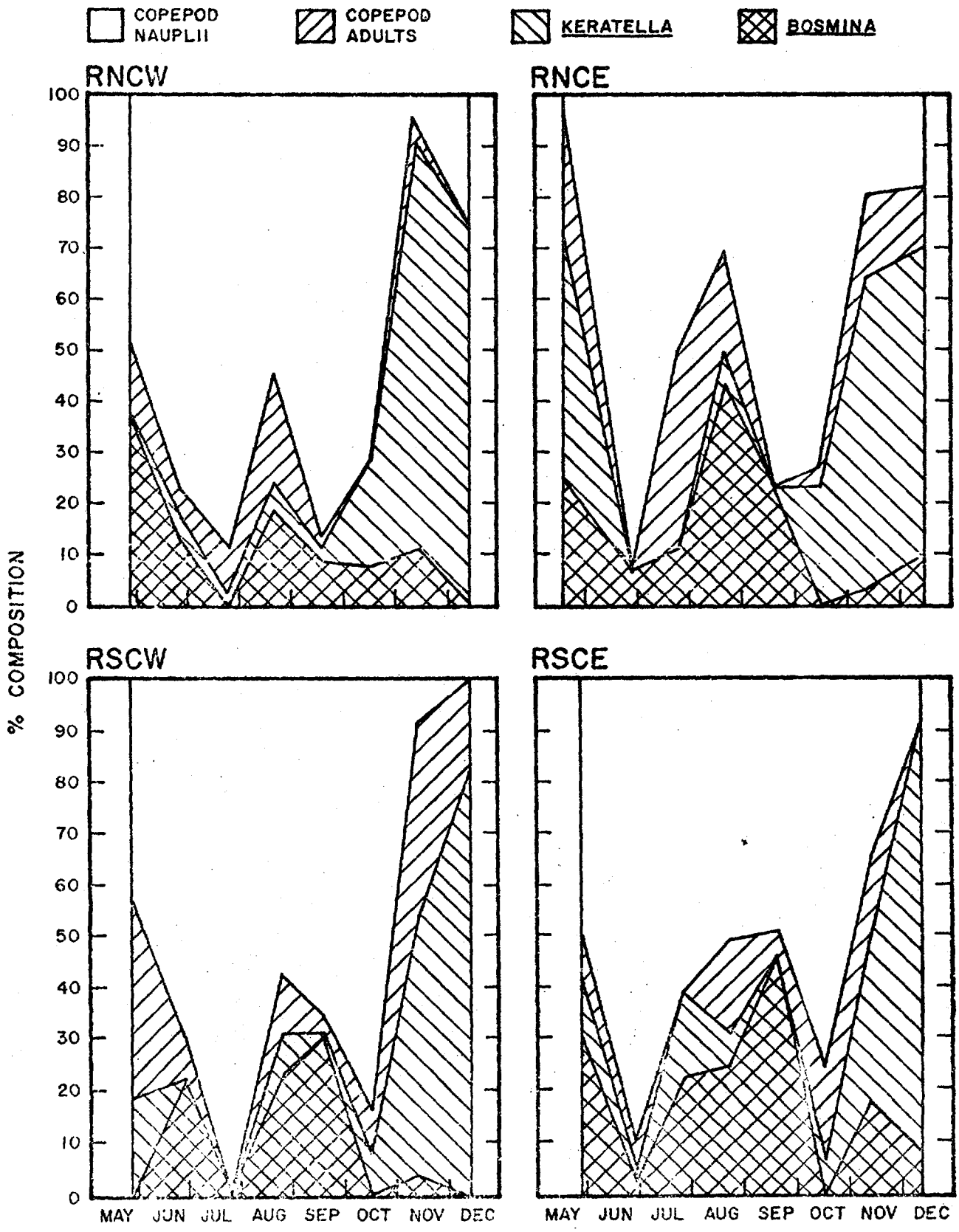
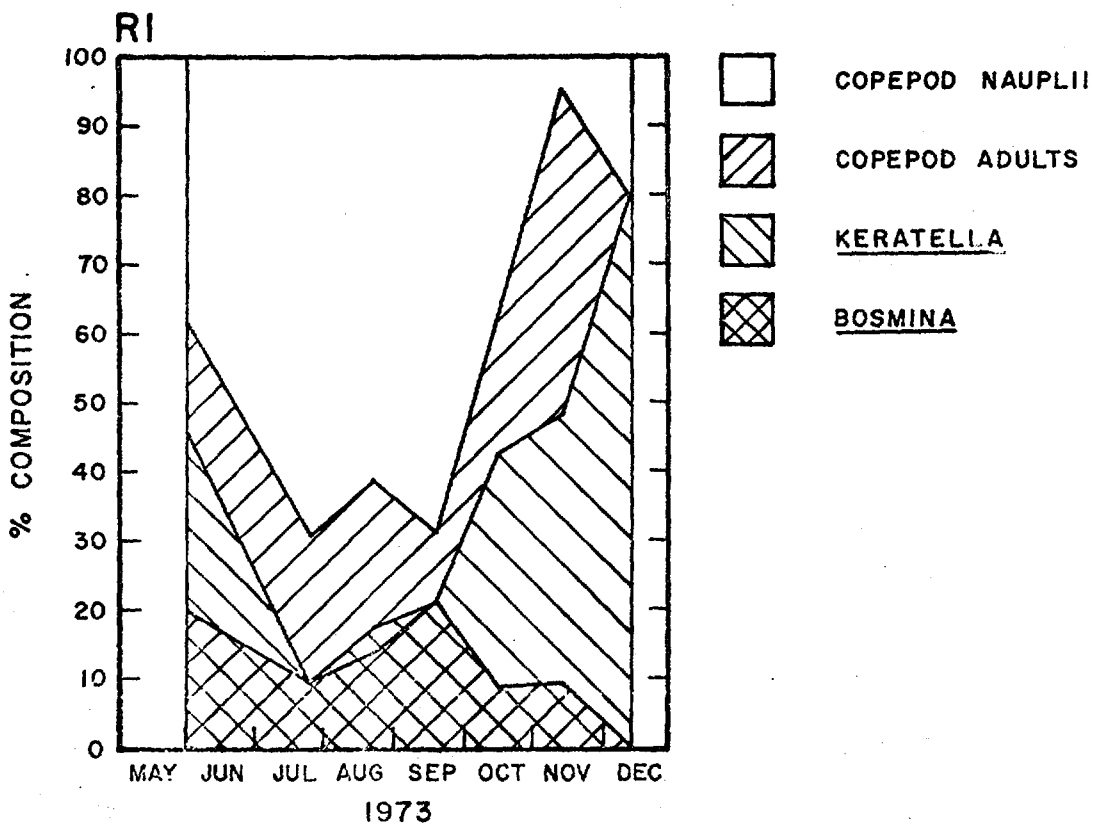

RI
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
NUMBER x $10^3/M^3$
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1973
COPEPOD NAUPLII
COPEPOD ADULTS
BOSMINA
KERATELLA

FIGURE III-10
Microzooplankton Composition: 0-10 ft., Dominant Representatives Roseton/Danskammer Point Vicinity, 1973




RI
100
90
80
70
60
50
40
30
20
10
0
% COMPOSITION
MAY JUN JUL AUG SEP OCT NOV DEC
1973
COPEPOD NAUPLII
COPEPOD ADULTS
KERATELLA
BOSMINA

(c) Comparisons

(i) Between Sampling Dates

The results of the three-way ANOVA indicated that there were significant differences in the abundance of copepods, cladocerans, rotifers, and total microzooplankton between collecting dates (see Table III-10).

The results of the one-way ANOVA for dates (Table III-10a) showed that significant differences in microzooplankton abundance occurred (disregarding the depth of tow) at all stations except RSCE. The stations for which differences in dates were proven varied depending on the depth of tow; the 0-20 foot and 0-30 foot depths were, with the exception of RNCE, similar in the locations of interdate differences.

(ii) Between Collecting Depths

The same analysis of variance showed that there were significant differences in the abundance of rotifers and total microzooplankton between sampling depths (Table III-10); the abundance of both decreased as the length (depth range) of the vertical tow increased. Student-Newman-Keuls ranking tests indicated (Table III-11) a decrease in total microzooplankton abundance with an increase in depth with a sharp decrease in rotifer abundance between 10 feet and 20 feet in depth. In both cases, abundance in the 0-20 feet and 0-30 feet tows were similar.

TABLE III-10

Microzooplankton: Three-way Analysis of Variance
ROSETON/DANSKAMMER POINT VICINITY

GROUP	SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Total Microzoo-plankton	Depth	2	0.255	0.127	3.432*
	Station	3	0.202	0.067	0.779
	Date	6	10.003	1.667	19.384*
	Depth Station	6	0.120	0.020	0.541
	Depth Date	12	0.881	0.073	1.973
	Trans Date	18	1.554	0.086	2.324*
		36	1.341	0.037	
	Total	83	14.355		
Rotifers	Depth	2	0.865	0.432	6.646*
	Station	3	0.127	0.042	0.646
	Date	6	2.181	0.363	5.584*
	Depth Station	6	0.165	0.028	0.431
	Depth Date	12	1.229	0.102	1.569
	Trans Date	18	1.796	0.100	1.538
	Depth Station Date	36	2.340	0.065	
	Total	83	8.702		
Cladocerans	Depth	2	0.412	0.206	0.105
	Station	3	8.875	2.958	1.574
	Date	6	92.370	15.394	4.756*
	Depth Station	6	3.860	0.643	1.073
	Depth Date	12	23.489	1.957	3.267*
	Trans Date	18	33.816	1.879	3.137*
	Depth Station Date	36	21.573	0.599	
	Total	83	184.394		
Copepods	Depth	2	0.034	0.017	0.500
	Station	3	0.491	0.164	1.344
	Date	6	23.796	3.966	32.508*
	Depth Station	6	0.172	0.029	0.853
	Depth Date	12	0.743	0.062	1.824
	Trans Date	18	2.190	0.122	3.588*
	Depth Station Date	36	1.240	0.034	
	Total	83	28.665		

*Significant difference at $\alpha = 0.05$

TABLE III-10a

MICROZOOPLANKTON: ONE-WAY ANALYSIS OF VARIANCE BETWEEN DATES
ROSETON/DANSKAMMER POINT VICINITY
1973

	Station	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
A. 0-10' Samples	DI	Date	3	0.318	1.559
		Error	33	0.204	
		Total	36		
	RI	Date	6	0.441	2.087
		Error	48	0.211	
		Total	40		
	RDE	Date	4	0.294	1.003
		Error	36	0.293	
		Total	40		
	RNCW	Date	7	0.639	2.787*
		Error	52	0.229	
		Total	59		
	RNCE	Date	7	0.913	3.518*
		Error	57	0.259	
		Total	64		
	RSCW	Date	7	1.379	4.285*
		Error	43	0.321	
		Total	50		
	RSCE	Date	7	0.537	1.920
		Error	48	0.280	
		Total	55		

*Significant difference at $\alpha = 0.05$

TABLE III-10a
(Continued)

B. 0-20' Samples

Station	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
DI	Date	3	1.594	9.291*
	Error	33	0.171	
	Total	36		
RI	Date	6	0.833	3.171*
	Error	52	0.262	
	Total	58		
RDE	Date	4	1.307	4.999*
	Error	41	0.261	
	Total	45		
RNCW	Date	7	0.357	1.302
	Error	58	0.274	
	Total	65		
RNCE	Date	7	0.613	2.579*
	Error	59	0.238	
	Total	66		
RSCW	Date	7	0.744	2.610*
	Error	51	0.285	
	Total	58		
RSCE	Date	7	0.588	1.748
	Error	65	0.337	
	Total	72		

*Significant difference at $\alpha = 0.05$

TABLE III-10a
(Continued)

	Station	Source of Variance	Degrees of Freedom	Square	F-Ratio
C. 0-30' Samples	DI	Date	3	0.740	3.649*
		Error	38	0.202	
		Total	41		
	RI	Date	6	0.671	2.495*
		Error	54	0.269	
		Total	60		
	RDE	Date	4	1.277	3.893*
		Error	41	0.328	
		Total	45		
	RNCW	Date	7	0.350	1.388
		Error	57	0.252	
		Total	64		
	RNCE	Date	7	0.581	1.703
		Error	69	0.341	
		Total	76		
	RSCW	Date	7	0.749	2.328*
		Error	60	0.322	
		Total	67		
	RSCE	Date	6	1.320	0.769
		Error	59	0.417	
		Total	65		

*Significant difference at $\alpha = 0.05$

TABLE III-11

Student-Newman-Keuls Ranking Test
for Microzooplankton

1) Total Microzooplankton, Depth

RANK	1	2	3
Depth	0-30 ft.	0-20 ft.	0-10 ft.

2) Rotifers, Depth

RANK	1	2	3
Depth	0-30 ft.	0-20 ft.	0-10 ft.

Ranked by increasing abundance from left to right

There were no significant differences in microzooplankton abundance between depths at any of the stations from which samples were obtained (Table III-11a).

Significant depth-date and depth-station interactions were found in cladoceran abundance data.

(iii) Between Stations

The same three-way ANOVA was also used to test for significant differences of abundance among stations. Although no significant differences in the abundance of any of the major microzooplankton groups or in total microzooplankton were found between stations, significant station-date and station-station interactions were found (Table III-10).

(iv) Between 1971-1972 and 1973

The microzooplankton collected in 1972 in the Roseton/Danskammer Point area of the Hudson River showed that copepods were the most abundant species in mid-June. As in 1973, copepod nauplii were more abundant in June than copepod adults, but copepod adults formed a larger fraction of total copepods in 1972 than in 1973. There were approximately half as many copepods present in June 1972 as there were in June 1973. During June 1972, rotifers were more abundant than cladocerans; the opposite relationship was recorded in 1973. As in 1973, a rapid decline in microzooplankton abundance followed the June peak of 1972; however, a second much smaller increase in copepods occurred during late July 1972. Cladocerans and rotifers increased at the same time to approximately four times the density of copepods; the

TABLE III-11a

MICROZOOPLANKTON: ONE WAY ANALYSIS OF VARIANCE BETWEEN DEPTHS
1973
ROSETON/DANSKAMMER POINT VICINITY

Station	Source of Variance	Degrees of Freedom	Mean Square	F-ratio
DI	Depth	2	0.044	0.538
	Error	9	0.082	
	Total	11		
RI	Depth	2	0.111	0.904
	Error	18	0.123	
	Total	20		
RDE	Depth	2	0.079	0.455
	Error	12	0.174	
	Total	14	0.417	
RSCW	Depth	2	0.003	0.012
	Error	21	0.226	
	Total	23		
RSCE	Depth	2	0.092	0.520
	Error	20	0.177	
	Total	22	0.420	
RNCW	Depth	2	0.060	0.404
	Error	21	0.149	
	Total	23		
RNCE	Depth	2	0.058	0.304
	Error	21	0.191	
	Total	23		

second major increase in numbers did not occur until September in 1973. Microzooplankton populations had decreased again by early August, 1972, but increased again in late August, and thereafter declined to less than 1×10^4 organisms/m^3 in October.

In summary, the seasonal patterns of microzooplankton abundance were considerably different between 1972 and 1973: microzooplankters were more abundant in 1973 than 1972; there were three peaks of abundance in 1972 and two peaks of abundance in 1973; and seasonal succession of group dominance was not as easily discernible in 1972 as it was in 1973.

3. Discussion

(a) Seasonal Variation in Abundance. The two copepod naupliar peaks noted in late June and mid-September reflect reproduction of the population (Figure III-9). The development of the first peak was extremely rapid, representing an increase of approximately two orders of magnitude in less than a month. The incorporation of these nauplii into the adult copepod population could have been severely curtailed by lack of adequate algal foods; however, Figures III-4 and III-5 indicate that adequate populations (ca. 1×10^5 cells/liter) were available at that time. The subsequent decrease in diatom abundance during the first peak in naupliar abundance (late June) may, therefore, reflect grazing pressure. The increase in the number of adult copepods during the June naupliar peak was almost certainly due to successful recruitment from immature stages.

A month later, however, naupliar abundance had decreased by an order of magnitude; this decrease was not matched by a recruitment increase in adult copepods (see Figure III-9). Since phytoplankton did not appear to be limiting in late July and early August (Figures III-4 and III-5) it is conceivable that macrozooplankton and ichthyoplankton grazing on copepod nauplii were responsible for the decline in the abundance of copepod nauplii during July and August. The data on seasonal variation of macrozooplankton and ichthyoplankton tend to support this hypothesis. The same hypothesis would appear to be valid for the reduction of naupliar abundance during mid-September. However, in the absence of heavy predation, Heinle (1970) noted that production of nauplii in cultures was always greater than required to replace adult mortality losses, and low naupliar viability may thus be a normal occurrence.

Since the cladoceran population responded in a pattern parallel to that of the copepod population, but at lower levels of abundance (approximately an order of magnitude less), it seems reasonable to assume that the cladoceran population was affected by the same factors and in the same manner as the copepod population.

The parameters affecting fluctuations in the rotifer population are not easily discernible. Temperature may be a controlling factor for Keratella, since these organisms occurred in the greatest numbers in the late spring and early winter (see Figure III-9). Since increases in Keratella abundance occurred when either diatoms or blue-green algae formed a large percentage (33%) of the phytoplankton (during May and October-November, respectively) it is also possible that these two

phytoplankters were necessarily dietary factors for Keratella.

(b) Differences Between Collecting Dates. The observed significant differences in the abundance of microzooplankters between collecting dates was a reflection of the seasonal variations in numbers discussed in the preceding subsection.

(c) Differences Between Depths. Total microzooplankton and rotifers decreased in abundance as the depth (length of tow) increased; there were no significant differences in cladoceran and copepod abundance with depth over the full course of the sampling program.

These results offer support to two interpretations: 1) Rotifers were more abundant in surface waters, whereas copepods and cladocerans were homogeneously distributed throughout the water column, 2) as the depth (length) of tow increased, the filtration efficiency of the net decreased due to progressive clogging. Since highly productive conditions were found in the Roseton/Danskammer Point area during 1973, clogging of a 76μ net was a possibility.

(d) Differences Between Stations. Although occasional differences were found in the abundance of microzooplankton between stations, the microzooplankton population was homogeneously distributed horizontally in the Roseton/Danskammer Point area over the full course of the sampling program.

(e) Differences Between 1971-1972 and 1973. The increase in the standing stock of microzooplankton from 1971-1972 to 1973 may have been related to an increase in phytoplankton, which form the bulk

of microzooplankton rations. It is also possible that the differences resulted from differences in the depth range of the samples used to describe microzooplankton populations; the 1971-1972 samples were based on bottom-to-surface tows, whereas the populations described in this report were obtained in the water between the surface and 10 ft.

4. Conclusions

(a) Copepods were numerically the most important microzooplankton group in the Roseton/Danskammer Point area; cladocerans were the second most abundant group and rotifers were third in abundance.

(b) The seasonal patterns of microzooplankton abundance paralleled the seasonal patterns of phytoplankton abundance and were also related to the seasonal temperature pattern.

(c) Microzooplankton abundance was dependent primarily upon phytoplankton abundance; microzooplankton grazing influences phytoplankton abundance.

(d) Microzooplankters were a food source for macrozooplankton and fish larvae, and the feeding of these predators may have significantly reduced microzooplankton numbers in mid-summer, causing a depression of microzooplankton abundance

(e) With the exception of temperature, which undoubtedly controlled the timing of the annual cycle of microzooplankton abundance,

no chemical or physical factors appeared to be correlated with microzooplankton abundance or distribution.

(f) Total microzooplankton and rotifer abundance, as measured with a 76μ Wisconsin type plankton net, decreased as the depth of water increased.

(g) Microzooplankton standing stocks were homogeneously distributed among the four sampling stations in the Roseton/Danskammer Point area.

(h) Microzooplankton standing stocks increased from 1971-1972 to 1973 probably due to increased availability of algal rations.

(i) Microzooplankton standing stocks can be expected to increase or decrease in the future in response to food (phytoplankton) availability.

E. MACROZOOPLANKTON

1. Materials and Methods

The macrozooplankton program was designed to estimate the importance of these organisms in the Hudson River ecosystem and the potential effects of entrainment on population numbers. Preliminary data were also obtained for the macrozooplankton/fish interface.

(a) Sampling. Macrozooplankton populations were sampled in conjunction with the ichthyoplankton program in 1973. Four transects running

parallel to the shoreline between Roseton and Danskammer Point were sampled at 10 foot intervals from surface to 50 ft as applicable to a particular station (Figure III-1 and Table III-12). Samples were taken with one meter diameter Hensen nets with a TSK or General Oceanics flowmeter mounted in the center of the net mouth; 571μ nylon mesh material was used in each net.

Nets were towed at the same time at each station. Flowmeter readings were recorded before and after each tow, and the samples were preserved in 5-10% formalin for laboratory analysis.

Samples were collected at the Roseton intake and discharge structures using one-half meter diameter nets of 571μ mesh with a TSK or General Oceanics flowmeter mounted in the center of the net mouth.

The nets were mounted in a fixed rigid frame such that they could be raised and lowered to take surface, mid-depth, and bottom samples at the intake. Discharge samples were collected from the discharge access pipe at the seal well.

At the Danskammer Point plant one meter diameter mouth nets were used at the intake (set at surface and bottom) and directly in front of the Unit 3 condenser cooling water discharge pipe. In addition, three one-half meter nets were set in the Danskammer Point intake canal (surface, mid-depth and bottom) for comparison with similar sized nets used at the Roseton Generating Station.

(b) Laboratory Analysis. After being washed on a 420μ screen and resuspended in water, the macrozooplankton samples were counted in a porcelain

TABLE III-12

MACROZOOPLANKTON SAMPLING STATIONS
1973
ROSETON/DANSKAMMER POINT VICINITY

Location	Abbreviation	Sampling Depths, Feet
West	RDW	0, 10, 20
West Channel	RDWCH	0, 10, 20, 30, 40, 50
East Channel	RDECH	0, 10, 20, 30, 40, 50
East	RDE	0, 10, 20
Roseton Intake	RI	0, 10, 20
Roseton Discharge	RD	Discharge Pipe
Danskammer Intake	DI	1, 5.5, 9
Danskammer Discharge	DD	Unit 3 Discharge Pipe

tray divided into four quadrats. During times of peak abundance subsamples were counted: if the first quadrat contained more than 250 organisms but less than 1000 two quadrats were counted; one quadrat was counted if the first quadrat contained more than 1000 organisms.

Counts were corrected for volume sampled using the flowmeter calibration factor, the number of flowmeter revolutions, and the mouth area of the net (Quirk, Lawler and Matusky Engineers, 1973a).

Samples for laboratory analysis were selected on the basis of providing abundance data for each sampling date and station. This goal was achieved for the period May through mid-August and for station FDE from March through mid-August.

(c) Statistical Analysis. Paired Student's 't' tests were conducted to determine significant differences in abundance between day and night samples at individual stations throughout the sampling period. Day samples and night samples were defined as those closest to local noon time and midnight, respectively; the change-over hours between day and night samples were 0600 and 2000 hours. Analysis was limited to amphipods, dipterans, and total macrozooplankton.

A two-way analysis of variance (ANOVA) was conducted to determine whether there were significant differences in abundance between stations and between dates. Separate analyses were done for amphipods, dipterans, and other macrozooplankters; data from night collections were used because macrozooplankton were more abundant in the water column during the night. The data used represented average abundance for the water column at a station.

A paired-t test was used to determine whether there were significant differences in macrozooplankton abundance between intake and discharge waters, and between abundance measurements based on one-meter nets and one-half meter nets at the Danskammer Point plant.

(d) Discussion of Field and Laboratory Procedures. The macrozooplankton program was initiated during 1973 and comparisons with previous data are, therefore, not possible.

Since the macrozooplankton were obtained from samples collected primarily for fish larvae, the period of macrozooplankton abundance determinations was limited to the seasons of larval fish collection (March through August).

Intake/discharge comparisons were conducted for the Danskammer Point plant, for which a greater amount of data were available.

2. Results

A tabulation of the macrozooplankton data collected at the Roseton and Danskammer Point intakes is presented in Appendix III-C.

(a) Species Inventory. Several major macrozooplankton groups were found in the Roseton/Danskammer Point area in 1973 (see Table III-13). Gammarus and dipterans were the most abundant groups, ranging from a few organisms per 1000 cubic meters to over 10,000 organisms/1000m^3, Copepods, cladocerans, Cyathura and Leptodora were often present in significant numbers; all others were present at one time or another.

(b) Diel Migration. Since it is known that the vertical distribution

TABLE III-13

INVENTORY OF MAJOR MACROZOOPLANKTON - 1973
ROSETON/DANSKAMMER POINT VICINITY

Phylum	Class	Sub Class	Order	Sub Order	Family	Genus
Arthropoda	Insecta	Apterygota	Collembola			
		Pterygota	Coleoptera			
			Diptera	Orthorrhapa Nemocera	Tendipedidae	
					Culicidae	*Chaoborus*
			Odonata	Zygopteria		
			Trichoptera			
	Crustacea	Branchiopoda	Diplostraca	Cladocera	Leptodoridae	*Leptodora*
		Copepoda				
		Malacostraca	Isopoda	Anthuridea	Anthuridae	*Cyathura*
				Valvifera	Idoteidae	*Chiridotea*
			Amphipoda	Gammaridea	Gammaridae	*Gammarus*

of many zooplankters, especially crustaceans, is a reflection of diel migration (see Introduction) a series of samples taken on a two-day sampling cycle were examined for the occurrence of diel migration of the macrozooplankton population in the Roseton/Danskammer Point area. Amphipods, as shown in Table III-14,migrated vertically and appeared to be relatively evenly distributed throughout the water column at night. During the day they were present in low numbers at the surface, but in greater numbers in deeper waters. Table III-15 shows that there were significant differences between day and night catches of amphipods, dipterans, and total macrozooplankton, presumably a reflection of diel migration, over the March to August time period; these results were based on paired-t tests of abundance at the stations and on the dates for which the most complete data were available.

Samples collected at the Roseton and Danskammer Point intakes and discharges also reflect diurnal migration. The abundance of macrozooplankton was greatest from midnight to dawn in these samples (Tables III-15a and III-15b).

(c) Seasonal Variation. The abundance of total macrozooplankton at RDE, for example, remained under 100 organisms/1000m^3 in March, April, and May; increased rapidly in June to an early July peak of almost 50,000 organisms/1000m^3 and then decreased to about 1000 organisms/1000m^3 in mid-August (Table III-15c). The rapid increase in abundance in June appeared to be a reflection of increases in Gammarus, although dipterans and other groups were increasing at the same time. Similarly, the decline from early July to mid-August appeared to be a reflection of changes

TABLE III-14

VERTICAL DISTRIBUTION OF AMPHIPODS,
RDECH ON JUNE 7 AND 8, 1973
ROSETON/DANSKAMMER POINT VICINITY

8:30 - 10:30 pm

DEPTH	NO./1000m^3
0	684
10	8843
30	6780
40	20997
50	23958

12:30 - 4:30 am

DEPTH	NO./1000m^3
0	762
10	1420
20	19383
40	11181
50	10842

5:30 - 10:30 am

DEPTH	NO./1000m^3
0	12
10	0
30	1448
40	4008
50	10344

TABLE III-15

COMPARISON OF DAY AND NIGHT MACROZOOPLANKTON
SURFACE SAMPLES IN THE ROSETON/DANSKAMMER POINT VICINITY, 1973

Paired t-Test

a) May 22 - 23, 1973; all stations

	t	Degrees of Freedom	p at $\alpha = 0.05$	
Amphipods	-14.26	7	<.001	Significant diff; night higher
Dipterans	- 4.68	7	<.001	" "
Total Macro.	-10.56	7	<.001	" "

b) June 7 - 8, 1973; all stations

Amphipods	- 5.16	7	<.001	Significant diff; night higher
Dipterans	- 4.72	7	<.001	" "
Total Macro.	- 4.38	7	<.001	" "

c) RDE; all dates

Amphipods	- 2.87	13	<.01	Significant diff; night higher
Dipterans	- 3.06	13	<.005	" "
Total Macro.	- .99	13	<.2	No Significant diff.

TABLE III-15a

MACROZOOPLANKTON ABUNDANCE
MAY 22-23, 1973
ROSETON/DANSKAMMER POINT VICINITY

Numbers/1000m^3

Date	Time	Depth	Amphipods	Dipterans	Others	Total
		A. Intake - 1/2m Net				
5/22	1200	Surface	0	0	25.2	25.2
		Mid-Depth	0	23.1	46.3	69.4
		Bottom	24.8	99.1	24.8	148.7
		Average	8.3	40.7	32.1	81.1
	1900	Surface	33.3	0	33.3	66.6
		Bottom	0	34.2	102.7	136.9
		Average	11.1	11.5	45.3	67.8
5/23	2400	Surface	1434.8	956.5	239.1	2630.4
		Mid-Depth	494.6	164.8	0	659.3
		Bottom	4092.7	629.6	89.9	4812.3
		Average	2007.4	583.6	109.7	2700.7
	0625	Surface	67.9	0	67.9	135.8
		Mid-Depth	125.8	0	0	125.8
		Bottom	0	0	0	0
		Average	64.6	0	22.6	87.2
	0940	Surface	0	25.7	0	25.7
		Mid-Depth	0	0	0	0
		Bottom	0	0	0	0
		Average	0	8.6	0	8.6

TABLE III-15a
(Continued)

Date	Time	Depth	Amphipods	Dipterans	Others	Total
		B. Discharge - 1m Net				
5/22	1245	Mid-Depth	0	0	35.4	35.4
	1826	Mid-Depth	5.8	0	23.1	28.9
	2310	Mid-Depth	0	0	0	0
5/23	0625	Mid-Depth	99.9	99.9	49.9	169.8

TABLE III-15b

MACROZOOPLANKTON ABUNDANCE
JULY 31-AUGUST 1, 1973
ROSETON/DANSKAMMER POINT VICINITY

Numbers/1000m^3

Date	Time	Depth	Amphipods	Dipterans	Others	Total
		A. Intake - 1/2m Net				
7/31	1107	Surface	29.5	0	236.2	275.7
		Bottom	80.2	53.5	4117.5	4251.2
		Average	54.85	26.75	2176.9	2258.5
	1600	Surface	0	783.6	3787.4	4571.0
		Bottom	147.6	147.6	1476.3	1771.6
		Average	73.8	465.6	2631.9	3171.3
	2135	Surface	4832.2	1750.0	26.1	6608.3
		Bottom	7119.0	4004.4	46.8	11170.3
		Average	5975.6	2877.2	36.5	8889.3
8/1	0106	Surface	32158.2	9687.4	2996.1	44841.7
		Bottom	66638.4	8807.3	4456.7	79902.4
		Average	49398.3	9247.4	3726.1	62372.1
	0545	Surface	17220.5	3395.6	0	20616.1
		Bottom	27892.3	8974.0	242.5	37108.9
		Average	22556.4	6184.8	121.3	28862.5

TABLE III-15b
(Continued)

Date	Time	Depth	Amphipod	Dipterans	Others	Total
		B. Discharge - 1/2m Net				
7/31	1123	Mid-Depth	48.1	323.2	2347.1	2818.4
	1635	Mid-Depth	188.6	754.6	565.9	1509.1
	2045	Mid-Depth	754.6	1383.4	251.5	2389.5
8/1	0145	Mid-Depth	3174.1	959.6	0	4133.8
	0615	Mid-Depth	5993.9	1771.6	29.5	7795.1

TABLE III-15c

MACROZOOPLANKTON ABUNDANCE BY SAMPLING
DATE AT RDE, 1973
ROSETON/DANSKAMMER POINT VICINITY

Date	No./1000m^3
March 13	11.5
March 21	0
April 11	11.0
May 10	55.1
May 22	22.3
June 8	102.5
June 19	770.3
July 2	49,320.0
July 17	27,629.7
July 31	635.3
August 14	1,004.3

Note: Samples taken closest to noon at the greatest depths

in the Gammarus population. The data showed that populations of dipterans and others remained constant or even increased slightly during the July-August decline in overall macrozooplankton abundance. Other groups were present only in very small numbers and on relatively few sampling dates.

Significant differences in abundance between dates occurred for all three taxonomic groups (Table III-16); these differences mirrored the seasonal trends discussed previously.

(d) Differences Between Stations. There were no significant differences in the abundance of amphipods, dipterans, or others between stations in the Roseton/Danskammer point area (Table III-16).

(e) Intake and Discharge Comparisons.

(i) Between One-Meter Nets and One-Half Meter Nets

A paired-t test (Table III-17) indicated that significantly more amphipods and total macrozooplankton were present at Danskammer Point intake as determined by the one-half meter nets than as determined by the one-meter nets.

(ii) Between Intake and Discharge Abundance

A paired-t test (Table III-18) showed that amphipods were significantly more abundant in intake waters than in discharge waters based on comparisons of abundance in one-meter net samples.

(f) River and Intake Comparisons. One-way ANOVA were conducted to determine whether there were significant differences in macrozooplankton

TABLE III-16

Macrozooplankton: Two-way Analysis of Variance
Between Stations and Dates
ROSETON/DANSKAMMER VICINITY, 1973

GROUP	SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Amphipods	Stations	3	0.17376	0.5792	0.124
	Dates	7	15.16040	2.16577	4.638*
	Error	42	19.61155	0.46694	
Dipterans	Stations	3	0.69911	0.23304	0.752
	Dates	7	15.46767	2.20967	7.131*
	Error	42	13.01365	0.30985	
Others	Stations	3	1.33649	0.44550	1.032
	Dates	7	43.47953	6.21136	14.392*
	Error	42	18.12644	0.43158	

*Significant difference at $\alpha = 0.05$

TABLE III-17

MACROZOOPLANKTON: ONE-METER AND ONE-HALF METER NET COMPARISON
FOR DANSKAMMER POINT INTAKE
1973
ROSETON/DANSKAMMER POINT VICINITY

PAIRED-T TEST

Group	Degrees of Freedom	t-value	p
Total Macrozooplankton	4	t = -3.627	0.01 < p 0.025
Amphipods	4	t = -2.898	0.025 < p 0.05
Dipterans	4	t = -2.541	0.05 < p 0.10
Others	4	t = -1.979	0.10 < p 0.20

Critical t-value at $\alpha = 0.05$: 2.776

TABLE III-18

MACROZOOPLANKTON COMPARISON OF ABUNDANCE
IN DANSKAMMER POINT INTAKE AND DISCHARGE
1973
ROSETON/DANSKAMMER POINT VICINITY

PAIRED-T TEST

Group	Degrees of Freedom	t-value	p
Total Macrozooplankton	4	t = -2.449	0.05 < p < 0.10
Amphipods	4	t = -2.945	0.025 < p < 0.05
Dipterans	4	t = -1.582	0.10 < p < 0.20
Others	4	t = -2.395	0.05 < p < 0.10

Critical t-value at $\alpha = 0.05$: 2.776

data among stations; data from night collections were used since macrozooplankton were significantly more abundant at night.

Table III-19 shows that amphipod abundance in surface waters was significantly different among stations. A Student Newman-Keuls ranking test indicated that amphipods at RDW were significantly more abundant than at the other stations.

A similar one-way ANOVA was conducted for macrozooplankton in mid-depth samples; there were no significant differences in macrozooplankton abundance among stations.

3. Discussion

(a) Diel Migration. River and plant macrozooplankton data collected during 1973 indicated greater concentrations of macrozooplankton in samples collected during night-time hours than in samples collected during daylight hours. Such diel migration will directly affect concentrations of entrained macrozooplankton; i.e., greater numbers will be entrained at night.

Diel migration is, however, also of significance in terms of trophodynamics. Macrozooplankters feeding in deeper waters during the daylight hours may be obtaining most of their nutritional needs as benthic-based carnivores or omnivores. During the night hours they may be primarily planktonic herbivores or omnivores. In any case, their metabolic products, in the form of fecal pellets and dissolved organic matter, may contribute significantly to the nutrition of organisms throughout the water column.

TABLE III-19

MACROZOOPLANKTON: ONE-WAY ANALYSIS OF VARIANCE
BETWEEN STATIONS
1973
ROSETON/DANSKAMMER POINT VICINITY

	Group	Source of Variance	Degrees of Freedom	Mean Square	F-Ratio
A. Surface Samples 1m Net	Total Macrozoo.	Stations	4	1.579	2.104
		Error	73	0.751	
		Total	77		
	Amphipods	Stations	4	2.862	2.970*
		Error	73	0.964	
		Total	77		
	Dipterans	Stations	4	1.438	1.843
		Error	73	0.780	
		Total	77		
	Others	Stations	4	0.862	0.710
		Error	73	1.214	
		Total	77		
B. Mid-Depth Samples 1m Net	Total Macrozoo.	Stations	4	2.444	1.882
		Error	69	1.299	
		Total	73		
	Amphipod	Stations	4	3.485	2.202
		Error	69	1.582	
		Total	73		
	Dipterans	Stations	4	0.640	0.734
		Error	69	0.872	
		Total	73		
	Others	Stations	4	1.457	0.959
		Error	69	1.519	
		Total	73		

*Significant difference at $\alpha = 0.05$

TABLE III-19
(Continued)

STUDENT-NEWMAN-KEULS RANKING TEST
FOR AMPHIPODS - SURFACE SAMPLES

Rank	1	2	3	4	5
Station	RDWCH	RDECH	RDE	DI	RDW

Macrozooplankters formed a significant portion of the diet of fishes in the Roseton/Danskammer Point area. Selected fish stomach content examinations showed that alewives, white perch, and brown bullheads consumed a variety of macrozooplankters, including copepods, dipterans, water mites, leeches, cladocerans, ostracods, amphipods, isopods, and caridean shrimp. It is possible that the vertical distribution of the macrozooplankters which contribute significantly to their diet.

It may be hypothesized on the basis of the present data that macrozooplankton populations are a crucial link in the rapid re-cycling of energy held in the benthos. At the same time, they may be the major trophic step between primary producers and populations of small herbivores and fish. Thus, any radical changes in macrozooplankton abundance could conceivably alter the abundance of commercially important fish species, as well as benthic populations and other planktonic populations.

(b) Seasonal Variations. The initial increase in macrozooplankton numbers appeared to parallel the spring increase in temperature (see Chapter VII). However, by comparing the development and decline of the macrozooplankton population with the abundance of phytoplankton and microzooplankton populations over time (Figures III-2, III-4, III-6 and III-8), a closer parallel is apparent. It is probable that the amphipods in particular were feeding on the microzooplankton, and may have been selecting for cladocerans (Hutchinson, 1967). Although the seasonal abundance data for macrozooplankton does not cover the full year, it is possible that the June-July abundance peak was matched by a fall pulse of abundance

since macrozooplankton food sources (phytoplankton and microzooplankton) were abundant during the fall months.

(c) Intake and Discharge Abundance and Viability Comparisons. In general it appeared that fewer macrozooplankton organisms were collected in discharge samples than in intake samples. Statistical tests for amphipod concentrations confirmed this observation. However, the number of samples available for comparison was small, and in conjunction with the technical sampling difficulties involved, the results are inconclusive at this time.

In conjunction with ichthyoplankton viability studies conducted at Danskammer Point and Roseton, viability observations were made on the dominant macrozooplankton populations. Evaluation for living and dead zooplankters was done on intake and discharge samples collected during the last two weeks in July and the first two weeks in August.

Dipterans were the dominant group collected at both sites composing 60% of the 14,720 specimens examined at Danskammer and 48% of the 25,587 organisms at Roseton. This group exhibited a high degree of viability at Danskammer Point: 99% of the dipterans from the intake collections and 96% of the dipterans from the discharge collection were alive. The viability percentage was slightly less in the Roseton intake and discharge collections (98% and 91%, respectively). At both plants the dominant dipteran was Chaoborus sp., which composed 96% of the total.

The second most abundant group in the samples examined was amphipods, represented by Gammarus sp.; they accounted for 36% of the Danskammer

Point macrozooplankton and 46% of the collection at Roseton. Little difference was noted between intake and discharge samples at Danskammer; both averaged 99% viability at the Roseton intake, amphipods exhibited 98% viability; amphipods collected at the discharge averaged 92% viability.

Overall viability at Danskammer for macrozooplankton averaged 99% the intake and 97% at the discharge. At Roseton the average intake viability was 95%, with 88% recorded in discharge samples. For both plants the difference between intake and discharge samples could be attributed to passage through the plant or to greater net mortalities experienced in the more turbulent discharge collections. The lower viabilities experienced at Roseton reflected poorer survival rates for cladocerans, which had a viability of 47% at Roseton intake and 26% at Roseton discharge. In the samples collected at Danskammer Point, cladocerans exhibited 100% viability at both intake and discharge.

(d) Differences Between Stations. There was no significant difference in total macrozooplankton abundance between the Danskammer Point intake and stations in the Hudson River. However, amphipods were significantly more abundant at RDW than at other river stations. Other than a simple explanation of lateral distribution, the reasons for this are not clear at this time. The number of samples collected at the Roseton plant intake was insufficient for statistical comparison with other stations.

4. Conclusions

(a) Amphipods (*Gammarus* sp.) and dipterans were the most abundant

macrozooplankters in the Roseton/Danskammer Point area during 1973.

(b) At least one peak of macrozooplankton abundance (in the early summer) occurs in the annual cycle of macrozooplankton abundance.

(c) Macrozooplankters in the Roseton/Danskammer Point area were an important link between the plankton community and planktivorous fishes, serving also to cycle nutrients between the benthic and plankton communities.

(d) One-half meter nets located in the Danskammer Point intake provided samples indicating significantly greater abundance of macrozooplankters than were indicated by samples from one meter nets.

(e) There was no significant difference between macrozooplankton abundance at the Danskammer Point intake and stations located in the Hudson River.

(f) Amphipod abundance was found to be significantly greater at RDW than at other Hudson River stations.

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TABLE IV-13

CALCULATED FISH SUPPORT POTENTIAL OF CRUSTACEANS PER m^2
ROSETON/DANSKAMMER POINT VICINITY
($B_F = 0.950\ B_B$)

	NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
	1	2	3	1	2	3	1	2	3	1	2	3
1971:												
Fall				442.97	454.43	86.31		5.31	247.06			311.27
					$\bar{x}$ = 327.90			$\bar{x}$ = 126.19			$\bar{x}$ = 311.27	
Winter			7805.56	NB	1750.24	215.56		229.88	64.63		644.63	3330.75
		$\bar{x}$ = 7805.56			$\bar{x}$ = ND			$\bar{x}$ = 147.26			$\bar{x}$ = 1987.69	
1972:												
Spring	4.50	235.59	2398.55		1129.76	654.85	NB	271.20	48.68	71.17	1220.55	2769.56
		$\bar{x}$ = 879.55			$\bar{x}$ = 892.31			$\bar{x}$ = ND			$\bar{x}$ = 1353.76	
Summer	118.22	104.31	921.14	174.66	1399.71	1423.02	166.89	1139.96	65.85	NB	11515.48	1925.30
		$\bar{x}$ = 381.22			$\bar{x}$ = 999.13			$\bar{x}$ = 457.57			$\bar{x}$ = ND	
Fall	NB	96.53	299.40	852.96	1098.24	NB	200.01	195.52	488.39	361.46	7.76	1355.54
		$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = 294.64			$\bar{x}$ = 574.92	
Winter		42.13	NB	NB	283.46	1734.30	NB	46.22		220.47	4.50	3097.61
		$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = 1107.53	
1973:												
Spring		63.39	227.01	36.39	37.63	249.93	52.76	188.97	48.26	353.39	26.99	825.01
		$\bar{x}$ = 145.20			$\bar{x}$ = 107.98			$\bar{x}$ = 96.66			$\bar{x}$ = 401.80	
Summer		62.17	75.26	NB	146.84	1553.08	93.25	96.94	1037.31	225.78	39.26	2912.71
		$\bar{x}$ = 68.72			$\bar{x}$ = ND			$\bar{x}$ = 409.17			$\bar{x}$ = 8509.99	
Fall	98.16	24.54	49.49	160.33	229.45	119.44	38.86	22.50	128.02	437.25	187.74	61.36
		$\bar{x}$ = 57.40			$\bar{x}$ = 169.74			$\bar{x}$ = 63.13			$\bar{x}$ = 228.78	
Winter		NB		1229.54	329.27	4053.91	94.90	380.40	571.18	851.19	NB	4461.31
		$\bar{x}$ = ND			$\bar{x}$ = 1870.91			$\bar{x}$ = 348.83			$\bar{x}$ = ND	

TABLE IV-12

CALCULATED FISH SUPPORT POTENTIAL OF INSECTS PER m^2
ROSETON/DANSKAMMER POINT VICINITY
($B_F = 0.950\ B_B$)

	NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
	1	2	3	1	2	3	1	2	3	1	2	3
1971:												
Fall	364.86	201.24	NB	43.77	195.52	NB	389.40	393.50	376.63	371.39	NB	
		$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = 386.54			$\bar{x}$ = ND	
Winter	50.60	1670.91	1170.24				829.93	720.72	1161.23	995.58	1906.08	2171.1
		$\bar{x}$ = 963.92						$\bar{x}$ = 903.96			$\bar{x}$ = 1690.93	
1972:												
Spring	58.08	1153.87	94.08	212.70	1222.60	315.77	218.02	226.61	330.50	487.98	265.46	174.6
		$\bar{x}$ = 435.34			$\bar{x}$ = 583.69			$\bar{x}$ = 258.38			$\bar{x}$ = 309.37	
Summer	105.12	415.99	502.29	277.32	629.09	157.47	322.32	478.98	382.03	477.34	327.64	205.3
		$\bar{x}$ = 341.13			$\bar{x}$ = 629.09			$\bar{x}$ = 394.44			$\bar{x}$ = 336.77	
Fall	479.38	754.25	841.38	NB	NB	NB	NB	58.08	NB	NB	NB	551.3
		$\bar{x}$ = 691.67			$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = ND	
Winter	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
		$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = ND			$\bar{x}$ = ND	
1973:												
Spring	121.89	472.83	468.33	182.01	663.45	414.34	337.85	539.10	508.83	139.89	90.80	186.1
		$\bar{x}$ = 354.35			$\bar{x}$ = 419.93			$\bar{x}$ = 461.93			$\bar{x}$ = 138.93	
Summer	474.07	188.16	712.94	675.72	854.05	7524.13	532.96	1070.43	1815.28	1155.10	40.50	1392.7
		$\bar{x}$ = 458.39			$\bar{x}$ = 854.05			$\bar{x}$ = 1139.56			$\bar{x}$ = 862.78	
Fall	343.59	175.07	242.55	892.91	110.86	19.23	274.05	321.49	831.16	123.10	162.38	605.7
		$\bar{x}$ = 253.74			$\bar{x}$ = 341.00			$\bar{x}$ = 475.57			$\bar{x}$ = 297.09	
Winter		1553.50	843.83	835.65	282.23	NB	1031.58	873.28	869.19	759.56	367.31	115.3
		$\bar{x}$ = 1198.67			$\bar{x}$ = ND			$\bar{x}$ = 924.68			$\bar{x}$ = 414.07	

TABLE IV-11

CALCULATED FISH SUPPORT POTENTIAL OF OLIGOCHAETES PER m^2
ROSETON/DANSKAMMER POINT VICINITY
($B_F = 0.950\ B_B$)

	NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
	1	2	3	1	2	3	1	2	3	1	2	3
1971:												
Fall	2116.33	NB	1117.87		793.93	2898.39	1288.04	4497.71	2542.95	4156.98	163.61	127.21
		$\bar{x}$ = ND			$\bar{x}$ = 1846.16			$\bar{x}$ = 2776.23			$\bar{x}$ = 1482.60	
Winter	3215.81	4703.05	4645.78	755.48	1733.88	1548.19	1065.11	2415.33	3460.00	1273.32	3306.62	1705.67
		$\bar{x}$ = 4188.21			$\bar{x}$ = 1345.85			$\bar{x}$ = 2313.48			$\bar{x}$ = 2095.20	
1972:												
Spring	7715.57	8765.55	722.86	16409.13	45879.48	2003.03	5535.43	15871.66	6221.37	3620.35	2814.96	809.07
		$\bar{x}$ = 5734.66			$\bar{x}$ = 21430.55			$\bar{x}$ = 19209.49			$\bar{x}$ = 2414.79	
Summer	4378.68	7306.13	2630.08	14589.76	12633.77	NB	8205.59	4144.31	5664.27	5530.52	1772.74	809.46
		$\bar{x}$ = 4771.63			$\bar{x}$ = ND			$\bar{x}$ = 6004.72			$\bar{x}$ = 2704.24	
Fall	936.68	2850.13	3430.15	9410.60	3342.60	541.56	NB	6438.16	2489.37	711.30	626.64	2666.89
		$\bar{x}$ = 2405.65			$\bar{x}$ = 4431.59			$\bar{x}$ = ND			$\bar{x}$ = 1334.94	
Winter	1475.79	1559.24	1046.31	1063.49	890.46	5411.90	NB	935.46	2329.44	944.44	1458.19	858.97
		$\bar{x}$ = 1360.45			$\bar{x}$ = 7365.85			$\bar{x}$ = ND			$\bar{x}$ = 1087.20	
1973:												
Spring	1151.42	2293.44	5081.40	1674.16	1004.99	1571.50	2495.91	781.66	1249.99	168.11	225.38	31.49
		$\bar{x}$ = 2842.09			$\bar{x}$ = 1416.88			$\bar{x}$ = 1509.19			$\bar{x}$ = 141.66	
Summer	2376.46	5306.37	4625.02	1774.38	2895.53	1352.66	1179.64	602.40	1272.49	2168.28	179.56	7358.48
		$\bar{x}$ = 4102.62			$\bar{x}$ = 2007.52			$\bar{x}$ = 1018.18			$\bar{x}$ = 3235.44	
Fall	231.10	1530.18	2550.72	822.15	1234.45	269.95	1383.34	750.98	7678.76	839.33	266.68	138.25
		$\bar{x}$ = 1437.33			$\bar{x}$ = 775.52			$\bar{x}$ = 3271.03			$\bar{x}$ = 414.75	
Winter	40.08	1608.72	3558.58	688.40	1741.26	744.02	1483.97	3363.87	2509.81	1028.72	493.30	58.49
		$\bar{x}$ = 1735.79			$\bar{x}$ = 1057.89			$\bar{x}$ = 2452.55			$\bar{x}$ = 526.84	

The rate of benthic productivity, P_B, is derived from values presented by Gerking (1962). Since productivity rate reportedly varies from approximately 1 to 10 times the average standing crop, a rate factor of 5 has been assumed. Most of the rates cited in Gerking (1962) were less than 5 although values up to 7.4 were reported. These values were based on studies of fresh water communities. Peer's (1970) work indicated production rates for a marine polychaete ranged from 1 to 10 times the standing crop. Since estuaries are generally more productive than the adjacent sea or freshwater systems (Odum, 1971) (Menzies and Rowe, 1973), the value of 5 may provide a reasonable estimate of benthic productivity.

The fish support potential (B_F) equation, with the appropriate values substituted, was used as follows:

$$B_F = 0.190\ (5)\ (B_B)$$

or

$$B_F = 0.950\ (B_B)$$

Benthic biomass data was used to calculate the fish support potential of the major classes that account for the bulk of the biomass, namely, oligochaetes, insects, and crustaceans. Calculated fish support potential for the major groups collected in benthic samples are presented in Tables IV-11 through IV-13 for all transects from fall 1971 through winter 1973. Although gaps in biomass calculations occur during the fall and winter of 1972, general trends based upon B_F may be discussed.

by some species (see Chapter VI). Other fish species were found to feed preferentially on other fish. This relationship of benthos at the lower levels of the trophic structure is the basis for the fish support potential analysis.

Due to this substantial interaction, theoretical consideration of energy flow from benthos to fishes can be made. The following equation, based on information presented by Gerking (1962) and Hayne and Ball (1956), has been developed to estimate the quantity of biomass (energy) transferred from the benthos to fish populations:

$$B_F = \frac{F_p}{B_p} \quad (P_B) \quad (B_B)$$

where: B_F = fish support potential, i.e., biomass of fish produced by consumption of benthos.

F_p = weight of fish production.

B_p = weight of benthic production.

P_B = rate of benthic productivity.

B_B = observed benthic standing crop biomass.

Hayne and Ball (1956) calculated F_p as 181 lbs. and B_p as 811 lbs. Data from Allen's New Zealand study (cited in MacFayden, 1963) indicate an F_p value of 2,280 kg and a B_p value of 14,620 kg. Using data from Hayne and Ball (1956) $\frac{F_p}{B_p} = 0.223$ and based on Allen's data the ratio is 0.156. The mean of these two values, 0.190, is used in this study. The ratio is the percentage of benthic biomass biologically converted into fish biomass.

Fluctuations in benthic community composition are largely due to mortality. Except for periods of natality, when dispersal of larval forms occurs, movement of most benthos is limited (Scheltema, Unpubl.). Mortality is due to physiological death, interspecific competition,or predation (Odum, 1971). Deaths due to causes other than predation no doubt do occur in benthic communities; however, a number of investigators (see Gerking, 1962; Hayne and Ball, 1956) have suggested that the percentage of the community to be lost by this cause is negligible. Most losses are attributed to predation by bottom feeding organisms. Peer (1970) estimated that 80% of the mortality in a marine population of Pectinaria was due to predation.

Predation on the benthos by fishes has considerable influence on benthic productivity. Hayne and Ball (1956) estimated fresh water benthic productivity to equal 17 times the standing crop when fishes were present in a pond. In the absence of fishes the production rate of the same pond was reduced but standing crop increased.

Allen (1951) found that trout in a New Zealand stream consumed 100 times the average benthic standing crop. Ball and Hayne (cited in Gerking, 1962) observed that following removal of the fishes from a Michigan Lake the standing crop of benthos was 2 to 3 times greater than at comparable periods before the fishes were removed.

Stomach analysis conducted on selected species of fish in the Roseton/ Danskammer Point area indicated selective feeding on benthic organisms

5. Fish Support Potential

Communities of organisms are in constant states of flux. Natality, mortality, immigration, and emigration influence community abundance, biomass, diversity, and stability (Odum, 1971). Periodic sampling of a community provides information about the instantaneous standing crop (i.e. the community composition, abundance, biomass, and diversity at that point in time and space). While this information is valuable, no estimate of community productivity is provided. Productivity is a measure of the amount of organic matter produced by a community per unit time and is usually derived from biomass data (Russell-Hunter, 1970).

Estimates of productivity are useful in assessing energy flow through biological systems (Hayne and Ball, 1956). Energy flow is effected by predation of one organism upon another. Organic matter produced by the prey organism is utilized by the predator to produce new organic material (see Smith, 1966). Determination of energy transferred between trophic levels provides improved understanding of the ecosystem.

Gerking (1962) has reviewed a number of estimates of benthic productivity in freshwater environments. Estimates based on direct measurements of productivity ranged from slightly more than 1.0 to 7.4 times the standing crop biomass. Production rates of certain organisms such as Tanypus, Corethea, and Chironomus were generally greater than total community production rate. Annual production by the marine polychaete Pectinaria hyperborea ranged from 1 to 10 times the standing crop biomass (Peer, 1970).

oligochaetes reproduce during early summer (Edmondson and Winberg, 1971). A general increase in biomass per unit area occurred at North Control and MaxΔT, which may reflect successful recruitment at these locations. No trends were observed with increasing depth.

Dipteran biomass distribution per unit area must be viewed cautiously, since seasonal biomass increase may be biased by major emergence. A general trend of increased biomass from spring through winter occurred at all stations in 1973. Biomass estimates were not determined for MaxΔT in the fall and winter of 1972. The greatest biomass per unit area occurred during the winter of 1971 at South Control. No apparent trends with depth or transect were observed.

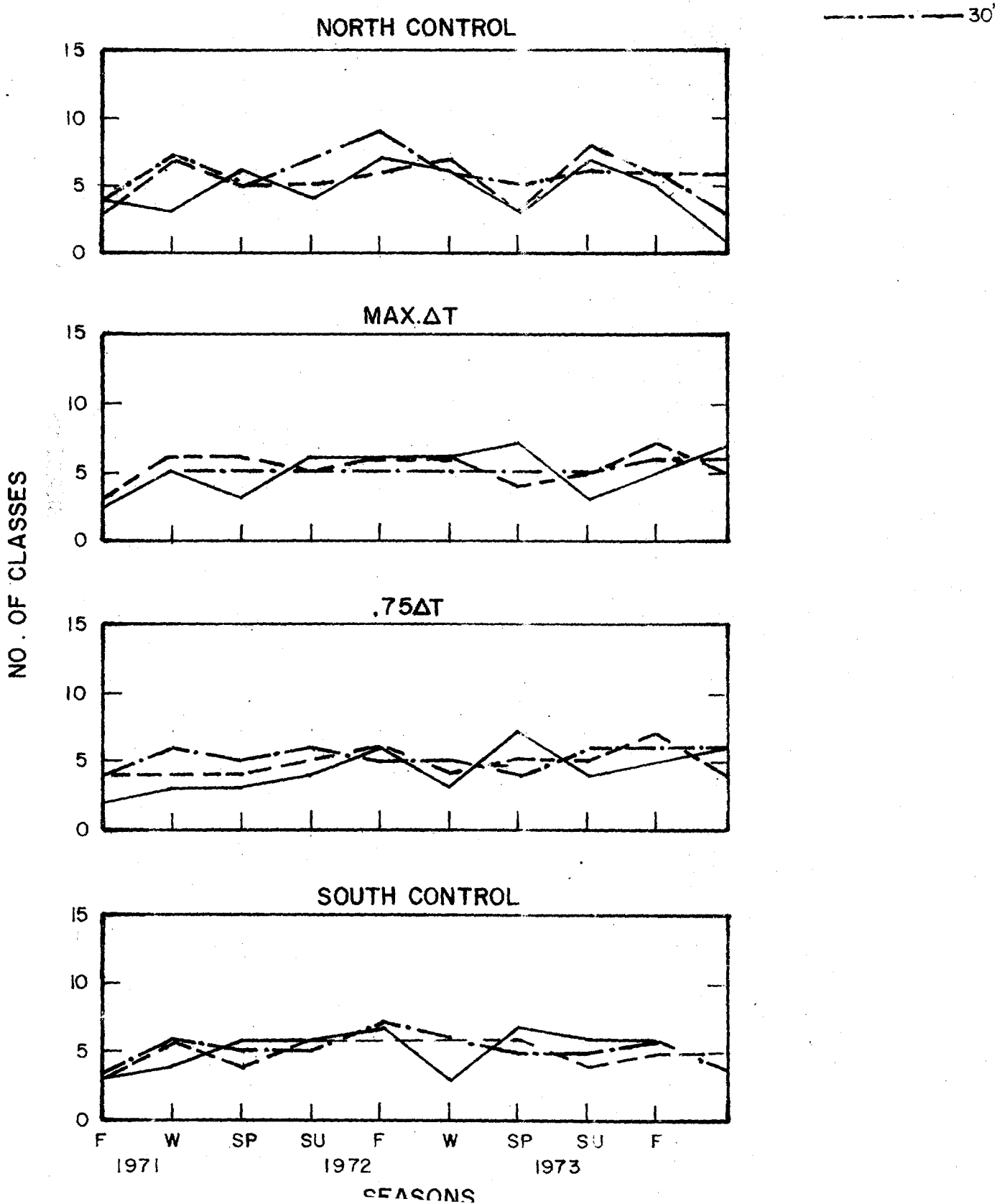
Crustacean biomass distribution reflects the contribution to community productivity by the isopod and amphipod groups. Greatest relative abundance was observed during the summer and fall of 1972 and winter of 1973. A general decrease in biomass per unit area occurred during the fall of 1972 and 1973 which may indicate summer reproduction and greater fall predation. No trends were apparent, although higher biomass per unit area with increasing depth was observed at South Control.

No trends with depth in total biomass were observed at the transects. Two general biomass peaks occurred during spring-summer 1972 and summer-fall 1973 at North Control and MaxΔT for all depths. Similar seasonal peaks were observed at .75ΔT for all depths.

FIGURE IV-28

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: NUMBER OF CLASSES PRESENT ACCORDING TO SEASON DEPTH AND TRANSECT 1971 - 1973



ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL BIOMASS BY SEASON, TRANSECT AND DEPTH 1971-1973

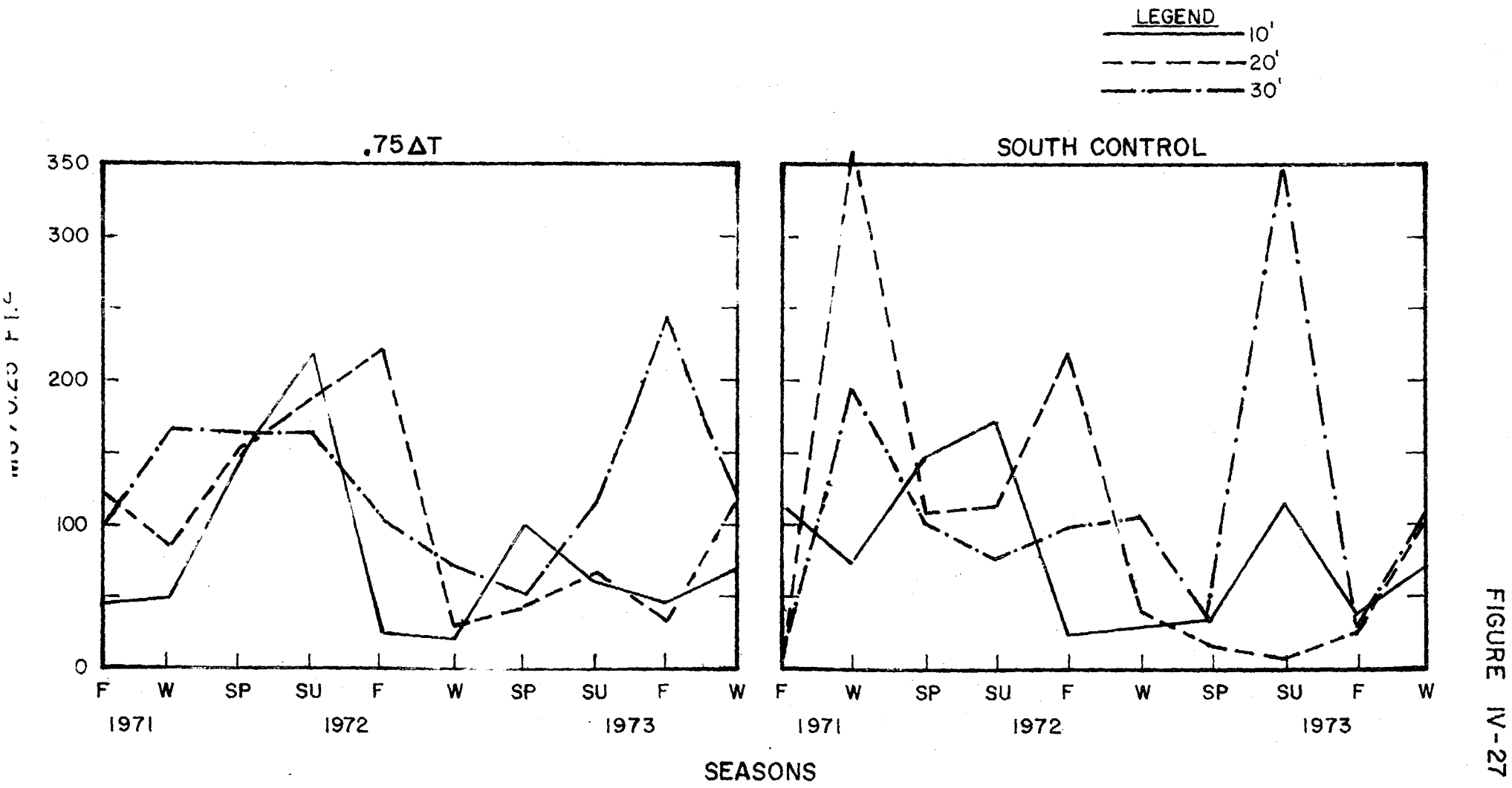


FIGURE IV-27

ROSETON / DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL BIOMASS BY SEASON, TRANSECT, AND DEPTH 1971-1973

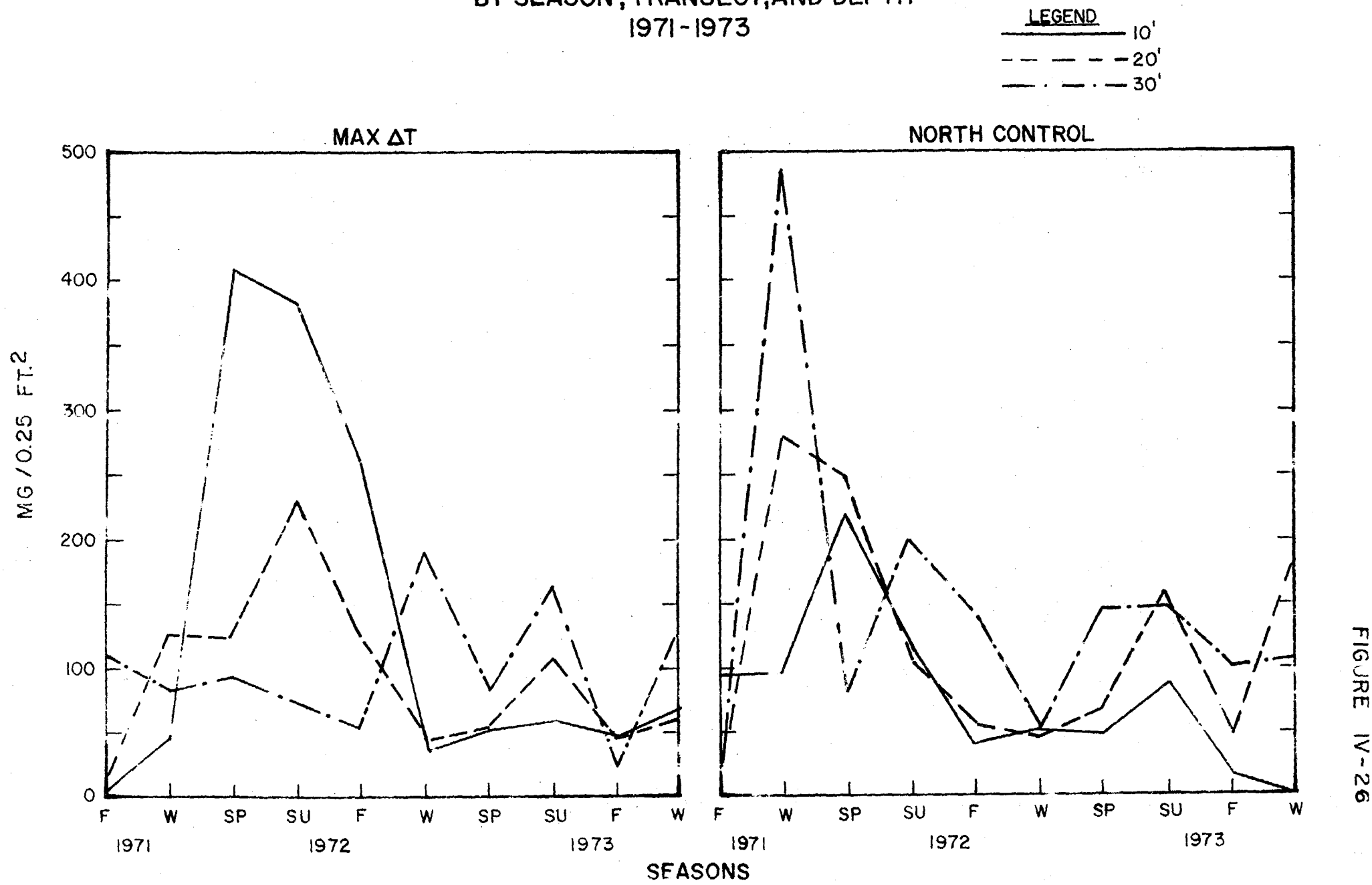


FIGURE IV-26

4. Biomass Distribution By Class

The standing crop of estuarine benthos may vary according to seasonal changes in community composition in response to alterations in physical and chemical components of a given location. Increases in standing crop are accomplished through reproduction and recruitment, whereas decrease may largely be the result of predation by benthic feeding organisms, interspecific competition, natural death and/or the emergence of adult stages of aquatic insects. Seasonal population densities, expressed as total biomass at each depth, are presented in Figures IV-26 and IV-27. Total biomass per unit area for oligochaetes, crustaceans, insects, molluscs and turbellarians are presented in Appendix IV-A.

Biomass comparisons of different classes will vary according to the number of species found within a class at a given transect (Figure IV-28). General trends are discussed for the dominant groups, namely oligochaetes, insects and crustaceans. The remaining groups (molluscs, turbellarians, arachnids and polychaetes) were patchy in distribution and represented a minor portion of the total community biomass.

Oligochates were the most abundant class throughout the survey period from fall 1971 through winter 1973. Oligochate biomass was generally greater at MaxΔT throughout the sampling period. Biomass per unit area decreased from summer to winter 1972 at all transects. This observation may indicate a reduction due to predation or limited recruitment, since many

Figure IV-25

MONTHLY AND SEASONAL TRENDS IN BENTHOS ABUNDANCE
AT THE 30 FOOT DEPTH OF MAX ΔT TRANSECT

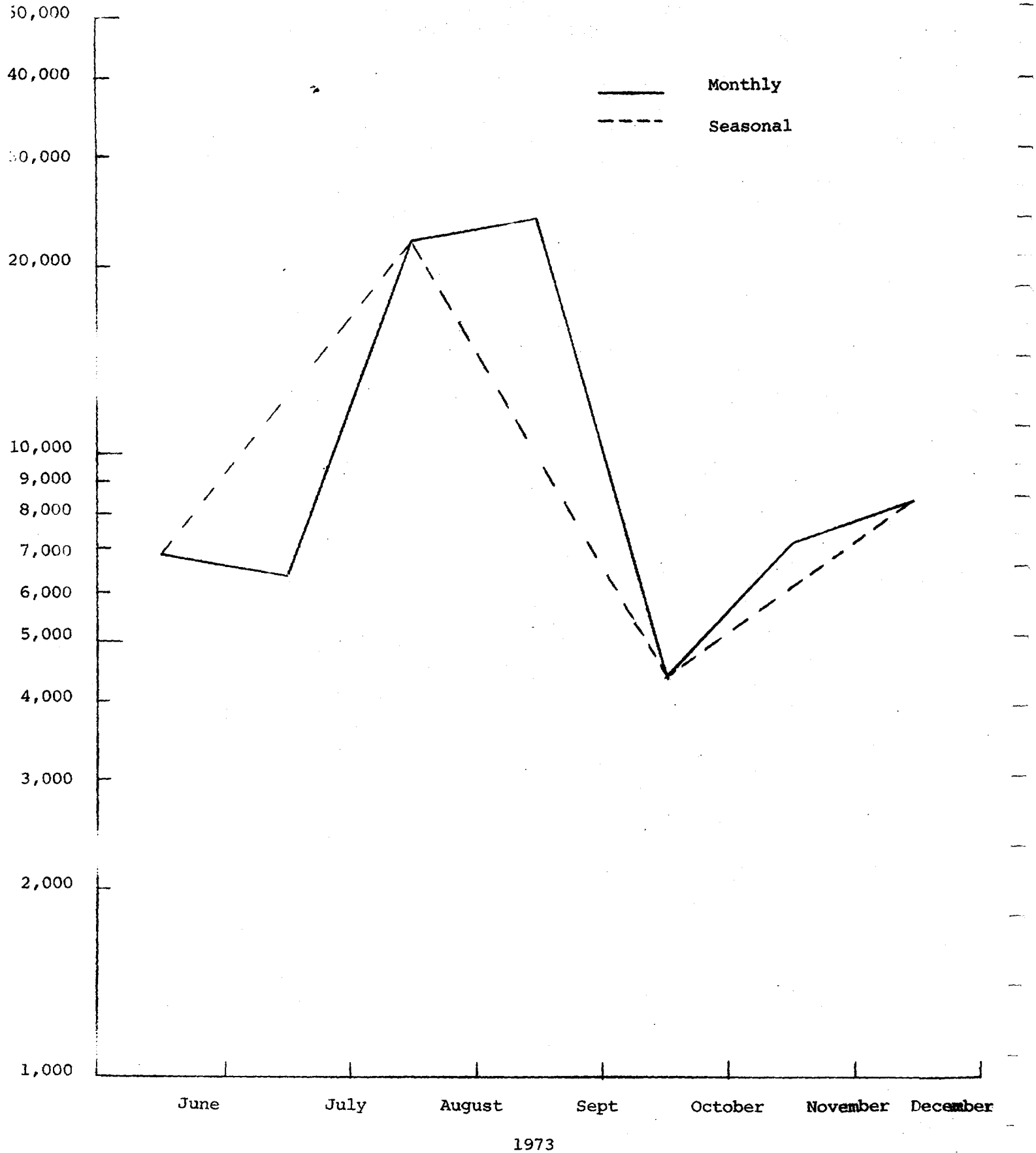
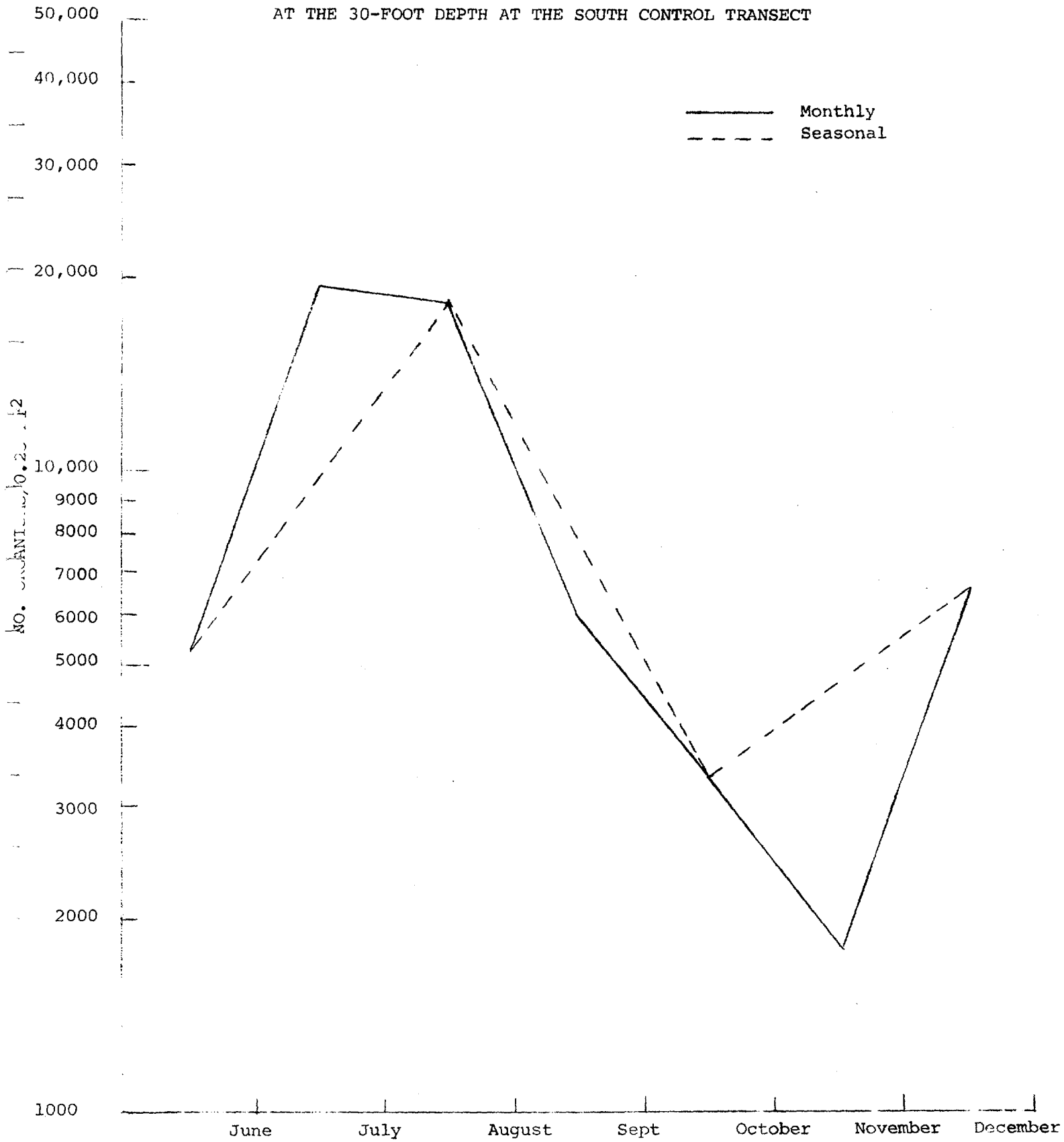


Figure IV-24

MONTHLY AND SEASONAL TRENDS IN BENTHOS ABUNDANCE
AT THE 30-FOOT DEPTH AT THE SOUTH CONTROL TRANSECT



1973

In summary, oligochaetes and dipterans were more abundant than any other group of benthic organisms collected at the four transects. Oligochaetes were most abundant during the spring of 1972 and least abundant during the fall of 1971. Greatest oligochaete abundance was observed at the MaxΔT transect. Dipterans were more abundant during the winter of 1971 and summer of 1973 than during any other season. Lowest dipteran abundance was recorded during the fall of 1971 and spring of 1972. Neither oligochaetes nor dipterans exhibited significant trends in depth distribution. Total benthos abundance and distribution generally followed the trends exhibited by the oligochaetes and dipterans.

3. Comparison of Monthly and Bimonthly Samples

Monthly benthos samples were collected from 10, 20 and 30-foot depths at each of the four transects from June through December 1973. All June, August, October and December samples were analyzed while only those samples from the 30-foot depth at South Control and MaxΔT transects were analyzed in July, September, and November. The latter set of samples was used to evaluate the reliability of using bimonthly samples to assess fluctuations in the benthic community. Monthly total benthos abundance at the 30-foot depth of the South Control and MaxΔT transects for 1973 is shown in Figures IV-24 and IV-25, respectively, together with results of the seasonal analysis. Seasonal trends were generally similar to the observed monthly trends; maximum and minimum values often occurred during months which were not one of the seasonal samples. Although these evaluations are limited to a single depth at two transects it appears that collection and analysis of samples on a seasonal schedule is adequate to monitor the changes in benthos abundance.

TABLE IV-10

MOLLUSCA ABUNDANCE STUDENT-NEWMAN-KEULS PROCEDURE
FOR DETERMINING THE SOURCE OF SIGNIFICANT MAIN EFFECTS
ROSETON/DANSKAMMER POINT VICINITY

Groups Underscored by a Single Line
Are Not Significantly Different at $p<0.05$

Rank	1	2	3	4	5	6	7	8	9	10
Mean Log_{10} (Data + 1)	1.000	1.911	2.004	2.065	2.115	2.115	2.208	2.225	2.232	2.273
Season	F-1971	W-1973	Sp-1972	Sp-1973	W-1972	W-1971	Su-1973	F-1973	F-1972	Su-1972

KEY
Sp - Spring
Su - Summer
F - Fall
W - Winter

Quirk, Lawler & Matusky Engineers

TABLE IV-9

THREE-WAY ANALYSIS OF VARIANCE OF SEASONAL MOLLUSCA ABUNDANCE
FROM FALL 1971 THROUGH WINTER 1973
ROSETON/DANSKAMMER POINT VICINITY

Data Transformed To Log_{10} At $\alpha = 0.05$

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Depth	2	1.0268	0.5134	5.593
Transect	3	5.6928	1.8976	20.671
Season	9	8.0019	0.8891*	9.685*
Depth x Transect	6	4.6410	0.7735*	8.426*
Depth x Season	18	4.1112	0.2284*	2.488*
Transect x Season	27	5.8941	0.2183*	2.378*
Depth x Transect x Season	54	5.4810	0.1015	1.106
Error	120	11.0160	0.0918	

*Significant at $\alpha = .05$

TABLE IV-8
(Continued)

B. STUDENT-NEWMAN-KEULS PROCEDURE FOR DETERMINING THE SOURCE OF SIGNIFICANT MAIN EFFECTS ROSETON/DANSKAMMER POINT VICINITY

Groups Underscored by a Single Line
Are Not Significantly Different at $p<0.05$

Rank	1	2	3	4	5	6	7	8	9	10
Mean $\log_{10}$ (Data + 1)	2.368	2.400	2.657	2.662	2.696	2.741	2.856	2.905	3.017	3.261
Season	F-1971	Sp-1972	F-1973	Su-1972	W-1973	Sp-1973	F-1972	W-1973	W-1971	Su-1973

KEY
Sp - Spring
Su - Summer
F - Fall
W - Winter

Quirk, Lawler & Matusky Engineers

TABLE IV-8

A. THREE-WAY ANALYSIS OF VARIANCE OF SEASONAL DIPTERAN ABUNDANCE
FROM FALL 1971 THROUGH WINTER 1973
ROSETON/DANSKAMMER POINT VICINITY

Data Transformed to Log_{10} Plus One.
Test Conducted At $\alpha = 0.05$

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Depth	2	0.0528	0.0264	0.345
Transect	3	0.4539	0.1513	1.978
Season	9	13.1274	1.4586	19.067*
Depth x Transect	6	0.7548	0.1258	1.644
Depth x Season	18	3.1734	0.1736	2.269
Transect x Season	27	4.6953	0.1739	2.273
Depth x Transect x Season	54	7.3008	0.1352	1.767*
Error	120	9.1800	0.0765	

*Significant at $\alpha = .05$

Dipterans were the major component of the insect fauna collected in benthic samples. Greatest dipteran abundance was observed in the winter of 1971 and the summer of 1973, while lowest abundance was found during the fall of 1971 (Table IV-8). Neither depth nor transect significantly influenced dipteran abundance during the study.

Molluscs (pelecypods and gastropods) exhibited patchy distribution throughout the study area, possibly due to substrate preferences by the various species. Depth and transect locations are often indicative of substrate characteristics. No differences in abundance were observed between depths or between transects (Table IV-9). With the exception of the fall 1971 and winter 1973 collections, similar numbers of molluscs were collected during all other seasons (Table IV-10). The number of molluscs collected during the winter of 1973 was similar to the number collected during the winters of 1971 and 1972 and during the spring of 1972 and 1973. No molluscs were collected in fall 1971.

Crustacean abundance was greatest during the summer and fall of 1972 and during the winter of 1973. A general trend of increasing crustacean abundance from the North Control transect to the South Control transect was evident. Considerable numbers of amphipods were observed in macrozooplankton collections (see Chapter III), which illustrates the interrelationships between the various ecological communities in the ecosystem.

TABLE IV-7

STUDENT-NEWMAN-KEULS PROCEDURE
FOR DETERMINING THE SOURCE OF SIGNIFICANT MAIN EFFECTS
ROSETON/DANSKAMMER POINT VICINITY

Groups Underscored by a Single Line
Are Not Significantly Different at $p<0.05$

Rank	1	2	3	4
Mean Log_{10} (Data + 1)	3.198	3.324	3.350	3.416
Transect	75 ΔT	South Control	North Control	Max ΔT

Rank										
Mean Log_{10} (Data + 1)	2.610	3.134	3.162	3.198	3.329	3.342	3.368	3.440	3.469	3.783
Season	F-1971	W-1973	F-1973	W-1971	Sp-1973	F-1972	Su-1973	W-1972	Su-1972	Sp-1972

KEY
Sp - Spring
Su - Summer
F - Fall
W - Winter

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TABLE IV-6

THREE-WAY ANALYSIS OF VARIANCE OF SEASONAL OLIGOCHAETE ABUNDANCE
FROM FALL 1971 THROUGH WINTER 1973
ROSETON/DANSKAMMER POINT VICINITY

Data Transformed To Log_{10} Plus One.
Test Conducted At $\alpha = 0.05$

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Depth	2	0.3106	0.1553	1.586
Transect	3	1.9248	0.6416	6.554*
Season	9	18.5418	2.0602	21.044*
Depth x Transect	6	1.5246	0.2541	2.596
Depth x Season	18	6.5862	0.3659	3.737*
Transect x Season	27	5.7429	0.2127	2.173
Depth x Transect x Season	54	9.3852	0.1738	1.775*
Error	120	11.7480	0.0979	

*Significant at $\alpha = .05$

TABLE IV-5

STUDENT-NEWMAN-KEULS PROCEDURE
FOR DETERMINING THE SOURCE OF SIGNIFICANT MAIN EFFECTS
ROSETON/DANSKAMMER POINT VICINITY

Groups Underscored by a Single Line
Are Not Significantly Different at $p<0.05$

Rank	1	2	3	4
Mean Log_{10} (Data + 1)	3.427	3.461	3.524	3.646
Transect	75 ΔT	South Control	North Control	Max ΔT

Rank	1	2	3	4	5	6	7	8	9	10
Mean Log_{10} (Data + 1)	2.815	3.398	3.422	3.507	3.523	3.581	3.614	3.651	3.705	3.892
Season	F-1971	F-1973	W-1973	W-1971	Sp-1973	F-1972	W-1972	Su-1972	Su-1973	Sp-1972

KEY
Sp - Spring
Su - Summer
F - Fall
W - Winter

Quirk, Lawler & Matusky Engineers

TABLE IV-4

THREE-WAY ANALYSIS OF VARIANCE OF SEASONAL TOTAL BENTHOS ABUNDANCE
FROM FALL 1971 THROUGH WINTER 1973.
ROSETON/DANSKAMMER POINT VICINITY

Data Transformed to Log_{10} Plus One.
Test Conducted At $\alpha = 0.05$

SOURCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
Depth	2	0.3490	0.1745	3.666
Transect	3	1.4562	0.4854	10.197*
Season	9	14.7159	1.6351	34.351*
Depth x Transect	6	0.7686	0.1281	2.691
Depth x Season	18	4.8492	0.2694	5.660*
Transect x Season	27	3.6477	0.1351	2.838
Depth x Transect x Season	54 120	4.7736	0.10884	1.857*
Error		5.7120	0.0476	

*Significant of $\alpha = .05$

numerical abundance occurred at the 20 ft. depth. These observations show possible yearly trends of abundance by depth at certain transects; however, no significant statistical difference was observed between depths over the entire sampling period.

Total benthic abundance was significantly greater at MaxΔT than at other transects (Table IV-4). Collections from the South Control, North Control and 75ΔT transects were similar. The MaxΔT transect was located within the tidal influence (on surface water temperatures only) of the Danskammer Point Generating Station cooling water discharge; this transect may also be influenced by a small tributary from a backwater area at the transect.

Significant differences in total benthos abundance were observed between seasons (Table IV-5). Fewer organisms were collected during the fall of 1971 while greatest number of organisms were collected during the spring of 1972, and summer of 1973. Spring, fall and winter of 1973 comprised a period during which low to moderate numbers of organisms were collected. Moderate to high numbers of organisms were collected during the summer, fall and winter of 1972 and during the summer of 1973.

Oligochaetes were the most abundant group of benthic organisms from fall 1971 through winter 1973. Greatest oligochaete abundance was observed during the spring of 1972. Fewest oligochaetes were collected in the fall of 1971 (Table IV-6). Oligochaete abundance was similar at the North and South Control transects and at MaxΔT but was significantly lower at 75ΔT (Table IV-7). The influence of depth on oligochaete abundance was not apparent during the study, although significant interactions were noted for depth and season.

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL ABUNDANCE BY SEASON, TRANSECT, AND DEPTH 1971-1973

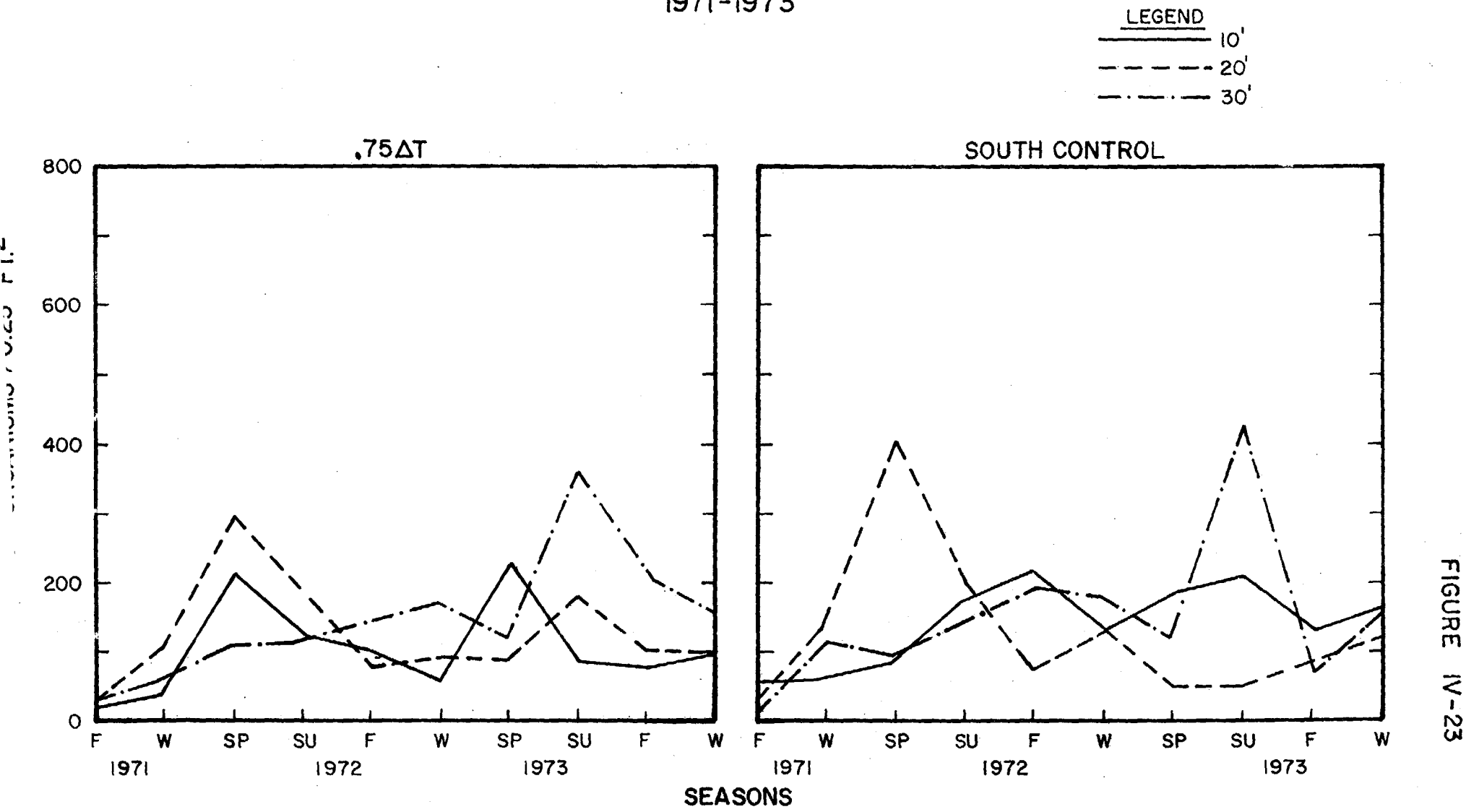


FIGURE IV-23

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL ABUNDANCE BY SEASON, TRANSECT, AND DEPTH 1971-1973

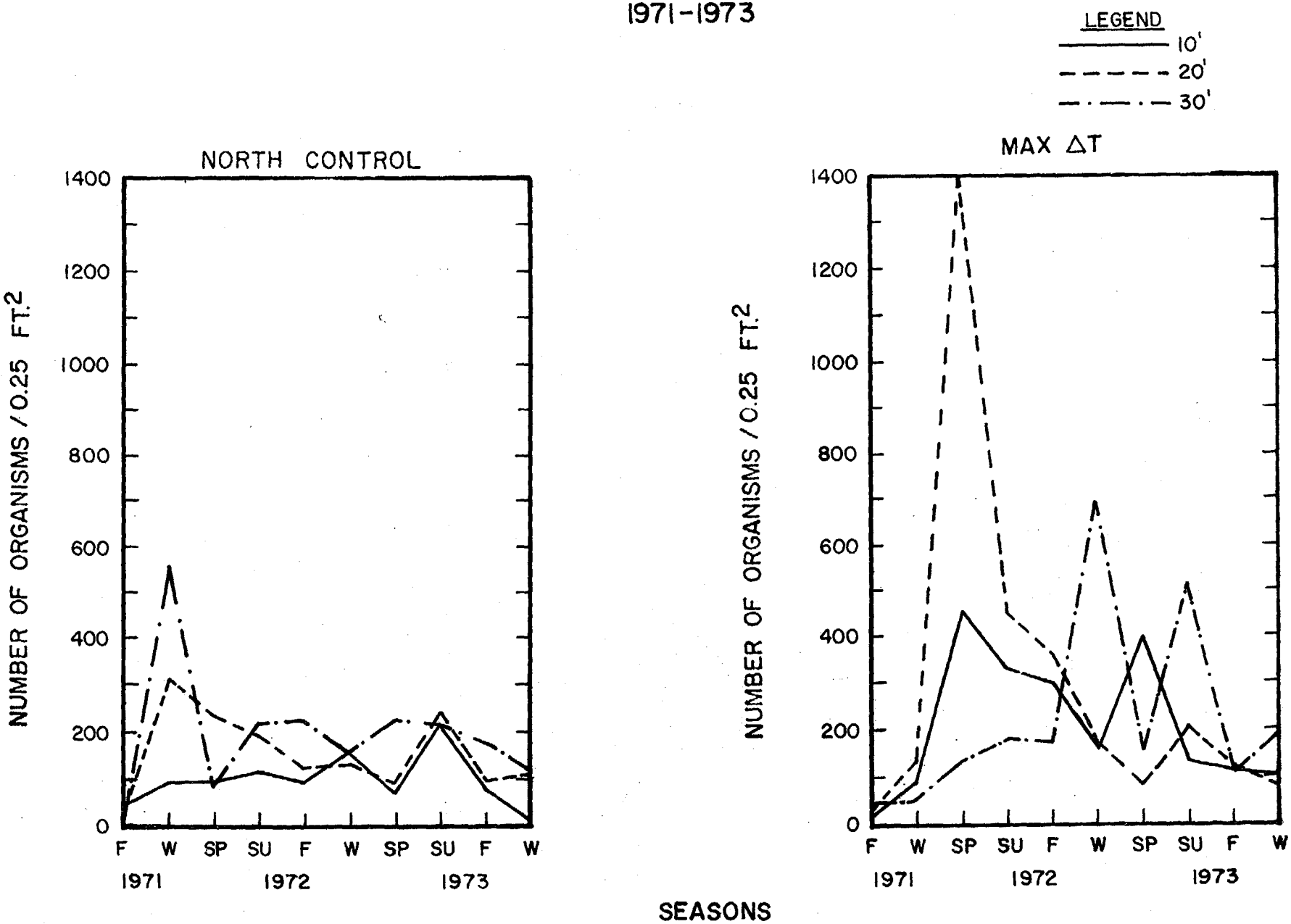


FIGURE IV-22

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL ABUNDANCE BY SEASON AND TRANSECT 1971-1973

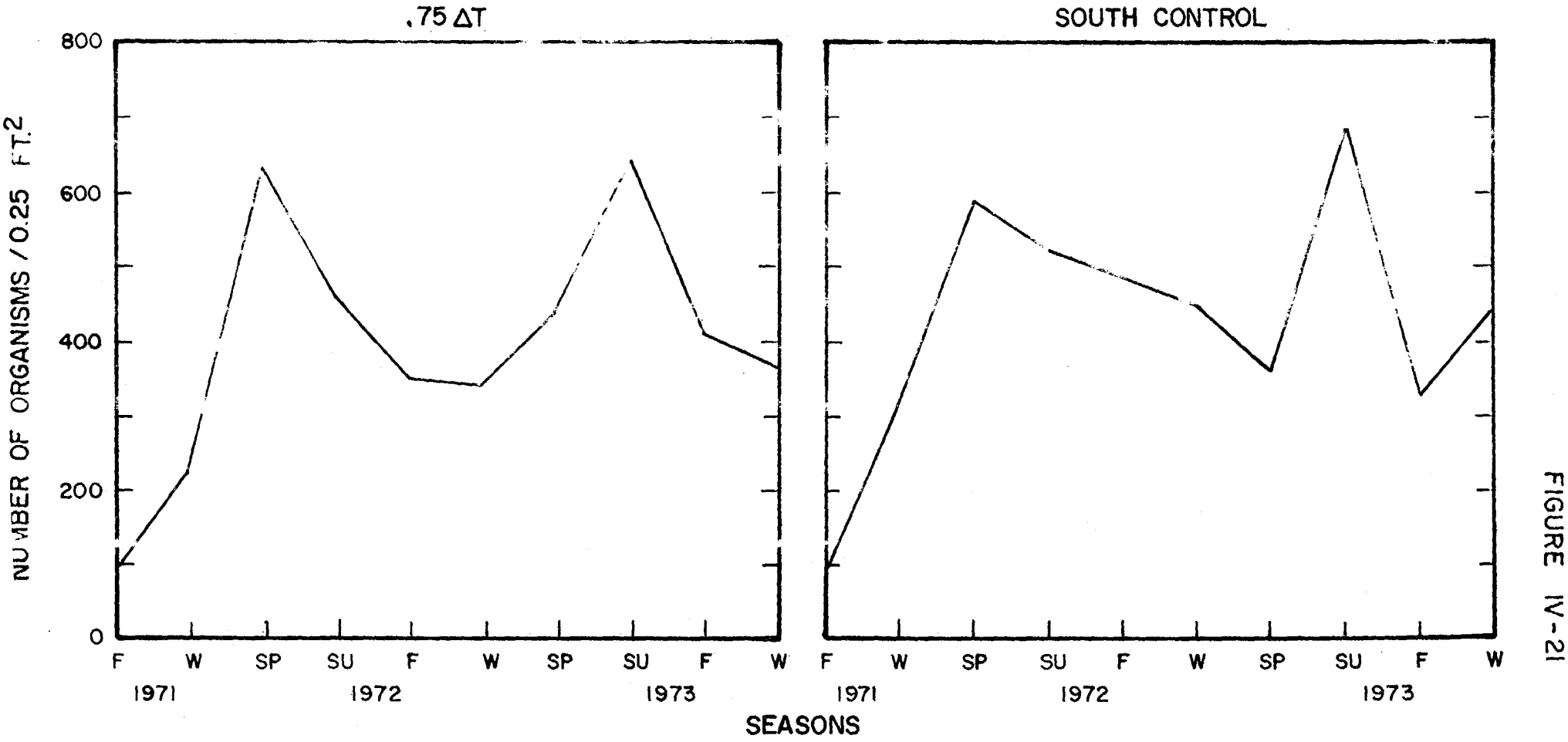
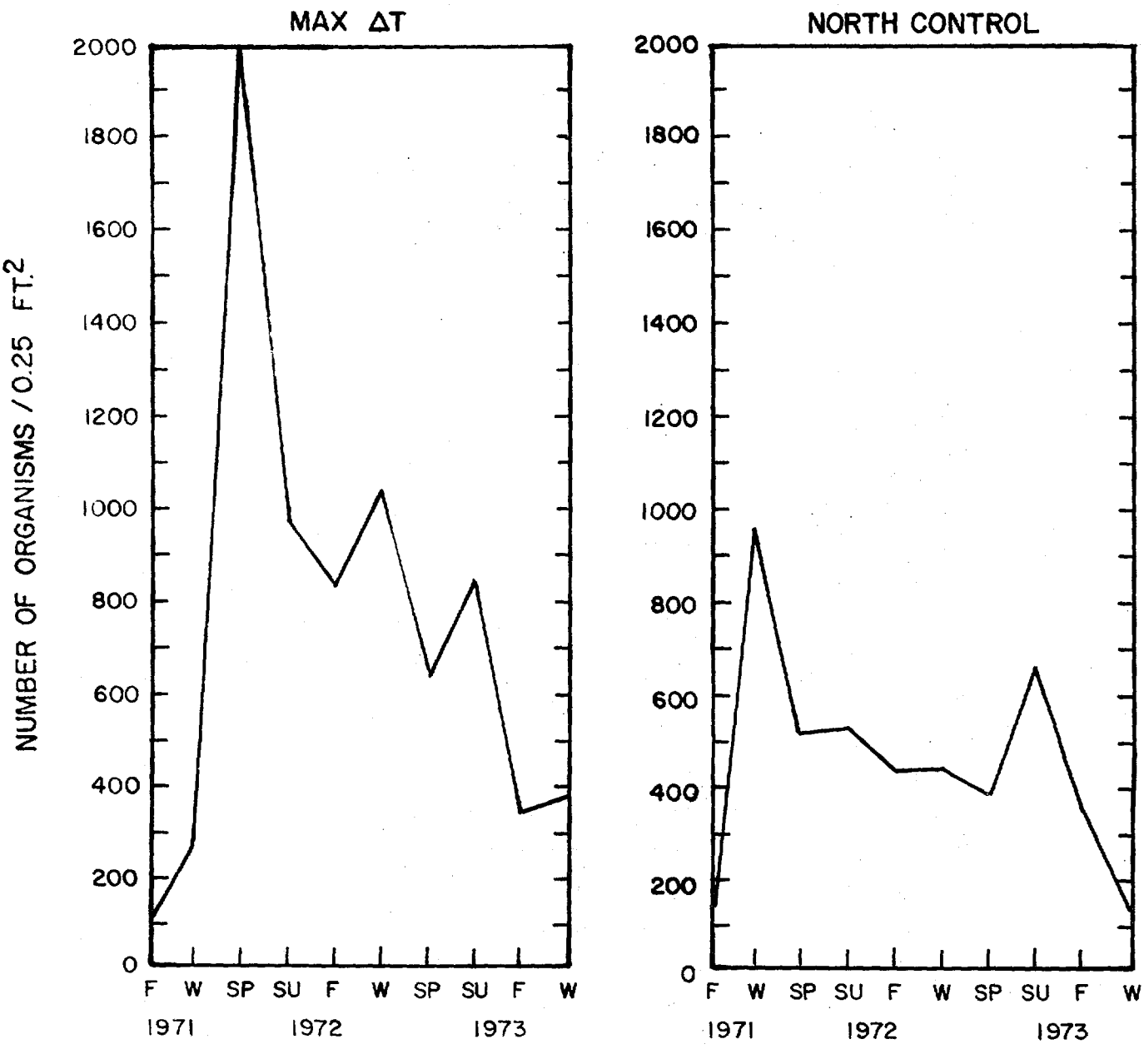


FIGURE IV-21

FIGURE IV-20

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: TOTAL ABUNDANCE BY SEASON AND TRANSECT 1971-1973



BENTHOS

PERCENT ABUNDANCE COMPOSITION OF

SOUTH CONTROL TRANSECT BENTHOS BY DEPTH

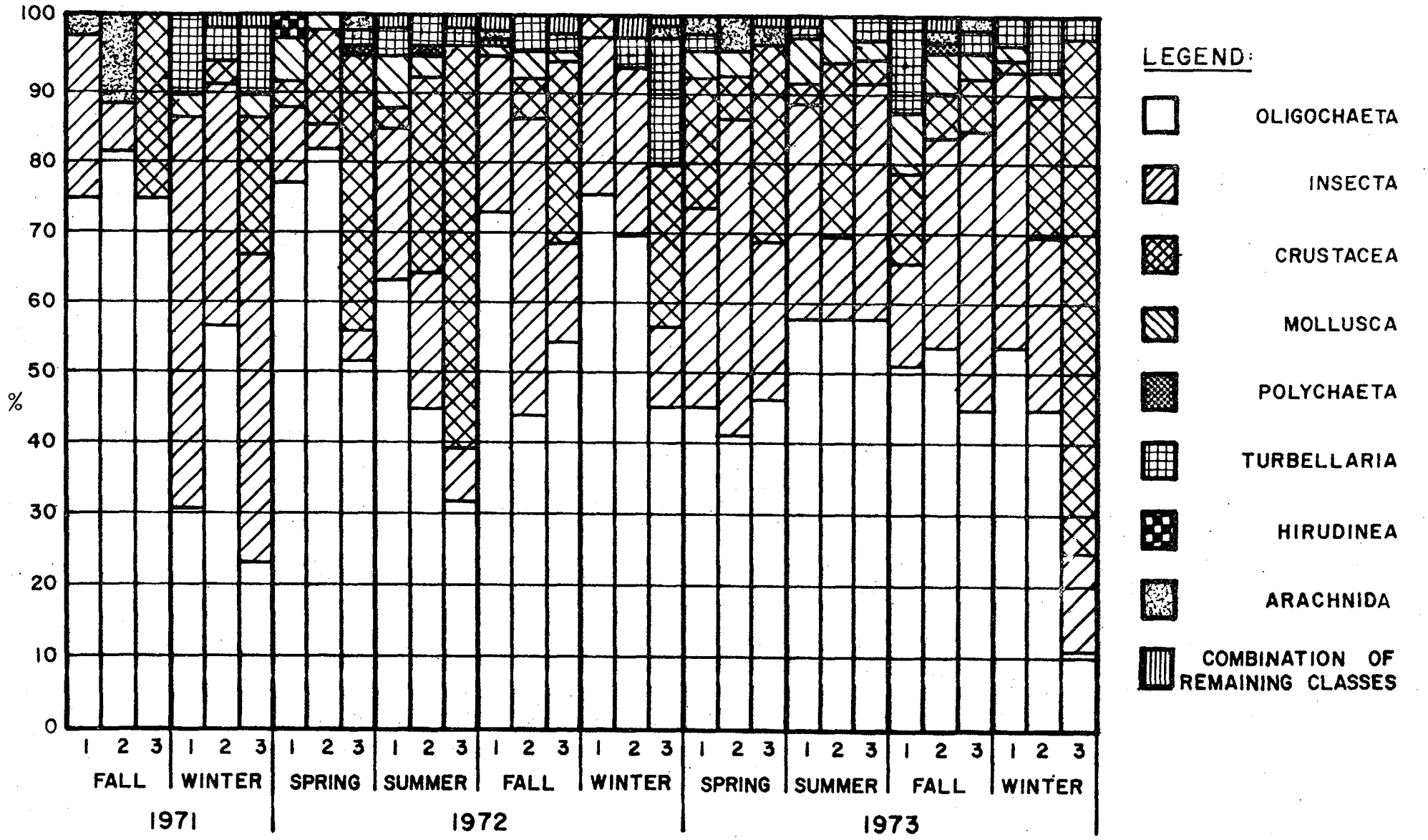
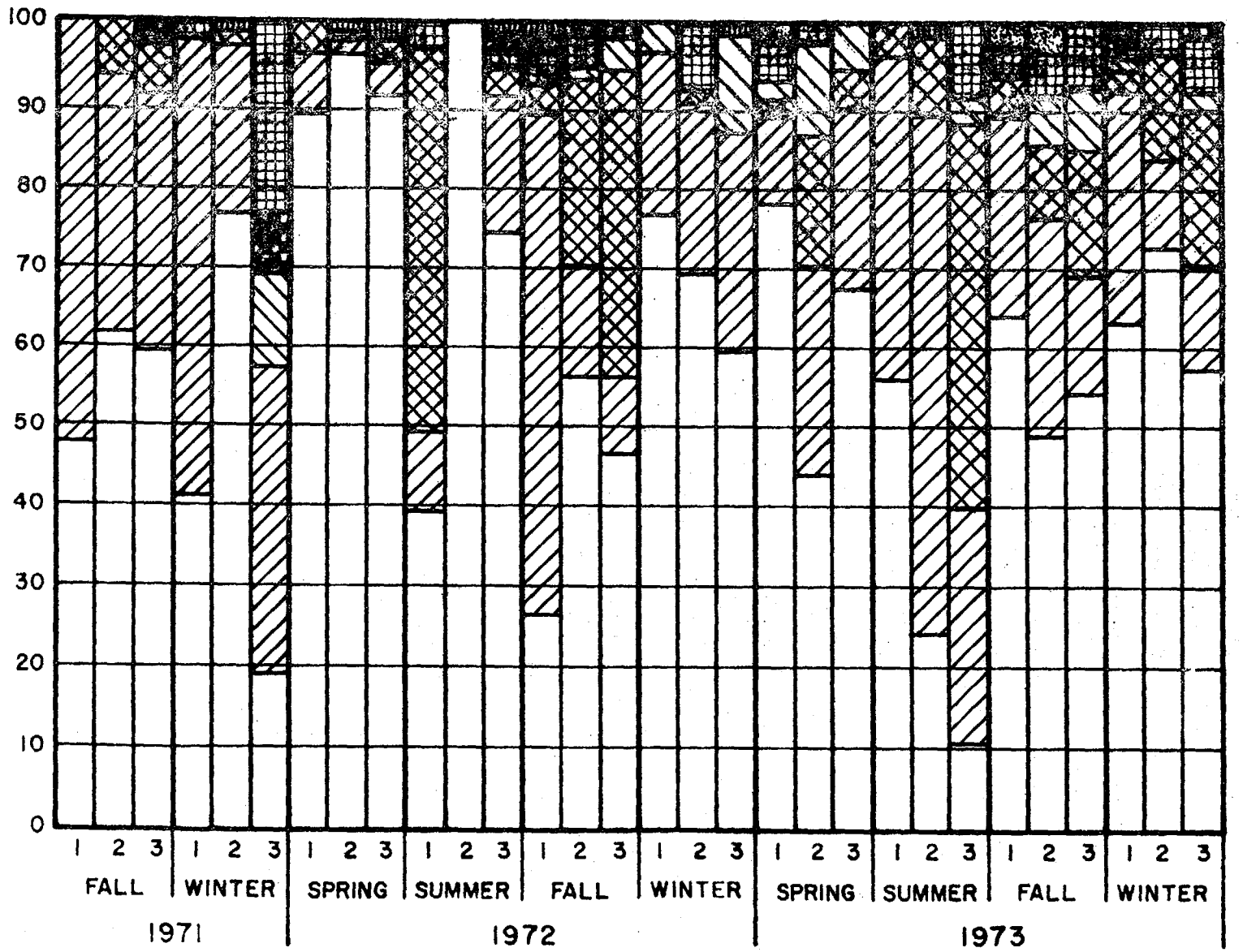


FIGURE IV-19

BENTHOS

PERCENT ABUNDANCE COMPOSITION OF

75 MAXIMUM ΔT TRANSECT BENTHOS BY DEPTH*



LEGEND:

- OLIGOCHAETA
- INSECTA
- CRUSTACEA
- MOLLUSCA
- POLYCHAETA
- TURBELLARIA
- HIRUDINEA
- ARACHNIDA
- COMBINATION OF REMAINING CLASSES

*INCOMPLETE FILE FOR SUMMER 1972 DEPTH 2

FIGURE IV-18

BENTHOS

PERCENT ABUNDANCE COMPOSITION OF

MAXIMUM ΔT TRANSECT BENTHOS BY DEPTH

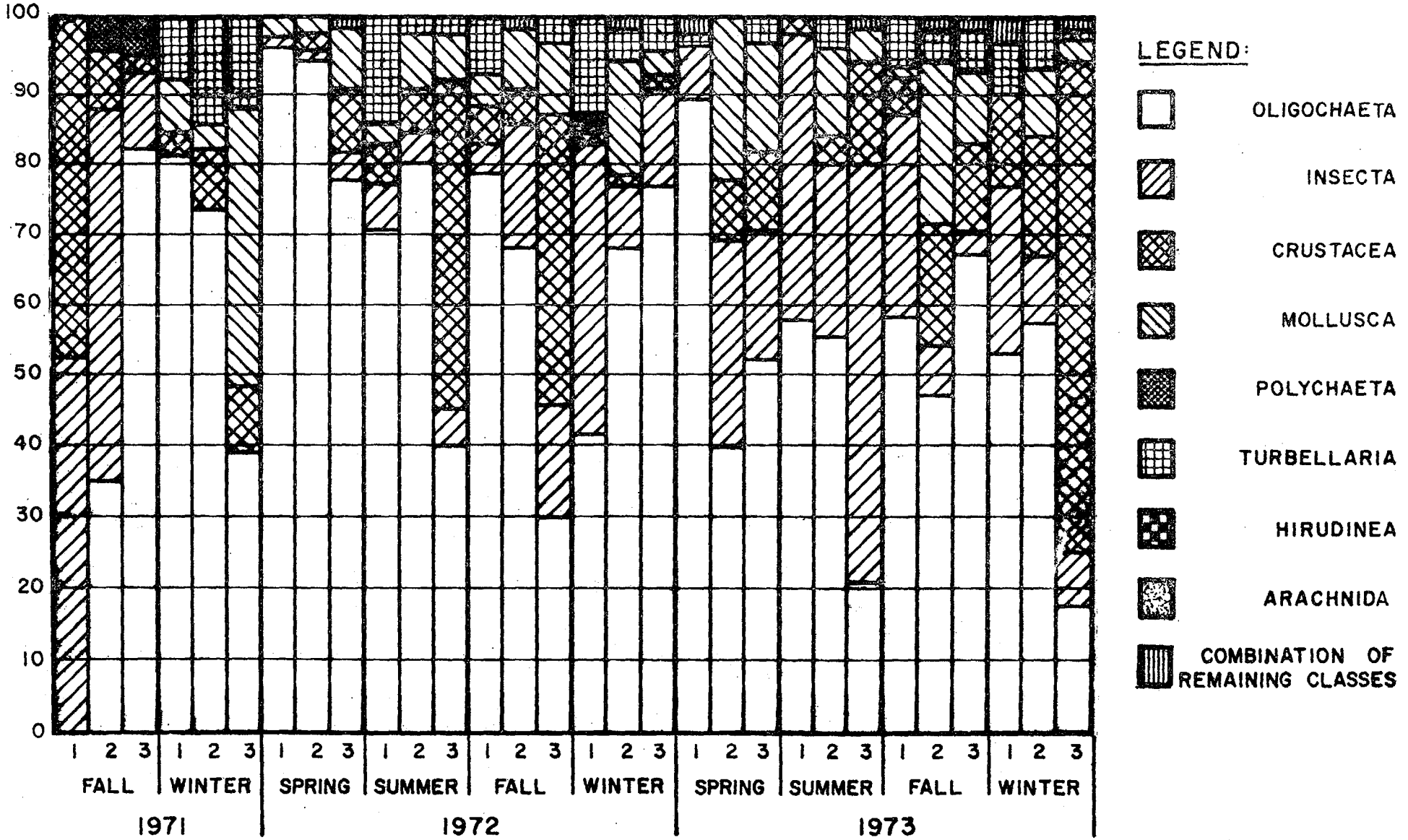
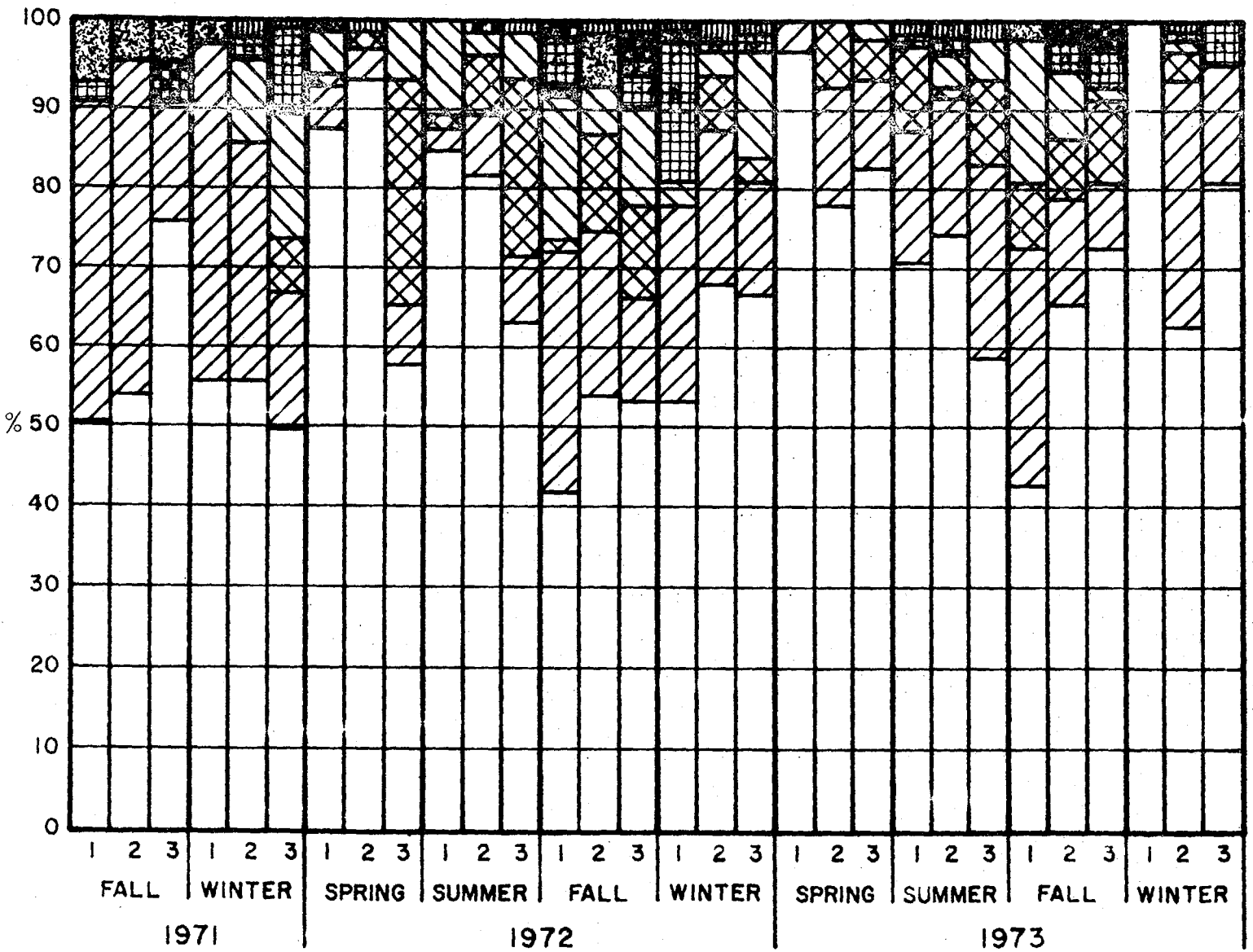


FIGURE IV-17

BENTHOS

PERCENT ABUNDANCE COMPOSITION OF

NORTH CONTROL TRANSECT BENTHOS BY DEPTH



LEGEND:

- OLIGOCHAETA
- INSECTA
- CRUSTACEA
- MOLLUSCA
- POLYCHAETA
- TURBELLARIA
- HIRUDINEA
- ARACHNIDA
- COMBINATION OF REMAINING CLASSES

FIGURE IV-16

Figures IV-16 through IV-19 present relative class abundance by transect and depth to illustrate the differences observed. Total abundance is presented for all transects in Figures IV-20 and IV-21. Variations in the number of classes and abundance of individuals according to depth are presented in Figures IV-22 and IV-23.

The most abundant groups of organisms at all transects were oligochaetes, followed by dipterans and crustaceans (Isopoda, Amphipoda) and the occasional occurrence of the classes Polychaeta, Turbellaria, Mollusca, Hirudinea, and Arachnida. A complete list of taxonomic groups is presented in Table IV-2.

Total benthos abundance and the abundance by major classes were tested for trends in distribution by season, transect, and depth by using analysis of variance and Student-Newman-Kuels procedures.

With the exception of the North Control transect, all locations exhibited high abundance values during the spring of 1972 and summer of 1973 (Figures IV-22 and IV-23). At the North Control transect greatest abundance was recorded during winter 1971. Over the 10 sampling seasons abundance was greatest during the spring of 1972 and lowest during the fall of 1971. Abundance of organisms collected during the winter of 1971, the summer, fall and winter of 1972, and the spring of 1973 were similar.

As indicated in Figures IV-22 and IV-23, peak numerical abundance at transect 75ΔT and MaxΔT, and South Control occurred at the 20 ft. depth during spring 1972. During summer 1973 peak abundance of benthic organisms at these three transects occurred at the 30 ft. depth. At North Control transect, greatest

Danskammer Point vicinity indicated no significant differences between stations in sediment type or organic content. No trend in organic matter versus depth or transect was evident; however, a greater organic content (8-14%) in the sandy loam sediments at MaxΔT and .75ΔT may account for oligochaete dominance.

In conclusion, seasonal variation in affinity similarities occurred at all transects. No consistent pattern of affinity association was found for depth, although South Control (30 ft. depth) was ecologically dissimilar during the seasons of highest community similarity (spring and winter 1972 and fall 1973) at other transects. This may reflect the influence of brackish water organisms at this location (for additional discussion on the occurrence of brackish water at this location see Chapter VII).

2. Abundance and Distribution

Estuarine benthic communities are subject to considerable seasonal variations in salinity, temperature, nutrient influx, current strength, and turbidity (Carricker, 1967). The resulting spatial and temporal distribution of benthic organisms is a product of physical, chemical, and biological gradients of the estuary and the limiting stresses imposed upon the organisms by these factors. Although estuarine species are broadly adaptable to such conditions, alteration of abundance and distribution of taxa may be indicative of the dynamic stresses imposed upon the benthic community.

TABLE IV-3

SAMPLE LOCATIONS WHERE COMMUNITY ABUNDANCE STRUCTURE IS DOMINATED BY ONE CLASS BASED ON NUMERICAL ABUNDANCE
ROSETON/DANSKAMMER POINT VICINITY

SEASON AND DEPTH

	Fall 1971			Winter 1971			Spring 1972			Summer 1972			Fall 1972			Winter 1972			Spring 1973			Summer 1973			Fall 1973			Winter 1973			TOTAL
	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30	
Oligochaeta																															
North Control	+	+	+		+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	26
Maximum ΔT			+	+	+		+	+	+	+	+		+	+			+	+			+	+	+		+		+	+	+		19
.75 ΔT		+	+		+		+	+	+		+	+		+		+	+	+	+		+	+			+		+	+	+	+	20
South Control	+	+	+		+		+	+	+	+			+		+	+	+		+			+	+	+	+	+		+			19
Insecta:																															
North Control				+																											1
Maximum ΔT	+	+																						+							3
.75 ΔT	+			+									+										+								4
South Control				+																											1
Crustacea:																															
North Control																															
Maximum ΔT																														+	1
.75 ΔT																															
South Control												+																		+	2
TOTAL	4		4	4		4	4		4	3		3	3		2	3		3	3	1	3	4		3	3	2	3	4	3	4	

NOTE:

+ indicates that the class contributed ≥ 50% of the total community.

FIGURE IV-15

BENTHOS AFFINITY INDEX

1973

WINTER

WINTER

	NC-1	NC-2	NC-3	MAT-1	MAT-2	MAT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	64											
NC-3	81	79										
MAT-1	53	83	72									
MAT-2	57	72	71	83								
MAT-3	18	31	27	41	47							
75-1	64	97	81	84	74	48						
75-2	73	80	88	80	82	39	81					
75-3	58	77	75	89	92	48	79	85				
SC-1	54	87	71	82	69	30	88	70	73			
SC-2	45	75	63	89	81	50	76	72	86	76		
SC-3	16	29	26	40	38	89	29	56	45	27	46	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-14

BENTHOS AFFINITY INDEX

1973

FALL

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	73											
NC-3	60	88										
MΔT-1	80	82	77									
MΔT-2	77	75	72	66								
MΔT-3	65	90	88	74	79							
75-1	75	85	80	92	63	76						
75-2	85	78	72	89	74	72	85					
75-3	74	85	79	83	82	83	78	85				
SC-1	76	84	75	79	80	81	75	85	92			
SC-2	86	80	69	91	68	70	85	89	83	80		
SC-3	86	72	64	84	67	63	79	88	75	76	87	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-13

BENTHOS AFFINITY INDEX

1973

SUMMER

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	92											
NC-3	87	87										
MΔT-1	73	77	82									
MΔT-2	83	80	95	81								
MΔT-3	43	43	52	63	55							
75-1	72	76	81	98	83	64						
75-2	41	45	50	67	54	90	68					
75-3	28	32	40	45	43	62	47	54				
SC-1	81	81	90	90	91	61	91	60	47			
SC-2	70	71	70	71	71	47	72	45	45	72		
SC-3	71	74	83	86	86	67	88	66	57	90	68	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-12

BENTHOS AFFINITY INDEX

1973

SPRING

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	89											
NC-3	95	94										
MΔT-1	94	87	92									
MΔT-2	55	62	58	49								
MΔT-3	67	74	70	63	82							
75-1	90	91	92	88	56	71						
75-2	59	65	61	54	86	86	61					
75-3	82	86	85	77	73	80	83	76				
SC-1	65	71	67	61	77	87	69	92	82			
SC-2	51	61	56	50	75	65	56	73	68	58		
SC-3	56	68	62	56	71	76	62	84	73	60	64	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-11

BENTHOS AFFINITY INDEX

1973

WINTER

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	78											
NC-3	74	89										
MΔT-1	81	61	61									
MΔT-2	71	83	93	58								
MΔT-3	75	89	89	63	86							
75-1	74	90	84	63	78	93						
75-2	83	90	85	72	83	89	91					
75-3	81	82	86	71	81	78	80	82				
SC-1	76	89	84	65	78	91	98	92	82			
SC-2	83	91	85	71	83	90	90	96	85	93		
SC-3	75	65	62	63	64	63	59	65	58	59	63	

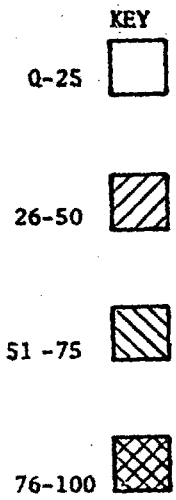


FIGURE IV-10

BENTHOS AFFINITY INDEX

1972

FALL

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	69											
NC-3	74	86										
MΔT-1	58	71	75									
MΔT-2	71	85	81	83								
MΔT-3	60	63	67	96	59							
75-1	63	52	49	39	50	50						
75-2	62	84	84	71	77	72	49					
75-3	59	72	74	62	67	83	43	83				
SC-1	68	78	71	81	89	48	52	73	60			
SC-2	82	71	70	60	70	57	77	68	65	64		
SC-3	62	81	83	68	75	74	49	96	86	71	68	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-9

BENTHOS AFFINITY INDEX

1972

SUMMER

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	89											
NC-3	73	80										
MΔT-1	78	85	79									
MΔT-2	92	93	79	84								
MΔT-3	51	55	72	55	59							
75-1	45	55	71	55	52	94						
75-2	59	64	66	64	61	48	50					
75-3	78	84	73	81	81	48	52	67				
SC-1	75	75	80	79	79	56	55	68	83			
SC-2	52	62	79	63	60	78	80	59	65	74		
SC-3	36	46	62	46	43	85	90	40	42	45	70	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-8

BENTHOS AFFINITY INDEX

1972

SPRING

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	93											
NC-3	70	65										
MΔT-1	91	95	62									
MΔT-2	91	97	64	97								
MΔT-3	87	84	77	82	83							
75-1	94	95	70	91	93	85						
75-2	91	97	62	92	97	81	93					
75-3	94	97	66	92	95	85	97	95				
SC-1	88	84	75	81	83	88	88	80	84			
SC-2	88	88	77	84	87	91	89	85	88	86		
SC-3	58	58	83	53	56	65	60	55	60	60	69	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-7

BENTHOS AFFINITY INDEX

1971

WINTER

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	74											
NC-3	61	81										
MΔT-1	45	67	69									
MΔT-2	45	62	71	86								
MΔT-3	45	52	71	58	62							
75-1	95	73	60	43	43	42						
75-2	65	78	70	79	76	42	62					
75-3	63	76	82	58	59	65	65	64				
SC-1	84	64	59	39	42	41	88	52	63			
SC-2	80	89	75	64	64	47	78	80	70	71		
SC-3	67	58	59	36	44	45	69	47	60	77	67	

KEY

0-25

26-50

51-75

76-100

FIGURE IV-6

BENTHOS AFFINITY INDEX

1971

FALL

	NC-1	NC-2	NC-3	MΔT-1	MΔT-2	MΔT-3	75-1	75-2	75-3	SC-1	SC-2	SC-3
NC-1												
NC-2	95											
NC-3	73	73										
MΔT-1	39	41	14									
MΔT-2	75	77	50	60								
MΔT-3	63	66	88	14	54							
75-1	87	88	62	52	88	59						
75-2	87	90	79	35	71	75	80					
75-3	85	86	77	37	73	74	79	95				
SC-1	77	80	91	24	60	86	71	87	84			
SC-2	65	66	87	7	42	88	54	71	66	83		
SC-3	51	55	75	25	44	77	48	65	66	75	75	

KEY

0-25

26-50

51-75

76-100

The North Control transect showed the only corresponding decrease in spring 1973 values at all depths sampled. The corresponding spring 1973 diversity values at MaxΔT, and .75ΔT indicated a more diverse community structure at 20 and 30 foot depths. From 1971-1973 the South Control generally displayed higher diversity at all depths than other transect locations.

No consistent seasonal trend in benthic diversity with depth was evident for any particular transect location. Diversity at all depths was low during the spring and higher during the fall from 1972-1973. No consistent pattern was evident with depth on a yearly basis, at all transects, although greater diversity with increasing depth was noted at all transects during fall 1971 and fall 1972.

Figures IV-6 through IV-15 present affinity values in trellis diagrams to indicate similarities in community structure based on organism abundance. High affinity values indicate sample stations that are most alike ecologically. The highest affinity values at all transects, and consequently the greatest similarity, occurred during spring and winter 1972 and fall 1973. These values were primarily the result of high oligochaete abundance at all transects (greater than 50% community composition).

As indicated in Table IV-3 oligochaetes represent more than 50% of the numerical community composition at all transects and at most depths throughout the sampling period. In addition, greater frequency of oligochaete dominance at all depths generally occurred at North Control. Sediment analyses (discussed in Chapter VII) for the Roseton/

This general seasonal fluctuation of diversity values was more evident at North Control. Diversity values at North Control were higher in fall 1972 and lower in spring 1973 than the remaining transect locations for the same years.

In summary, from fall 1971 through winter 1973, all transect locations generally displayed low spring and high fall diversity values suggesting a more diverse and more evenly distributed community structure during the fall season. Generally similar numbers of species were collected during spring and fall; however, fewer individuals were collected during the fall which resulted in increased diversity values.

Decreases in fall abundance may be attributable to emergence, predation or low abundance of over-wintering organisms. The range of diversity peaks (high vs. low) generally decreased from North to South Control, which suggests an increase in community stability from North to South Control (Margalef, 1968).

Comparison of diversity values according to depth showed a general increase at the 30-foot depth stations for North Control, 75ΔT and MaxΔT from fall 1971 to fall 1972; however, succeeding diversity values through winter 1973 indicate no patterns at the various depths for any transect location. With the exception of fall 1971, all depths show a general trend of low spring and high fall diversity.

TABLE 1. -

BENTHOS DIVERSITY VALUES BASED ON CLASS ABUNDANCE
BY SEASON, TRANSECT AND DEPTH, 1971-1973
ROSETON/DANSKAMMER POINT VICINITY

$$H^1 = \sum \frac{s_i}{P} \log_2 \frac{P_i}{P}$$

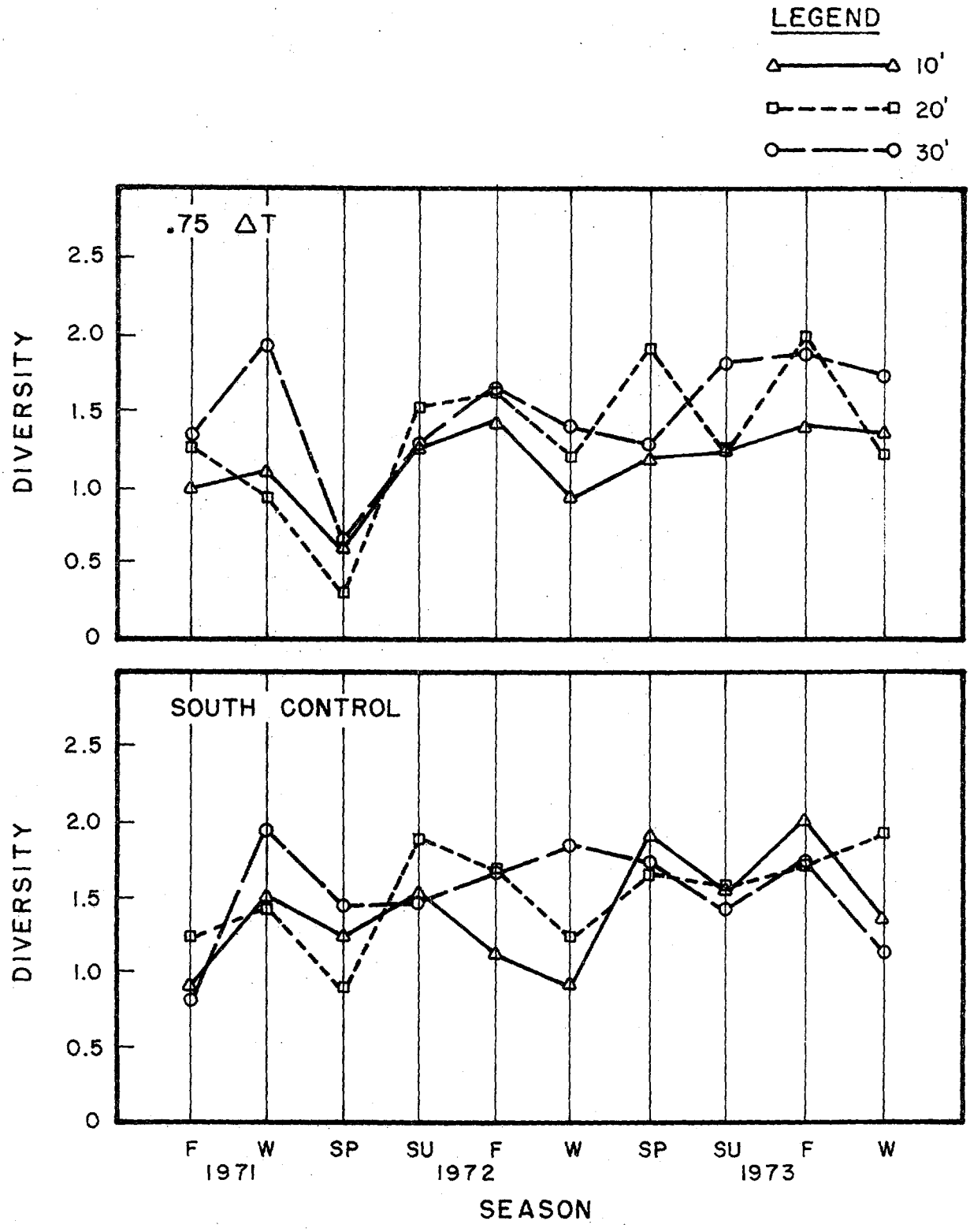
		1971						1972											
		FALL			WINTER			SPRING			SUMMER			FALL			WINTER		
TRANSECT	DEPTH FT.	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1
North Control	10	4	42	1.512	3	92	1.124	6	94	0.800	4	118	0.787	8	95	1.950	6	158	1.675
	20	3	22	1.207	7	314	1.561	5	337	0.458	5	193	0.990	6	122	1.828	7	131	1.939
	30	4	21	1.118	7	559	2.054	5	89	1.557	7	218	1.526	9	223	2.113	6	156	1.481
	Total	5	95	1.439	8	965	1.925	7	520	0.827	8	529	1.254	9	440	2.1 0	7	445	1.652
Maximum ΔT	10	2	17	0.978	5	94	1.328	3	459	0.263	6	332	1.402	6	300	1.187	6	163	1.667
	20	4	25	1.178	6	133	1.739	6	1407	0.399	5	459	1.071	6	363	1.407	6	182	1.465
	30	4	45	0.706	5	54	2.021	8	136	1.126	5	181	1.609	5	195	2.008	5	697	1.156
	Total	4	87	1.555	6	286	1.793	7	2002	0.443	6	972	1.457	7	838	1.624	7	1042	1.392
75 ΔT	10	2	21	0.998	3	46	1.112	3	218	0.585	4	133	1.255	6	109	1.444	3	65	0.910
	20	4	31	1.279	4	107	0.934	4	301	0.293	**	**	**	6	86	1.617	4	99	1.198
	30	4	35	1.349	6	68	2.075	5	112	0.585	6	122	1.282	5	130	1.665	5	175	1.397
	Total	5	87	1.306	6	221	1.550	5	631	0.463	**	**	**	7	325	1.941	6	339	1.355
South Control	10	3	55	0.913	4	58	1.503	6	83	1.242	6	171	1.542	7	214	1.120	3	130	0.916
	3	3	22	1.241	6	138	1.436	4	407	0.883	6	204	1.895	6	73	1.602	6	138	1.209
	2	4	0.811	6	112	2.002	5	93	1.438	5	141	1.473	7	194	1.670	6	176	1.846	
	3	81	1.050	8	308	1.818	8	583	1.125	7	516	1.873	8	481	1.596	6	444	1.563	

		1973											
		SPRING			SUMMER			FALL			WINTER		
TRANSECT	DEPTH FT.	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1	# OF CLASSES	# OF ANIMALS	H^1
North Control	10	3	69	0.725	7	211	1.342	5	79	1.843	*	*	*
	20	3	94	0.945	8	240	1.212	6	95	1.609	6	110	1.295
	30	5	224	0.917	6	211	1.598	6	176	1.402	3	117	0.921
	Total	5	387	0.918	8	662	1.412	7	350	1.676	6	234	1.098
Maximum ΔT	10	7	399	0.671	3	135	1.075	5	115	1.541	7	103	1.823
		4	84	1.828	5	204	1.701	7	123	2.029	5	112	1.803
		5	158	1.858	5	311	1.578	6	104	1.728	6	174	1.400
		7	641	1.311	5	850	1.699	7	345	1.896	8	409	1.889
75 ΔT	10	7	231	1.195	4	91	1.231	5	84	1.419	6	104	1.358
	20	5	95	1.919	5	184	1.224	7	109	1.977	4	104	1.213
	30	4	127	1.300	6	366	1.825	6	214	1.890	6	183	1.741
	Total	7	453	1.495	6	641	1.842	7	407	1.880	6	391	1.572
South Control	10	8	181	1.907	6	208	1.530	6	130	2.011	5	167	1.367
	20	5	51	1.652	4	52	1.555	6	82	1.715	5	124	1.931
	30	5	122	1.729	5	423	1.413	6	77	1.734	4	163	1.148
	Total	8	354	1.873	7	683	1.530	7	289	1.933	5	444	1.845

* Only 1 class present
** Incomplete sample

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: DIVERSITY VALUES BASED ON ABUNDANCE BY SEASON, TRANSECT AND DEPTH 1971-1973



ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS: DIVERSITY VALUES BASED ON

ABUNDANCE BY SEASON, TRANSECT AND DEPTH

1971-1973

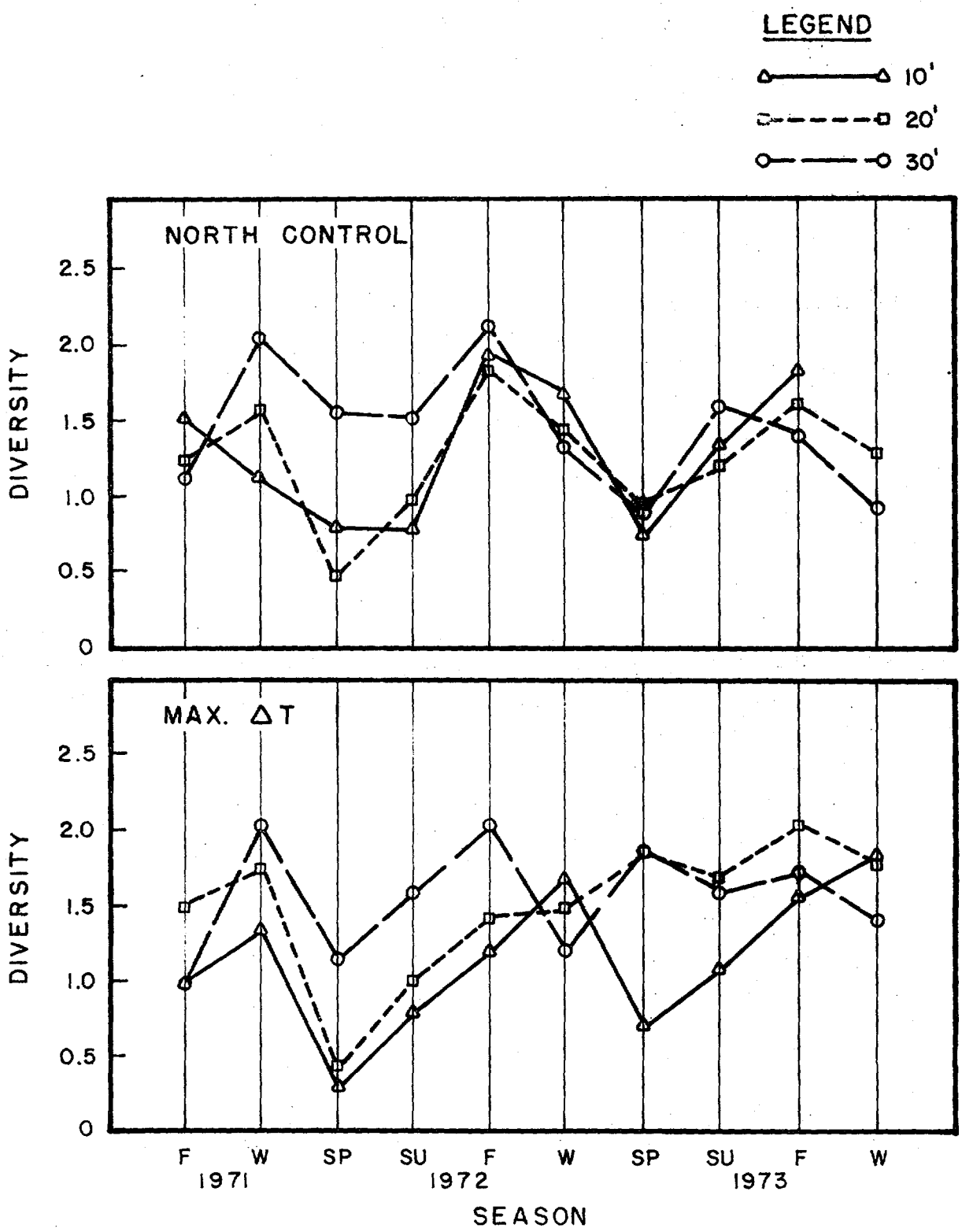
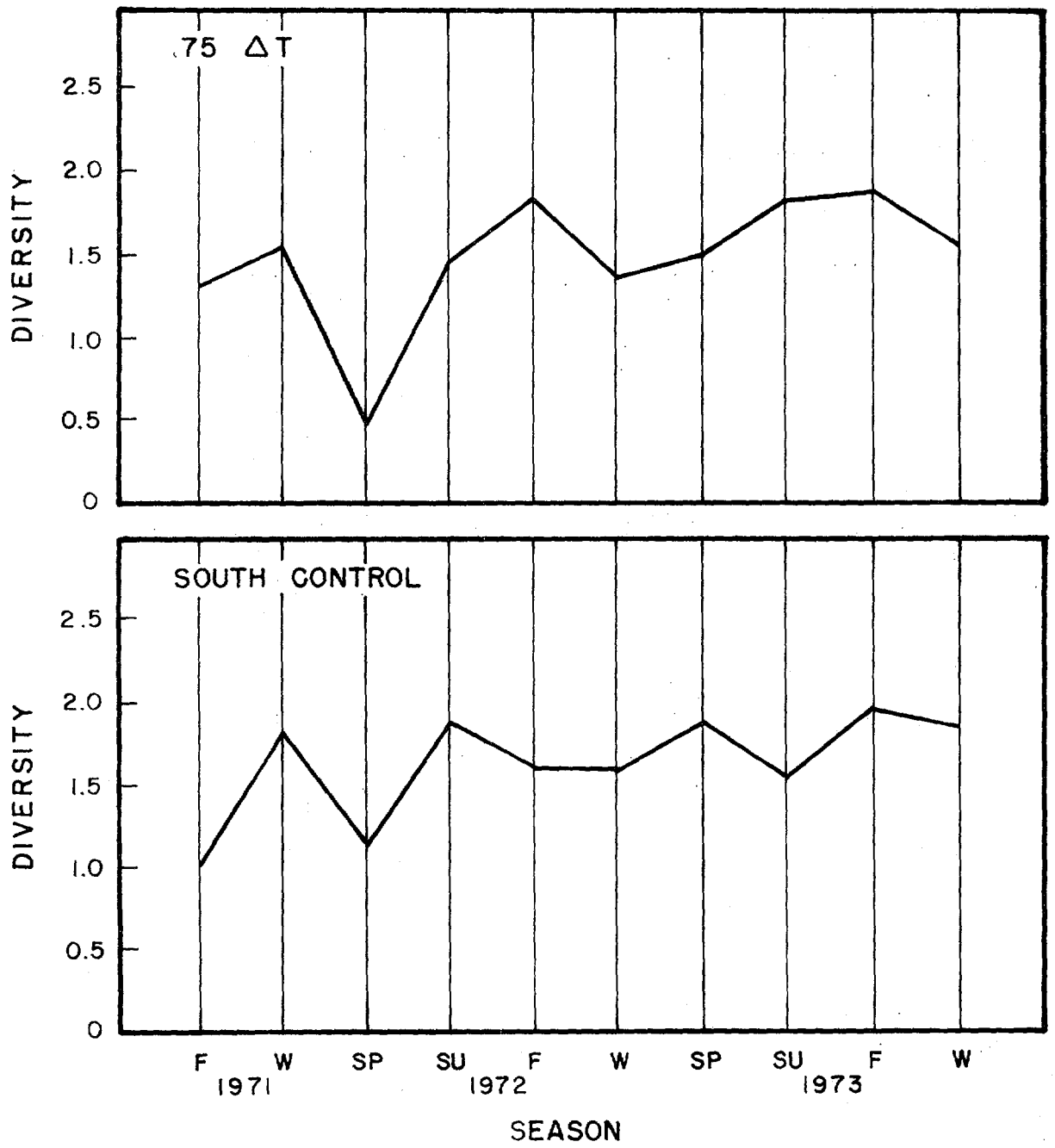


FIGURE IV-3

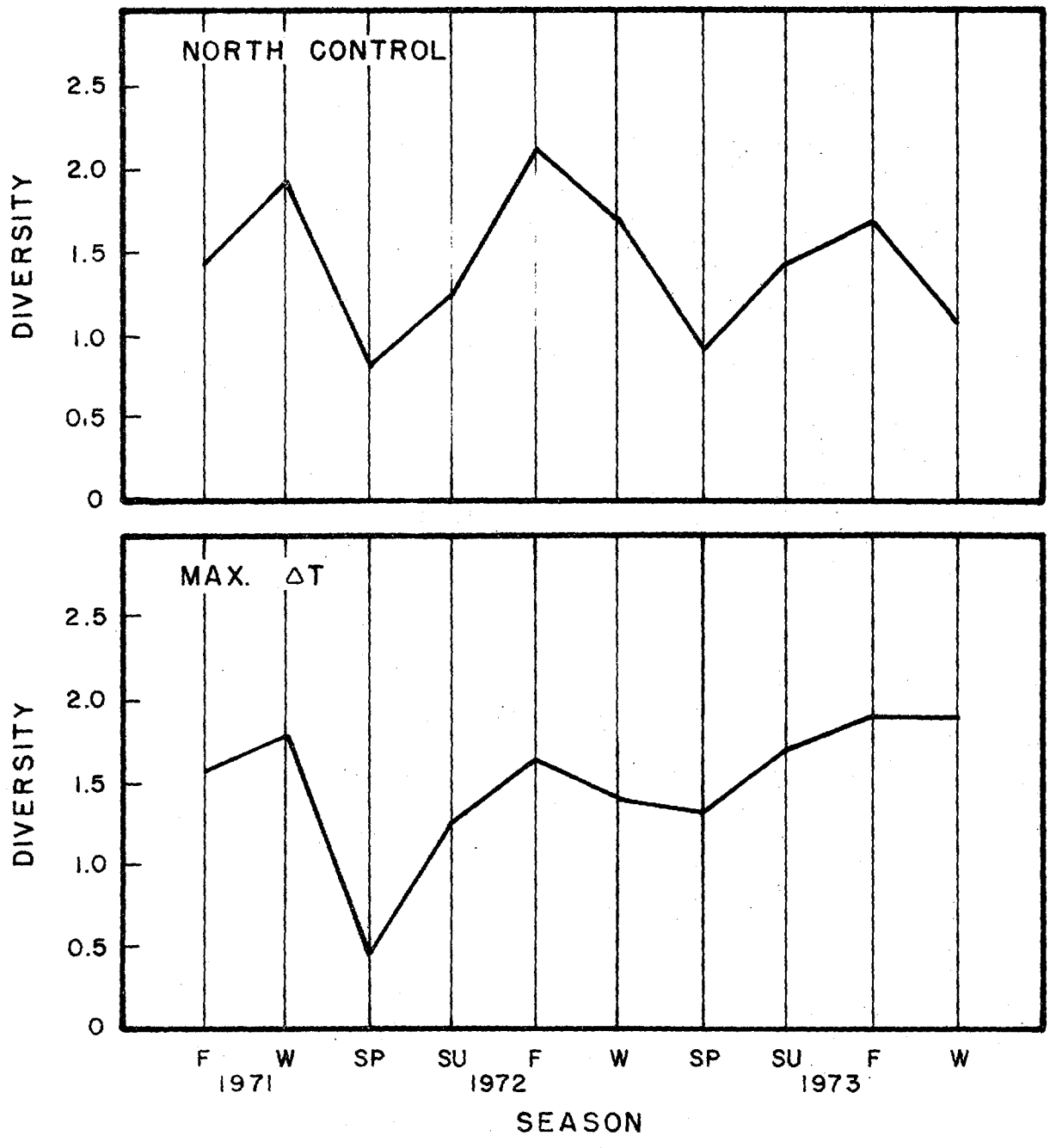
ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS
TOTAL DIVERSITY BASED ON ABUNDANCE BY SEASON AND TRANSECT 1971 – 1973



ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BENTHOS
TOTAL DIVERSITY BASED ON ABUNDANCE BY SEASON AND TRANSECT 1971 – 1973



1. Group Diversity Based on Class Abundance

The Shannon-Weaver general diversity index (H) was used to determine species diversity at the four transect locations from 1971-1973. Data were tabulated on a seasonal basis and are presented in Table IV-2. Total (pooled) diversity values are graphically presented in Figures IV-2 and IV-3. Diversity values are indicated from fall 1971 through winter 1973. Diversity values are also presented by depth in Figures IV-4 and IV-5.

Total (pooled) diversity index values may be examined for all transects to determine spatial and temporal (i.e., seasonal) patterns in community diversity. From spring 1972 to summer 1973 all transects showed a general increase in diversity; a yearly diversity occurred during the fall. From fall to winter diversity values decreased but, in general, were not as low as spring values of the same year. The increase in total diversity values at all transects reflects a more even distribution of individuals among the constituent classes at the stations.

Diversity values at all transects for fall 1971 were lower than fall 1972 and 1973. This may indicate a sampling artifact since the total number of animals collected during fall 1971 composed approximately one-third the total number of animals collected during the same period in 1972 and 1973.

Gastropoda
- generally found on substrate in water 10 cm. to 2 m. deep
- primarily feed on algae; some omnivores have been reported
- Amnicolidae, Pleuroceridae, and Valvatidae remove oxygen directly from the water
- generally fewer species and individuals are found in soft water than in hard water
- some species restricted to particular substrate type

Isopoda
- mainly scavengers
- usually remain secreted under rocks, vegetation and debris; shallow water forms
- unusual to find more than one species in one habitat

Pelecypoda
- food consists of zooplankton, phytoplankton, and organic detritus by filtration
- most abundant in water less than two meters deep; occasionally found in deeper lake waters
- burrow in fall to avoid harsh climate
- growth period is from April to September
- Sphaeriidae are an important fish food source

Turbellaria
- require well oxygenated water conditions
- most appear to be negatively phototropic, i.e. shaded or secluded areas
- triclads usually more active under colder conditions

- usually associated with plant material in waters up to two meters deep

- active during daylight hours

- some evidence of movement to weedy shallows in spring and movement back to deeper waters in fall

Annelida

Hirudinea - abound in warm protected shallows

- chiefly nocturnal

- found at depths up to two meters; a few species occur in deeper water

Oligochaeta

- often abundant among filamentous algae

- most occur in ten meter deep water or less

- mainly detrital feeders

- Naididae can reproduce by budding a new individual every two or three days

- late summer-early autumn protective cocoons found as early as July

- temperature usually not limiting but often determines relative abundance

- Tubificidae are deeper water forms

Amphipoda - usually more active at night

- voracious omnivorous feeders; general scavengers

- breed between February and October

- Gammarus faciatus has a general distribution in unpolluted clear waters

- strongly thigomotropic and negatively phototropic

- primary food source for fishes

TABLE IV-1 Continued

Diptera
- Culicidae
  - Chaoborus punctipennis
  - Chaoborus rotundifolia
- Ceratopogonidae
  - Bezzia setulosa
  - Palpomyia gibralis
- Tendipedidae
  - Coelotanypus concinnus
  - Procladius
  - Cricotopus
  - Polypedilium
  - Prodiamesa
  - Chironomus genuicaudatus

TABLE IV-1 Continued

- *Limnoldrilus udelcemianus*
- *Peloscolex ferox*
- *Homochaeta naidina*
- *Rhyacodrilus coccineus*

Naididae

- *Nais pseudobtusa*
- *Paranais frici*
- *Vejdorskgella intermedias*

Arthropoda

Arachnida

Acarina

Crustacea

Cladocera

Copepoda

Calanoida

Cyclopoida

Mysidacea

Mysida

Mysis

Amphipoda

Gammaridae

Gammarus fasciatus

Oedicerotidae

Monoculodes

Isopoda

Osellidae

Asellus militarus

Anthuridae

Cyathura polita

Idoteidae

Chiridotea almyra

Insecta

Collembola

Istomidae

Istomurus palustris

Coleoptera

Hydrophilidae

Trichoptera

Hydroptilidae

Oxyethira

Agraylea costello

Leptoceridae

Athripsodes dilutus

Oecetis inconspicua

Ocetis cinerascens

TABLE IV-1

Roseton Benthos 1973
Species List
ROSETON/DANSKAMMER POINT VICINITY

- Platyhelminthes
  - Turbellaria
    - Tricladida
- Ectoprocta (Bryozoa)
  - Phylactolaemata
    - Plumatellina
      - Lophopodidae
        - *Pectinatella magnifica*
- Mollusca
  - Gastropoda
    - Mesogastropoda
      - Amnicolidae
        - *Amnicola*
      - Viviparidae
        - *Viviparus*
  - Pelecypoda
    - Heterodonta
      - Sphaeridae
        - *Pisidium*
        - *Sphaerium fabale*
        - *Sphaerium simile*
        - *Sphaerium striatinum*
    - Eulamellibranchia
      - Unionidae
        - *Lampsilis*
        - *Elliptio*
- Annelida
  - Polychaeta
    - Sedentaria
      - Spionidae
        - *Scolecolepides*
      - Sabellidae
        - *Manayunkia speciosa*
  - Clitellata
    - Hirudinea
      - Piscicolidae
        - *Pisicola punctata*
      - Erpobdellidae
        - *Erpobdella punctata*
    - Oligochaeta
      - Tubificidae
        - *Aulodrilus americanus*
        - *Aulodrilus plyriseta*
        - *Limnodrilus hoffmeisteri*
        - *Limnoldrilus profundicola*

The affinity values were arranged according to transect, e.g., MaxΔT 1, 2, 3, to illustrate the ecological variation, if any, with depth. A high affinity index therefore indicated ecologically similar communities. In these studies an affinity index value of greater than 76 was used to indicate close ecological similarity.

Biomass data were collected for most classes of benthic organisms. Occasional absence of biomass data for a single class resulted in inaccurate determination of total biomass for that collection. The frequency of this occurrence was relatively low; however, the discontinuity in the data limited its use for describing community biomass structure. Calculations of diversity based on biomass were not attempted; consequently much of the following discussion was based on numerical abundance data rather than biomass.

C. RESULTS AND DISCUSSION

An inventory of benthic organisms (Table IV-1) collected in the Roseton/Danskammer Point area of the Hudson River indicated that at least forty-five species representing seventeen classes were present. Brief descriptions of the ecology for selected classes (from Pennak, 1953) are presented to provide a better understanding of each animal's relationship to the environment:

Acari
- common in littoral regions of lakes using rooted aquatic vegetation clearly associated with substrate
- most are carnivorous or parasitic
- found at all times of year; usually more abundant in late spring and early autumn

components between two samples; the greater index value the more similar the communities. Affinity values were calculated by summing the values of identical taxa between two stations, i.e., oligochaetes are common between two stations and compose a certain percentage of the total fauna for each.

For example, affinity values are calculated as follows:

Station A % Composition	Common Classes	Station B % Composition	Common Value
40	Oligochaeta	20	20
5	Diptera	10	5
8	Gastropoda	8	8
		TOTAL:	33

A diagrammatic presentation of the affinity index relationships is presented by utilizing the trellis diagram (MacFayden, 1963). The calculated indices are arranged in the squares of the trellis diagrams with the linear order of the sample stations corresponding in the rows and columns. Stations with highest affinity values may then be considered as part of the same biological community and distinct from other groups in the diagram. The trellis diagram is therefore used to graphically indicate the degree of ecological similarity based upon values of the affinity index.

The trellis diagrams are presented so that the degree of biological similarity among the transect locations from North Control (NC) to the South Control (SC) can easily be viewed.

the data. Abundance data for total benthos, dipterans, molluscs and oligochaetes were tested.

One sample from depth 2 on transect 75ΔT was misplaced from the August (summer) 1972 collections. To facilitate the ANOVA and affinity procedures and graphical presentation of the data, the number of organisms in this sample were considered as being equal to the number in the replicate for that collection. Paired t-tests indicated that there were no differences in the number of organisms in the paired samples at either depth 1 or depth 3 from transect 75ΔT on that collection date. For samples 1 and 1R, $t = 0.121$ with four degrees of freedom and for 3 and 3R, $t = 1.085$ with five degrees of freedom. Both t values were not significant at the 5% level.

Student-Newman-Keuls procedures were applied to mean log-abundance or mean log-biomass values whenever ANOVA testing indicated significant differences between depths, transects, or seasons (Sokal and Rohlf, 1969).

Community structure was determined by the percentage composition of the total community by each class. Percentage composition based on biomass was calculated when possible. Composition was determined on the basis of abundance.

The diversity components of samples were further compared by use of an affinity index (Sanders, 1960). This index is a numerical value that expresses the degree of similarity in the arrangement of the diversity

3. Data Analysis

Diversity indices are valuable in describing community composition in terms of the relationship between individuals and groups (species, orders, classes, etc.) present in the community (Odum, 1971). Numerical diversity values are based on ratios of these factors which may be calculated from abundance, biomass, productivity, or other data (Odum, 1971). A variety of formulae are available for calculating diversity values (see McErlean and Mihursky, 1969). Pielou (1966) provided criteria for choosing the appropriate formula based primarily on sample size.

Diversity values for Roseton/Danskammer Point area benthic communities were calculated from the formula suggested by Pielou (1966):

$$H = -\sum_{i=1}^{s} P_i \log_2 P_i$$

where s is the number of groups and P_i is the proportion of the i^{th} group in the population.

Egloff and Brakel (1973) have demonstrated the feasibility of using class abundance values for calculating diversity by this formula. Diversity values given for Roseton/Danskammer Point area benthos were calculated from abundance or biomass values based on taxonomic classes.

Abundance data were tested for differences between depths, transects and seasons by three-factor analysis of variance (Simpson, Roe and Lewontin, 1962). All three factors were considered to be random. Analysis of variance (ANOVA) also tests for interactions between all possible combinations of the three factors. Tests were conducted for each year and each possible combination of years based on log transformation of

with determining specific identifications of large numbers of benthic organisms. These authors have suggested assigning the various benthic organisms to groups defined by the shape of the individuals or other arbitrary criteria. Certain groups are readily separated to genus and are considered as such.

Preserved wet weight biomass was determined to an accuracy of ± 0.01 mg for each group of organisms. This method is subject to considerable variability depending on the water content of the individuals (Russell-Hunter, 1970). Consistent handling of each sample aids in controlling this problem. Corrections were not applied to mollusc weights to reduce the influence of shell weight on biomass (Holme and McIntyre, 1971; Williams and Thomas, 1967). The contribution of molluscs to total community biomass was generally small; correction of these data would have had little influence on the present discussion.

Sediment samples were collected by a core sampler from the four benthic transects in October 1973. Core samples were collected from all depths except NC-2 and SC-3. Sediment from the top of the core, up to 10.2 cm, was removed for determination of organic content and particle size distribution (Lambe, 1951). Organic content was determined by weight loss following volatization of dried sediment. Particle size distribution was determined by settling techniques (Lambe, 1951). The results of the core sampling program are presented in Chapter VII.

The results of the benthic analysis studies are presented in Appendix IV-A.

(c) Sampling Frequency. Sampling dates in 1973 were as follows:

June 7
July 5
August 3
September 5
October 4
November 1
December 3

Samples representing the seasons: spring (June), summer (August), fall (October), and winter (December) were completely analyzed in the laboratory to obtain information on seasonal trends in animal abundance and biomass. Selected samples were analyzed from the other monthly collections to monitor animal population fluctuations which would therefore more accurately pinpoint changes in community structure. The selected samples were from the 30-foot stations at MaxΔT and SC.

2. Laboratory Procedures

Samples collected in the field were washed through a cone of 500μ mesh screening. Screening procedures washed away sediment particles and most microbenthic organisms. Residue retained on the screens was preserved in a solution of 70% ethyl alcohol and phloxine-B dye. The red phloxine-B was taken up by the organisms and afforded easy distinction of animals and debris (Mason and Yevich, 1967).

Samples were examined under a stereomicroscope and the organisms sorted by taxonomic group. Each group was blotted dry and weighed to the nearest tenth of a milligram. Specimens were retained for speciation.

King and Ball (1964), Cairns et al. (1968) and Cairns and Dickson (1971) have pointed out the problems associated

Engineers and Oceanographic Analysts,Inc. (1969) on the cooling water discharge from the plant.

.75ΔT - The transect expected to experience 75% of the maximum temperature change (Quirk, Lawler & Matusky Engineers and Oceanographic Analysts, Inc., 1969).

SC - The South Control transect was 3 miles south of the proposed discharge on the west side of the river.

Transects NC and SC were estimated by Quirk, Lawler & Matusky Engineers and Oceanographic Analysts, Inc. (1969) to be outside the thermal influence of the Roseton plant.

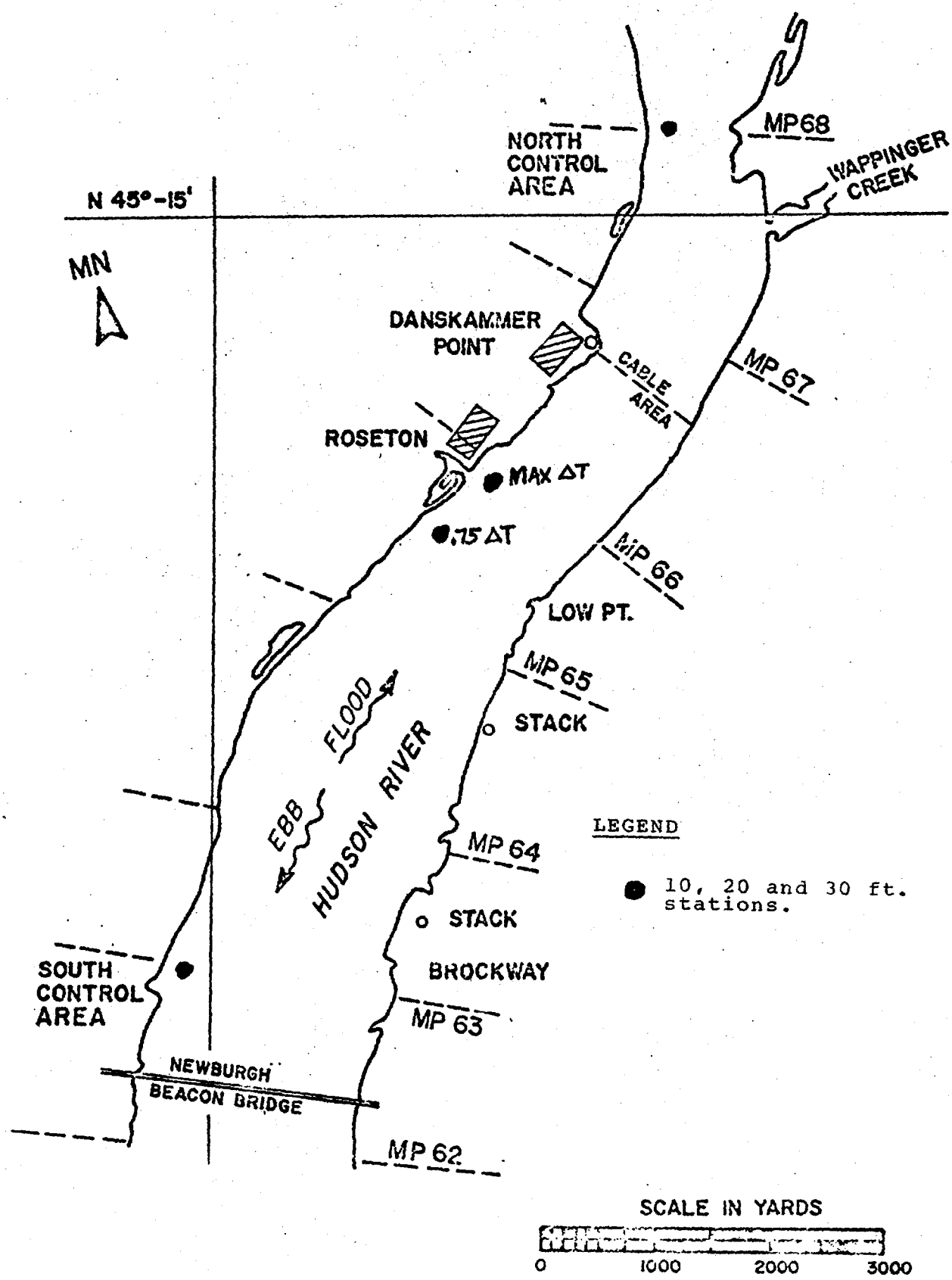
Each transect was sampled at depths of 10, 20, and 30 feet (measured from mean low water). At each station these depths were designated as 1, 2 and 3. Each station was marked by an anchored buoy.

(b) Sampling Procedure. A 6" x 6" Ponar sampler with a 500 micron mesh covering was used to collect benthic samples during slack water periods. The sampler was lowered in a rapid, controlled descent from a boat moored to a station buoy. The sampler was returned to the boat, and the sample washed into a plastic bag to which 40% formalin was added to achieve a final concentration of 5-10% formalin. A replicate sample was taken at each station. Each bag was sealed, labeled, and returned to the laboratory for analysis.

FIGURE IV-1

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
ROSETON/DANSKAMMER POINT GENERATING STATIONS

BENTHOS SAMPLING STATIONS, 1973



Feldman (1971) conducted studies on the microflora and microfauna at four locations: the Roseton area, Danskammer Point intake and discharge areas and at a control 2.5 miles north of Danskammer Point. He observed "substantial benthic fauna" at three locations; the discharge area had absence of benthos.

The studies reported herein consist of a summary of the results of a three year investigation of Hudson River macrobenthos in the Roseton/Danskammer Point vicinity. Details of the 1971 and 1972 studies have been presented previously (Quirk, Lawler & Matusky Engineers, 1973a). Emphasis is placed on seasonal abundance and the distribution, by depth and location, of the various classes of macrobenthos sampled in this region of the Hudson River. Consideration is given to biomass distribution and seasonality.

B. MATERIALS AND METHODS

1. Collection Procedures

(a) Sampling Locations. Four sampling transects (Figure IV-1) were established in October 1971 and defined as follows:

NC - The North Control transect was 2-1/2 miles north of the Roseton discharge on the west bank of the Hudson River.

Max ΔT - This transect is expected to experience the maximum temperature change during the operation of the Roseton plant. This designation was based on predictions made by Quirk, Lawler & Matusky

of sediment is of considerable importance in determining the distribution of benthic organisms (Sanders, 1958; Lie and Kelley, 1970). Carricker (1967) has reviewed these and other factors which influence estuarine benthic communities.

Studies performed by Quirk, Lawler & Matusky Engineers and Oceanographic Analysts, Inc. (1969), Pierce (1971), Feldman (1971), Rehwoldt et al. (1972), Barnett (1973), and Quirk, Lawler & Matusky Engineers (1973a) have provided information on the aquatic biology in the vicinity of the Roseton and Danskammer Point plants. The study conducted in 1969 compared results of sampling efforts immediately south of the proposed Roseton plant, to those collected immediately south of (and within the probable area influenced by) the Danskammer Point cooling water discharge.

Pierce (1971) conducted a qualitative survey of benthic organisms, aquatic weeds and plankton found 700 feet south of the Danskammer Point plant and at a control area two miles north of the plant. Pierce concluded that the same species were present in both the heated discharge area and the control area. No quantitative measures were performed, but general comparison of abundance indicated that fewer aquatic weeds were found in the discharge area than in the control area. In addition, organisms associated with the weeds were less abundant in the discharge area than at the control.

IV. BENTHOS

A. INTRODUCTION

Benthic animal populations contribute to energy flow in estuarine systems and directly or indirectly support commercial and sport fisheries (Williams and Thomas, 1967). Energy flow is effected by consumption and utilization of phytoplankton, zooplankton, and detritus by the benthos (Townes, 1936) and the subsequent use of benthos as energy sources by other predators (Gerking, 1962; Hayne and Ball, 1956). Benthos thus serve as an intermediary link between primary producers and consumers and third and fourth order consumers (Odum, 1971).

In order to understand energy flow through estuarine systems and the role played by the macrobenthos, qualitative and quantitative investigations are necessary. Abundance and distribution of macrobenthos are influenced by a variety of physical, chemical, and biological factors acting alone or in combination (Reid, 1961). Thut (1969) discussed the influence of depth on the distribution of freshwater benthos. The depth patterns were primarily associated with photic relationships of the organisms to a particular plant food source and to seasonal migrations to or from deeper water.

Distribution and abundance of littoral marine benthos are influenced by salinity, dissolved oxygen concentrations, temperature, and mineral composition of the sediments (D'Agostino and Colgate, 1973). Preference for specific size or type

Oligochaetes represent the largest fish support potential at all transects with maximum values obtained during the summer and winter of 1972 and the summer of 1973 (Table IV-11). During this period the oligochaete fish support potential was greater during the summer of 1972 with the highest values calculated at MaxΔT and .75ΔT. Although oligochaetes represent the largest food source per unit area, fish stomach analysis of young striped bass and resident white perch has indicated general dietary preference for crustaceans and insects (Table IV-12) (Quirk, Lawler & Matusky Engineers, 1974)

Crustaceans (Table IV-13) reflected the greatest food source on a yearly basis with insects being comparable during the fall and winter. Highest fish support potential was observed for crustaceans at the North and South Control transects during the survey period. Generally, higher values for crustaceans at South Control during the summer of 1973 may be indicative of the presence of the isopod Cyathura polita which is generally more abundant at North and South Control during this period.

In summary, oligochaetes, crustaceans, and insects offered the greatest source of fish food in the Roseton/Danskammer Point area. Seasonal abundance appeared to determine the types of benthic organisms selected by fish. Crustaceans and insects represented the source of food most utilized by the young striped bass and white perch.

Substantial regional differences in the river benthos as fish food may reflect the biological transition between fresh and brackish water. Higher fish support potential values were calculated for Kingston (mile point 95), north of Roseton/Danskammer Point, and for Bowline (mile point 35), further south (Quirk, Lawler & Matusky Engineers, 1973b). These values were calculated using the formula presented and converted to fish support potential per square meter. Based on the 1972 mean total benthic biomass, fish support potential at Kingston was 1,667 gm/m^2/year, 307 gm/m^2/year at Roseton/Danskammer Point and 766 gm/m^2/year at Bowline.

6. Salinity Influence

Faunal gradients in an estuary reflect a series of salinity changes which vary in duration and amplitude (Young, 1949). Runoff due to rainfall and melting ice and snow determines the general location and persistence of the salt front in the estuary. Daily tidal cycles expose faunal communities to varying amplitudes of salt concentrations in the immediate vicinity of the salt front.

In general these assemblages of organisms are noted: one above the area of influence of the salt front, including characteristically freshwater forms; a second marine grouping near the mouth of the estuary; and a third characterized by euryhaline organisms in the area of fluctuating salinities (Carricker, 1967). The concentration and rate of salinity change are ecologically important and may act to determine community diversity and distribution (Reid, 1961).

Quantitative and qualitative evaluation of the samples collected from fall 1971 through winter 1973 indicated that oligochaetes and dipterans were the

dominant benthic organisms in the study area. Oligochaetes and dipterans also dominated the benthos at Kingston, thirty river miles north (Quirk, Lawler & Matusky Engineers, 1973b). However, the greater community diversity index found at Kingston suggests a more varied faunal assemblage than that of the Roseton/Danskammer Point area.

Thirty river miles south, in the Haverstraw Bay area, a different community structure was noted: oligochates were the primary benthic organisms; polychaetes and molluscs replaced dipterans in the benthic community (Quirk, Lawler & Matusky Engineers, 1974). Kingston and Haverstraw Bay represent spatial differences in salinity gradients with fresh and primarily saline environments, respectively. The change in the community structure between the three areas is reflective of the differences in the salinity gradient.

Biological observations suggest that the Roseton area is a transition zone or ecotone between brackish and freshwater benthic communities. Biological evidence for this observation is the distribution of various polychaetes. The freshwater species Manayunkia speciosa is found at Kingston and Roseton/Danskammer Point and the marine genus Scolecolepides is found at Roseton/Danskammer Point and Haverstraw Bay. Concentrations of Manayunkia were greater at Kingston and concentrations of Scolecolepides were greater in Haverstraw Bay.

The presence of two species, in small concentrations, one marine and one freshwater , suggests an area of transition between the two (Reid, 1961). For the two species there also appeared to be a temporal

change in composition with the freshwater species more abundant in the spring and the marine members increasing in the fall. The peak abundance periods for the two groups correspond to low and high chloride concentrations, respectively (see Chapter VII for further discussion).

Cronin et al. (1962) described a distinct and persistent change along the length of the Delaware River estuary which could be attributed to a salinity gradient. The amphipod Gammarus fasciatus was especially important in the upper reaches where salinity was less than 5% (an oligohaline condition). This amphipod species was present throughout the year; greatest densities were observed during the summer at all stations. The increase in abundance during the warmer water periods at all stations may indicate an interaction between temperature and salinity.

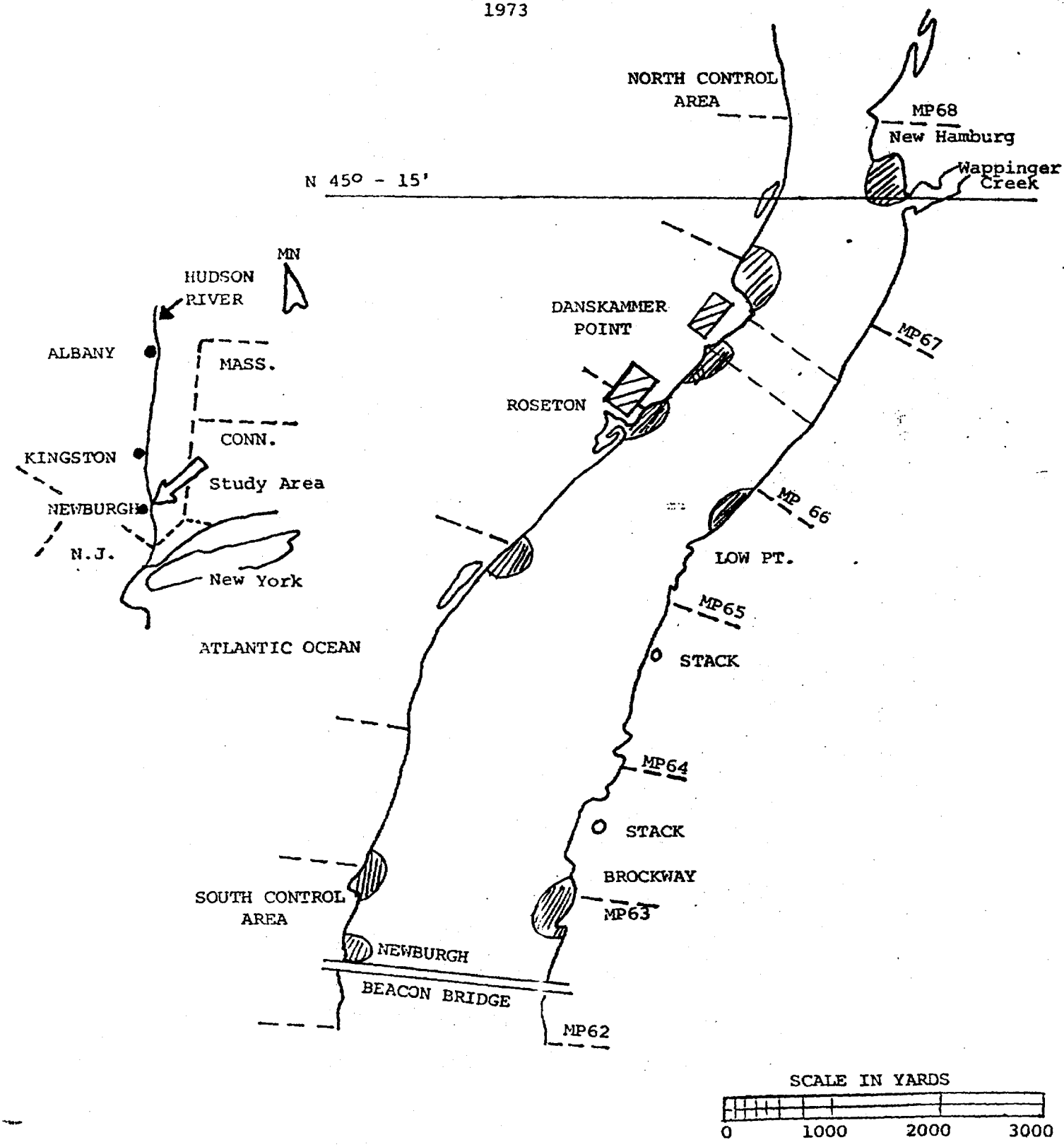
The seasonal abundance of the estuarine isopod Cyathura polita may be further evidence of the interaction between temperature and salinity. Certain estuarine crustaceans have been observed to have greater survival in low salinities at higher temperatures (Pearse and Gunter, 1957; Kinne, 1964). C. polita appears to reflect this tendency with increased abundance during the summer and fall.

7. Littoral Survey

A littoral survey was conducted on August 3, 7 and 13, 1973. Samples were collected in shallow water areas along the east and west shore of the Hudson River in the vicinity of the Roseton/Danskammer Point generating stations (Figure IV-29). Rooted aquatic plants, bottom sediments and rock substrates were selected at specific sites to coincide with river sampling locations for fish and benthos.

Figure IV-29

ROSETON/DANKSAMMER POINT LITTORAL SURVEY AREAS
1973



(a) Materials and Methods. Representative species of rooted plants were carefully covered with a plastic bag and cut just below the surface of the sediment. The bag was sealed to prevent the loss of any organisms or plant parts. Excess water in the bag was removed by pouring through a 400μ wire mesh screen. All material retained on the screen was returned to the sample bag. The volume of each rooted plant was determined by water displacement and recorded to the nearest 1.0 ml. In addition, the wet weight biomass of each plant was determined to the nearest 0.1 g. after rinsing the plant with water and blotting it with paper towels to remove excess moisture.

The organisms that were removed from each plant and retained on the 400 micron mesh were classified to order and enumerated. The wet-weight biomass of each order was determined.

Growth on small rocks was removed by scraping or brushing. The material removed was examined to determine qualitative species composition.

(b) Results and Discussion. A total of ten species of rooted aquatic plants were collected during the survey (Table IV-14). The quantitative and qualitative results of associated epiphytic plants and animals are presented in Table IV-14. The vascular plants most frequently collected throughout the survey area included the cosmopolitan species Potamogeton Richardsonii (pondweed) and Myriophyllum (water milfoil). In terms of the diversity of vascular plant flora, greater members of plant species were collected at Roseton East South Control (RESC), Roseton Max. ΔT (RMΔT) and Danskammer Cove (DC).

TABLE IV-14

ROSETON/DANSKAMMER POINT LITTORAL SURVEY
SPECIES INVENTORY

ROOTED AQUATIC PLANTS	ASSOCIATED FLORA	BLUE-GREEN ALGAE	GREEN ALGAE	ASSOCIATED FAUNA
Galinsoya parviflora	Diatoms	*Lyngbya sp.*	*Chlorella sp.*	*Acari*
Lemna sp.	*Cyclotella sp.*	*Oscillatoria limosa*	*Pediastrum tetras*	*Amphipoda*
Myriophyllum spicatum	*Navicula sp.*		*P. duplex*	*Bryozoa*
Potamogeton crispus	*Melosira varians*	Dinoflagellate	*Scenedesmus quadricauda*	*Copepoda*
Potamogeton epihydrus	*Coscinodiscus sp.*	*Peridinum sp.*	*Ankistrodesmus sp.*	*Diptera*
Potamogeton foliosus	*Cocconeis sp.*	Euglenophyte	*Oocystis sp.*	*Gastropoda*
Potamogeton pectinatus	*Gyrosigma obtusatum*	*Phacus sp.*	*Closterium sp.*	*Hirudinea*
Potamogeton Richardsonii	*Cymbella sp.*		*Ulothrix sp.*	*Hydra*
Trapa natans	*Fragilaria sp.*		*Cosmarium sp.*	*Isopoda*
Vallisneria americana	*Stephanodiscus sp.*		*Eudorina sp.*	*Nematoda*
	Opephora sp.		*Mougeotia sp.*	*Odonata*
	Synedra sp.		*Spirogyra sp.*	*Oligochaeta*
	Diatoma sp.			*Trichoptera*
	Gomphonema sp.			*Turbellaria*
	Amphipleura sp.			*Ostracoda*
	Achnanthes			*Coleoptera*
	Surirella patella			*Pelecypoda*
	Nitzschia dissipata			*Lepidoptera*
	N. obtusa			
	Campylodiscus sp.			Rotifer
	Hantzochia sp.			*Trichocerea*
				Keratella
				Ploesoma

Several rooted aquatic species found in the study area provide food and protection for wildlife. The tape grass, Vallisneria americana, and Myriophyllum sp., which was relatively common in the survey area, are an excellent food for wildfowl and attract various marsh and shore birds, in addition to providing a substrate for colonization by epiphytic flora and fauna.

The fauna observed on the various rooted aquatic species included gastropods, insects, crustaceans, water mites, oligochaetes, turbellarians, nematodes, pelecypods, isopods, bryozoans and copepods. In general, numerically dominant faunal groups throughout the survey area were dipterans, amphipods and oligochaetes. Dipterans were numerically dominant at all sampling sites and reflected the seasonal increase of this group found in river sampling stations (see Section C-2). A diverse and abundant fauna was observed only at RESC, REMΔT and DC, possibly because of the variety of substrate provided by the different kinds of rooted aquatic plants at these locations.

Associated algal groups found attached to rock and wood substrates at the sampling sites included diatoms, blue-green algae and green algae. In terms of numbers of different species, diatoms were most frequently represented on the rock and wood substrates. The faunal groups present at other stations included dipterans, rotifers, nematodes and ciliate protozoans. The relative paucity of fauna in these areas may be attributed to type of substrate available.

D. CONCLUSIONS

Benthos collection efforts were conducted in 1973 in the Roseton/Danskammer Point vicinity of the Hudson River to determine abundance, distribution and composition of benthic populations. Similar studies were also conducted in 1971 and 1972. These data will serve as baseline information for eventual comparison with data collected after initiation of commercial operation of the Roseton Generating Station. The results of the 1971, 1972 and 1973 studies indicate the following:

1. The benthic community in the Roseton/Danskammer Point vicinity during 1973 consisted of a large variety of organisms falling into the following categories:
   (a) oligochaetes
   (b) molluscs
   (c) insects
   (d) crustaceans
   (e) others
   The community was dominated throughout most of the year by oligochaete worms.

2. The overall abundance of benthic organisms increased from the spring through the fall of 1973. Similar increases in abundance have been noted at the same location for the years 1971 and 1972.

3. The diversity of the benthic community increased from the spring to the fall during the years 1971, 1972 and 1973. A decrease in diversity was noted in all years between fall and winter samples.

4. A gradient in species diversity was noted during 1973. Species diversity increased from the North Control transect to the South Control transect. No gradient in species diversity was noted with depth. The seasonal differences in species diversity were found to be significant.

5. Abundance of dipterans and molluscs was found to vary significantly with season. Variation in the numbers of dipterans was attributed to life cycle characteristics of the dipterans.

6. Benthic biomass values were found to be associated primarily with the oligochaetes. Biomass of benthos was found to vary significantly with season for oligochaetes, molluscs, dipterans and crustaceans. Seasonal variation in abundance and biomass of the dominant groups composing the benthos were attributed to life history phenomena (oligochaetes) and to predation by fishes upon the benthos.

7. Fish support potential for benthos varies significantly with season. The greatest fish support potential occurred during the fall in the years 1972 and 1973. Fish support potential in the vicinity of the study area was found to be the lowest of three sites studied in the Hudson River: Kingston (mile point 95), Roseton/ Danskammer Point (mile point 66), and Haverstraw Bay (mile point 38).

8. Species inventory population characteristics, community structure, and physical/chemical characteristics show that this sector of the Hudson River is in the transition zone where significant variations

in salinity occur on an annual basis. The biological characteristics of the Hudson River identify the area as being within the "species impoverished zone" generally found in estuaries where saline environments exist.

8. Estuarine benthos characteristic of the "species impoverished zone" generally demonstrate a capacity for resistance to environmental impact and a remarkable resiliency to the effects of predation, environmental stress, population decimation and habitat destruction. The background stress associated with the variable saline environment at Roseton/Danskammer Point has resulted in a benthic community capable of withstanding significant environmental impact without harm. Studies over three years (1971, 1972 and 1973) confirm that the benthos in this vicinity are characterized by low diversity, the capacity to withstand stress and a resiliency to environmental impact.

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CHAPTER V

V. FISH LARVAE

A. INTRODUCTION

Fish larvae are temporary members of the plankton community and react in much the same manner as zooplankton to various physical and chemical stimuli. Reports of diel migration of fish larvae, for example, have been published by Croker (1965). As documented for zooplankton by Jørgenson (1966), ichthyoplankters select food by size and type (Detwyler and Houde, 1970). Besides their classification as plankton because of small size and feeble swimming abilities, fish larvae are bound to the remainder of the plankton through similar nutritional requirements, until more adult feeding habits are assumed. Several species, including blueback herring and alewife, remain planktivorous throughout their lives. It is important then to investigate ichthyoplankton not only in terms of presence and abundance in the water column, but also more importantly in terms of their role in the plankton community of the Hudson River.

The effects of entrainment on aquatic organisms through the condenser systems of electrical generating stations utilizing once through cooling systems is another important ecological consideration. Little actual information exists on the effects of entrainment. It is necessary, therefore, to investigate the actual effects of entrainment on the biotic community.

When water is withdrawn from the river for cooling purposes, organisms that are contained in the water and which are small enough to pass through the traveling screens at the plant intake or which cannot actively avoid entrainment, are

drawn into the cooling system along with the water. Once inside the cooling system, these organisms may be subjected to changes in pressure and temperature and to possible mechanical damage when they pass through the condenser pipes.

Planktonic organisms which occur within the influence of a plant intake are subject to entrainment. In an area such as the Hudson River Estuary, the entrained organisms may include a large number of individuals of both phytoplankton and zooplankton. Since little information exists on the effects of entrainment on any of these organisms and since the presence and interactions of the plankton members is critical to the structure of the ecosystem, an accurate prediction of the effects of entrainment upon the ecosystem as a whole is not possible utilizing information that is currently available.

Most of the current studies of entrainment covering the Hudson River plankton investigate the effects on fish eggs and larvae, since fish are the most obvious inhabitants of the river and are the only organisms present which have both a commercial and recreational value. Striped bass have received more attention basically because this species is of the greatest interest to sport fishermen.

Several investigations concerning the distribution and abundance of fish eggs and larvae in the Hudson River have been completed in recent years. The first of these studies was the Hudson River Fisheries Investigation by Carlson and McCann (1969), designed to evaluate the potential effects of a proposed pumped storage plant at Cornwall, New York, on fish populations.

Fish eggs and larvae were collected from 1966-1968 at eight stations on the river, from Croton Point to Coxsackie, with the major sampling effort in the Cornwall area. The authors calculated that a withdrawal of water from the Hudson River by the proposed Storm King Pumped Storage Facility of an average volume of 18,000 cubic feet/second over an 8-hour period each night would result in the removal of 2.3-2.6% of the striped bass larvae produced in the entire estuary.

The results of the Carlson and McCann study have been criticized because the authors neglected to consider tidal effects, utilized average values for larval abundance in a cross section of the river, did not consider behavioral characteristics which might have prevented entrainment, and did not consider cumulative effects that removal of larvae would have on the striped bass population of the Hudson River over a number of years. Although data were collected on all larval species of fish in the study area, detailed analysis was conducted only for striped bass.

That report, along with the study of Rathjen and Miller (1957) provided the basis of published knowledge concerning larval distribution of striped bass in the Hudson River. Several other reports exist, including Raytheon Corporation (1972) and Quirk, Lawler & Matusky Engineers (1973). The former contains information on the distribution of several species of larval fish in the Indian Point area. The latter reported on the occurrence and distribution of ichthyoplankton in the Roseton/Danskammer Point area.

The objective of the studies reported herein was to supplement and expand similar ichthyoplankton investigations conducted in 1971 and 1972 in the Roseton/Danskammer Point vicinity (Quirk, Lawler & Matusky Engineers, 1973) of the Hudson River.

The studies conducted in 1973 consisted of abundance collections of fish larvae in the Hudson River, at the Danskammer Point plant intake and discharge structure and at the Roseton plant intake and discharge structure.

In addition attempts were made to estimate viability of fish larvae associated with the intake and discharge structures. Inasmuch as very little work had been done at any power plant on the viability of entrained fish larvae, the viability study and the results obtained must be considered as preliminary. Studies planned for future years will be designed to attempt to substantially improve on fish larvae viability estimates.

The results presented herein basically encompass the studies conducted at the intake and discharge structures of the two plants. Where relevant, results from studies conducted in the Hudson River are also presented.

The general objectives of the 1973 ichthyoplankton studies conducted in the Roseton/Danskammer Point area of the Hudson River were:

1. to provide more substantive basic information on the composition, abundance, and distribution patterns of larval fish; and
2. to determine the composition and abundance of fish larvae entrained in the cooling water systems of the two plants.

In addition to the two major objectives, consideration was given to the following areas of investigation:

1. the abundance and distribution of fish larvae collected in 1973 compared to 1972;
2. the relationship of the fish larvae entrained in the cooling water system of the two plants to the populations present in the river; and
3. the viability of fish larvae before and after passage through the plant cooling water systems.

B. MATERIALS AND METHODS

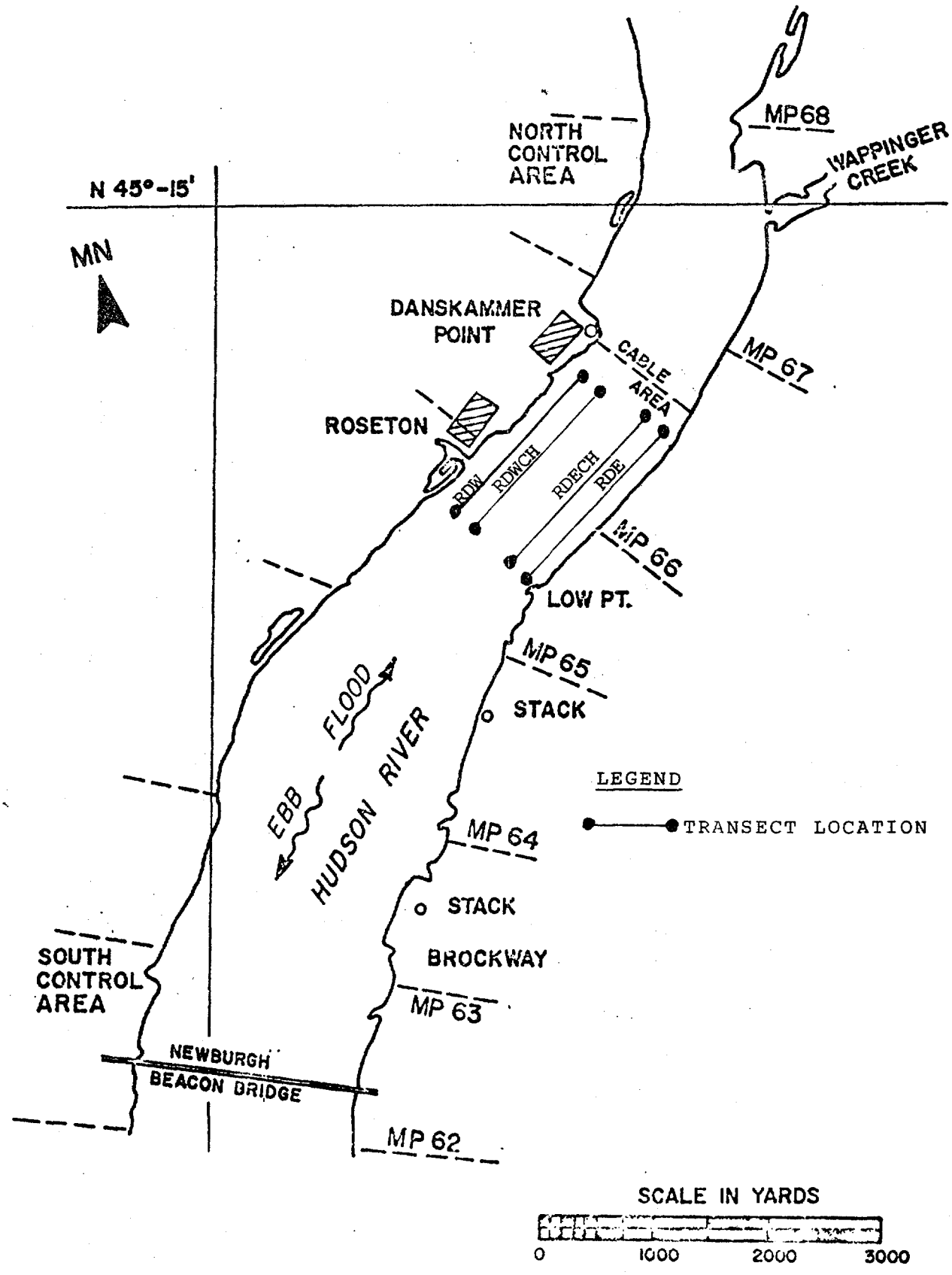
1. Field Procedures

(a) River Sampling. From March 13 to August 30, 1973 four transects in the Hudson River parallel to the shoreline between the Roseton and Danskammer Point plants were sampled (Figure V-1). Five minute horizontal tows were made against the tidal current, or, if collections were at slack tide, the tow was conducted against the direction of the next expected tide. Samples were collected at ten-foot intervals from surface to bottom to evaluate larval distribution by depth and location. Sampling was conducted every other week over a twenty-four hour period. The twenty-four hour collections permitted determination of diurnal patterns in larval distribution.

Figure V-1

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
ROSETON/DANSKAMMER POINT GENERATING STATIONS

FISH LARVAE SAMPLING STATIONS



All tows were conducted using a one meter diameter Hensen type plankton net (#0 mesh net; 571 micron). A TSK flowmeter was positioned in the center of the net mouth to estimate the flow of water. All samples were preserved in a 10% formaldehyde solution.

To obtain additional information on larval populations, selective simultaneous tows were conducted using both one meter and one-half meter nets. This permits comparison between sampling programs conducted in 1971 and 1972 which used one-half meter nets to the 1973 data, as well as evaluation of efficiency and possible selectivity of the two nets.

(b) Plant Sampling. To determine the number and viability of fish larvae in the cooling water systems, samples were obtained at the intake and discharge structures of both the Roseton and Danskammer Point plants.

One meter and/or one-half meter plankton nets were used for the plant sampling. A flowmeter, either TSK or a General Oceanics, was mounted in the mouth of each net to estimate the volume of water sampled during each collection. Physical characteristics of the intake and discharge structures determined the size of the net utilized for sampling at each plant. Although it is preferable to use the same collecting gear at each plant location and in the river, it was physically impossible to fit the larger nets into the space available at the Roseton generating station.

In all cases the method employed for setting the nets prior to and during sampling was the same. A framework of steel pipe was constructed extending from several feet above the surface of the water to the deepest sampling depth. Nets were fastened to polyvinyl chloride frames that

could be lowered on the steel pipes to a given sampling depth. The sampling locations and gear employed at each plant site are described below:

(i) Danskammer Point

The intake structure at Danskammer Point permitted the use of both one meter and one-half meter nets. A single one meter net was used at the Unit 3 cooling water discharge pipe. Two sampling frames were suspended in the intake from a catwalk spanning the intake channel. The frame on the west side of the channel held two one-meter nets vertically to sample surface and bottom. The frame on the east side of the channel held three one-half meter nets vertically to obtain surface, mid-depth and bottom samples. Both one meter and one-half meter nets were sampled simultaneously to obtain comparative larval concentration data across the intake channel and for gear comparison information.

The plant full flow calculated velocities were used in computing an average volume of water filtered by each net since plant operating conditions were full flow during most of the collection periods. A value of 28.73 m^3/minute was used for the volume of water filtered by the one meter net and 7.18 m^3/minute for the one-half meter net. The discharge value was 47.12 m^3/minute.

(ii) Roseton

The Roseton intake and discharge permitted the use of only one-half meter nets. A frame was constructed between the trash racks and travelling screens of Unit 1; three nets were placed vertically to sample the surface, mid-depth and bottom. A single net was used at the discharge to obtain quantitative samples. The sampling frame was constructed above the discharge pipe at the shoreline seal well, and the net was lowered directly into the discharge pipe.

During 1973 the Roseton plant was not fully operational and could therefore be sampled only on the dates when the circulating pumps were operating. This schedule was pre-arranged with plant personnel to include only dates that did not interfere with plant construction or peak power demands. Since the plant was not in operation, the collections indicated only pressure and/or mechanical effects of passage through the cooling water system.

(iii) Field Analysis

Field analysis of ichthyoplankton samples collected during 1973 consisted of determination of larval viability at the two plant sites. At the termination of each viability collection the cod-end bucket was transferred to an ambient water temperature table, and the larvae were separated into three categories: live, dead, or stunned. The larvae from these short term viability collections were placed in separate vials corresponding to the three categories to enable species viability determinations.

2. Laboratory Procedures

Preliminary analysis to separate fish larvae from detritus and particulate matter and to enumerate total larvae per sample was conducted on all larval samples collected during the 1973 studies. For river sampling, the number of larvae in each sample were converted to concentration of larvae per thousand cubic meters of water filtered by the following formula:

$$\text{Larvae}/1000\text{m}^3 = \frac{\#\ \text{larvae}}{ar\alpha}$$

where: a = area of net mouth in m^2.
r = number of meter revolutions
α = flowmeter calibration coefficient.

Calculated velocities based on plant flow data were used in computing larval abundance in the plant intakes and discharges.

The second phase of laboratory analysis was to separate and identify all larvae of the genus Morone (striped bass, white perch) from the larva samples collected. At the completion of the Morone analyses, samples representing day/night collections from each sampling date were selected for complete taxonomic analysis. All remaining samples were catalogued and stored for possible future analysis.

Samples for detailed analysis were usually chosen so that on a given date, each sampling depth was represented once during the day and once during the night, therefore providing data on the preferred depth of each species and possible diurnal variations in larval distribution.

Attempts were made initially to speciate river herring larvae (shad, blueback herring and alewife), but these were discontinued due to the extreme difficulty in distinguishing between the species at most developmental stages. Yolk sac shad, however, are fairly obvious and were noted on the data sheets.

Other fish identified included the Atlantic tomcod, tesselated darter, cyprinids (either carp or goldfish), rainbow smelt and sunfish. Individuals which could not be positively identified were classified as "others."

The numbers of larvae per thousand cubic meters of water for all samples and the speciation of larvae from selected samples were tabulated according to station, date of collection and depth.

The samples selected for speciation were further analyzed to yield length-frequency information on populations of striped bass, white perch and Alosa spp. If a sample contained small numbers (less than 60) of these larvae, all larvae of each species were counted and classified in 1 mm. length categories. If a large sample containing more than 60 larvae was analyzed, an aliquot (sub-sample) containing the first 60 larvae was processed; and the concentration was then proportionately adjusted to reflect the number of larvae of each species expected in the total sample. A complete tabulation of larvae abundance and composition data resulting from the 1973 studies is presented in Appendix V-A; length-frequency data is presented in Appendix V-B.

C. RESULTS AND DISCUSSION

1. River Sampling

(a) General Larval Distribution. River sampling was initiated on March 13 and continued through August 1973. Collections for March and April were made during the daylight hours only at RDW and RDE. Sampling commenced in May over a twenty-four hour period every two weeks at the four transects RDW, RDWCH, RDECH and RDE. Larvae were present in the study area prior to the first sampling date and persisted through early August.

A total larval distribution was obtained by averaging all samples collected on a given day at all stations (Table V-1). These data are presented graphically in Figure V-2. Two peaks of larval concentration were noted during 1973; one during the middle of March and a second during the first week of June. Few larvae were collected during April or after the middle of July.

The March peak of ichthyoplankton abundance was due almost exclusively to Atlantic tomcod which spawn during December and January (Bigelow and Schroeder, 1953; Booth, 1967). The smaller numbers of tomcod larvae collected during April indicate that the tomcod larvae migrate from the study area or are able to avoid the sampling gear.

Similar concentrations of tomcod with a peak occurring approximately the third week of March were also noted in the Haverstraw Bay area (Quirk, Lawler & Matusky Engineers, 1974a). The same trend of a higher abundance of larvae during March and decline in abundance during April was found by Howe (1971) in the Weweantic River estuary of Massachusetts.

TABLE V-1

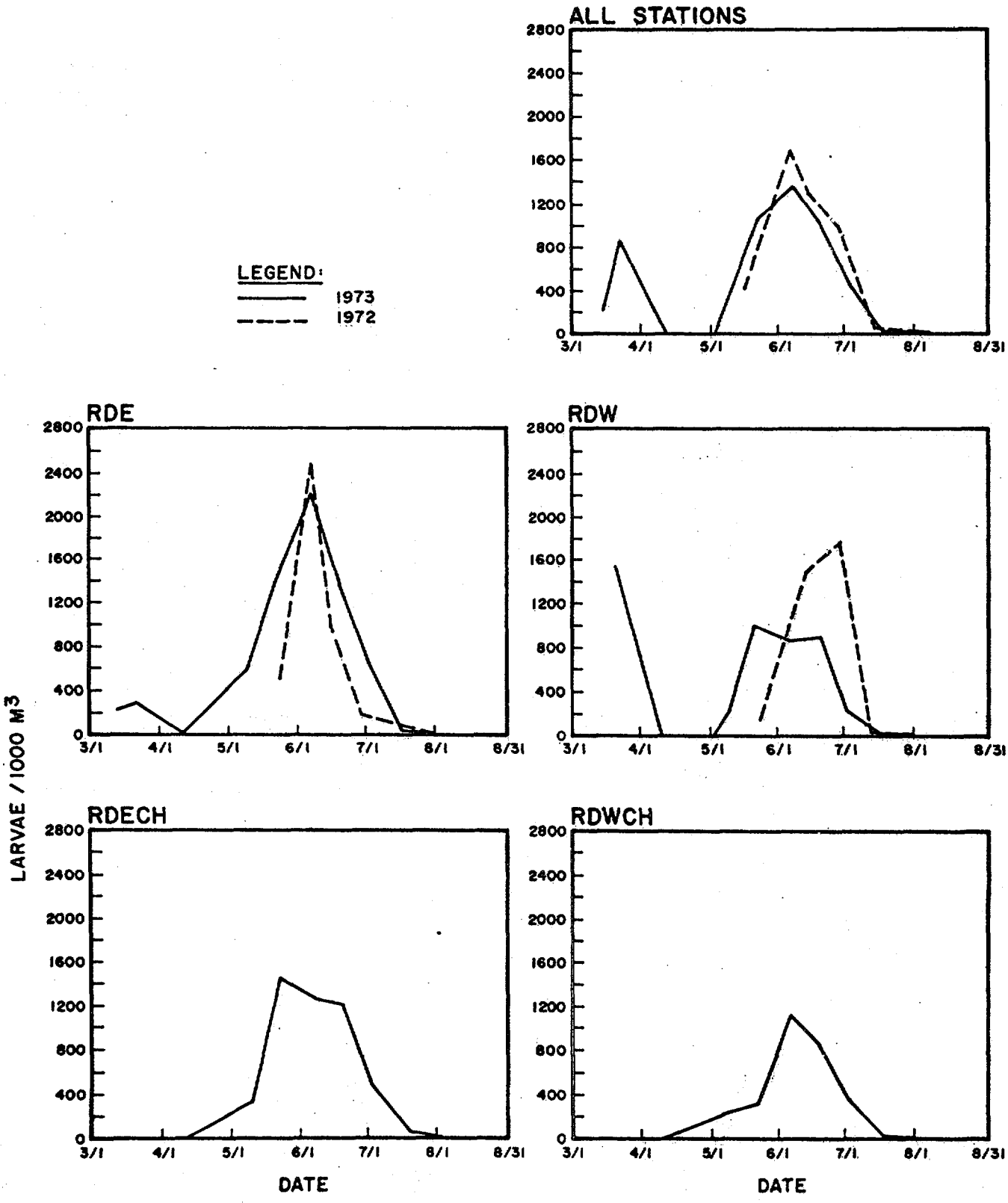
AVERAGE CONCENTRATION OF TOTAL LARVAE
ROSETON/DANSKAMMER POINT VICINITY, 1973
Number of Larvae/1000m^3

Date	TRANSECT				Average All Stations
	RDW	RDWC	RDECH	RDE	
3/13	N/S*	N/S	N/S	238	238
3/21	1488	N/S	N/S	297	893
4/11	0	2	0	3	1
5/3	38	N/S	N/S	N/S	38
5/10	240	245	334	606	356
5/22-23	1119	313	1444	1411	1072
6/7-8	880	1118	1270	2202	1368
6/19-20	913	858	1220	1387	1095
7/2-3	240	352	484	671	437
7/17-18	29	27	65	34	39
7/31-8/1	7	7	16	14	11
8/14-15	2	2	8	0	3
8/29	1	2	3	0	2

Note: N/S Denotes No Samples

FIGURE V-2

HUDSON RIVER FISH LARVAE ABUNDANCE: 1972-1973
SPECIES: ALL LARVAE
ROSETON/DANSKAMMER POINT VICINITY



With the exception of the Atlantic tomcod, the main spawning period for Hudson River fish populations in the Roseton/Danskammer Point vicinity occurs from May through July. This period encompasses the spawning of several anadromous species (blueback herring, alewife, American shad, striped bass) as well as resident species, including white perch and sunfish. Eggs spawned in the spring may have resulted in larvae at a stage of development in July and August capable of avoiding the larval net or others having already left the study area; either occurrence would result in the decline of abundance noted during late July and August.

Sampling conducted during 1972 encompassed the time period from the middle of May to the middle of August. During both years the same peak of larval abundance was observed, although the magnitude of the two peaks was slightly different. The decline and absence of larvae in the study area occurred during the same period during both years. The average total larval abundance was also calculated by date for each of the four transects sampled. These values are listed in Table V-1 and shown graphically in Figure V-2. During March, only RDW and RDE were sampled; the largest average concentration of larvae at this time was at RDW on March 21; 1,487 larvae/1000m^3 of water sampled were collected along the west transect, while 297 larvae/1000m^3 of water were collected along the east transect.

The highest average concentrations of total larvae resulting from the spring spawn were collected along the eastern transects. RDE had the greatest average larval concentration with 7028 larvae/1000m^3. RDECH

had the second highest concentration with 538 larvae/1000m^3. The two western transects had similar average larvae concentrations of 347 and 325 larvae/1000m^3, for RDW and RDWCH, respectively.

Peak abundance of larvae at a single transect occurred during the June 7-8 sampling effort. However, during the period from May 22 to June 20 high concentrations of larvae were found at all transects. The greater number of larvae collected at the eastern transects could be attributed partially to the transect's proximity to a large shallow area around the mouth of Wappinger Creek, which could be an area preferred for spawning, and to the more pronounced shallowness of the eastern shore of the river affording protection and food availability.

A one-way analysis of variance (ANOVA) was conducted to compare the total larval concentrations at the four transects.

Transect Comparison of Total Larvae/1000m^3

Source	Degrees of Freedom	Mean Square	F-Ratio
Transects	3	0.102	0.0471
Error	36	2.174	
Total	39		

There was no significant difference found for the average larval concentration between the four transects.

Sampling conducted at RDE during 1973 (Figure V-2) suggests a slightly greater larval abundance peak with a protracted residence time for larvae in the study area than in 1972. At RDW, larval abundance during 1973 was

fairly constant during the peak period, while a definite peak in abundance was found in 1972. The peak at RDW during 1972 also appeared at a later date than the comparable peak abundances at RDE during 1972 and 1973, and later than the greatest concentration found in 1973 at the same location.

Depth distribution for total larvae collected is presented in Table V-2 by month and transect. Many of the depth trends are not evident since a combination of larval species were collected, each species having varying patterns of growth and development and particular ecological requirements. A general trend in May of greater larval abundance in the surface waters to more larvae in bottom samples was observed. A more even distribution of larvae in the water column was found during June probably due to larval fish of several species at different stages of development occupying various levels in the water column. For the few larvae collected in August a pattern of avoidance of surface waters during daylight hours was detected.

(b) Species Occurrence. Atlantic tomcod (Microgadus tomcod) larvae dominated the March samples (see Appendix V-A). Throughout the remainder of the study the following larvae were collected: alewife (Alosa pseudoharengus), blueback herring (Alosa aestivalis), American shad (Alosa sapidissima), striped bass (Morone saxatilis), white perch (Morone americana), rainbow smelt (Osmerus mordax), tesselated darter (Etheostoma olmstedi), sunfish (Lepomis spp.) and cyprinids (Carassius auratus and/or Cyprinus carpio).

TABLE V-2

TOTAL LARVAE DEPTH DISTRIBUTION BY MONTH
AND TRANSECT, 1973
ROSETON/DANSKAMMER POINT VICINITY
Number of Larvae/1000m^3

MONTH	DEPTH (ft)	TRANSECT			
		RDW	RDWCH	RDECH	RDE
May	0	2308 (9640)	4491 (367)	9169 (7992)	6427 (2263)
	10	1397 (1574)	1275 (816)	11861 (5626)	5592 (638)
	20	523 (18)	2890 (75)	4651 (23)	(1317)
	30	2155 (65)	1691 (398)	4526 (66)	(1642)
	40	224	1589 (93)	4288 (6)	
	50	876	964 (12)	888 (15)	
June	0	9101 (4444)	2763 (4342)	2878 (2790)	12875 (2172)
	10	2271 (3947)	3519 (7175)	6918 (1742)	14005 (1703)
	20	1589 (2307)	2129 (3346)	551 (5277)	4779 (5591)
	30	3506 (3228)	4239 (3331)	3667 (4394)	1877 (3662)
	40		2379 (2668)	3988 (3333)	
	50		3896 (2738)	5587 (2116)	
July	0	1471 (661)	5384 (330)	2777 (288)	4349 (148)
	10	146 (1370)	97 (805)	231 (1625)	2299 (4757)
	20	202 (215)	85 (1251)	761 (1026)	1086 (641)
	30		99 (728)	598 (2674)	
	40		283 (585)	3348 (915)	
August	0	0 (19)	0 (26)	0 (160)	(107)
	10	3 (35)	0 (25)	90 (87)	0 (0)
	20	0 (29)	0 (27)	0 (90)	0 (5)
	30		17 (20)	15 (43)	
	40		8 (24)	6 (127)	

Note: ( ) Denotes Night Sample

Developmental keys were used for the identification of fish larvae. For some families of fish, such as the Cyprinidae, there is lack of specificity concerning many or all stages of growth. All samples were analyzed for Morone; selected samples were used for the complete identification of other taxa. Occurrence of the commercially important species (striped bass, white perch and the Alosa spp.) are discussed below.)

(i) Striped Bass (Morone saxatilis)

The transect distribution of striped bass larvae (Table V-3) (RDW, 66; RDWCH, 138; RDECH, 17; RDE, 13) points to greater concentrations at the western transects, especially RDWCH. Graphic presentation of the total abundance for all transects is shown in Figure V-3.

The average number of larvae per transect was compared using a one-way analysis of variance and no significant difference was found between the transects. The test table is presented below.

Transect Comparison of Striped Bass Larvae/1000m^3

Source	Degrees of Freedom	Mean Square	F-Ratio
Transect	3	0.403	0.3754
Error	36	1.074	
Total	39		

Peak concentration of striped bass larvae occurred during the June 7-8 sampling effort; when approximately 90% of the total striped bass larvae were collected. The greatest numbers were collected at RDWCH; the fewest were collected at RDE.

Only 14 striped bass larvae were collected during 1972; the majority were collected at RDE. The abundance peak occurred earlier in the year on May 24; however, since this was the first sampling date, peak abundance could have occurred prior to the initiation of sampling. Length frequency analysis of the 1972 samples would appear to confirm an earlier peak in abundance (Quirk, Lawler, & Matusky Engineers, 1973a).

Length distribution for striped bass larvae are presented graphically in Figure V-4 by transect and sampling date. Very few larvae were collected prior to May 22-23. Those larvae collected during sampling on May 22-23 approximated 3.0 mm in length, indicating that they were newly hatched (Pearson, 1938; Mansueti, 1958). Larvae from the peak abundance collection of June 7-8 averaged 5.0 mm in length, the length usually attained two to five days after hatching (Mansueti, 1958).

Striped bass eggs are free-floating and semi-buoyant during the first days after hatching; the larvae are poor swimmers and are barely able to maintain their position in the water column (Pearson, 1938; Mansueti, 1958). The type of egg and swimming ability of the larvae collected would suggest that spawning in 1973 occurred north of the study area and that these organisms

TABLE V-3

AVERAGE CONCENTRATION OF STRIPED BASS LARVAE, 1973
ROSETON/DANSKAMMER POINT VICINITY

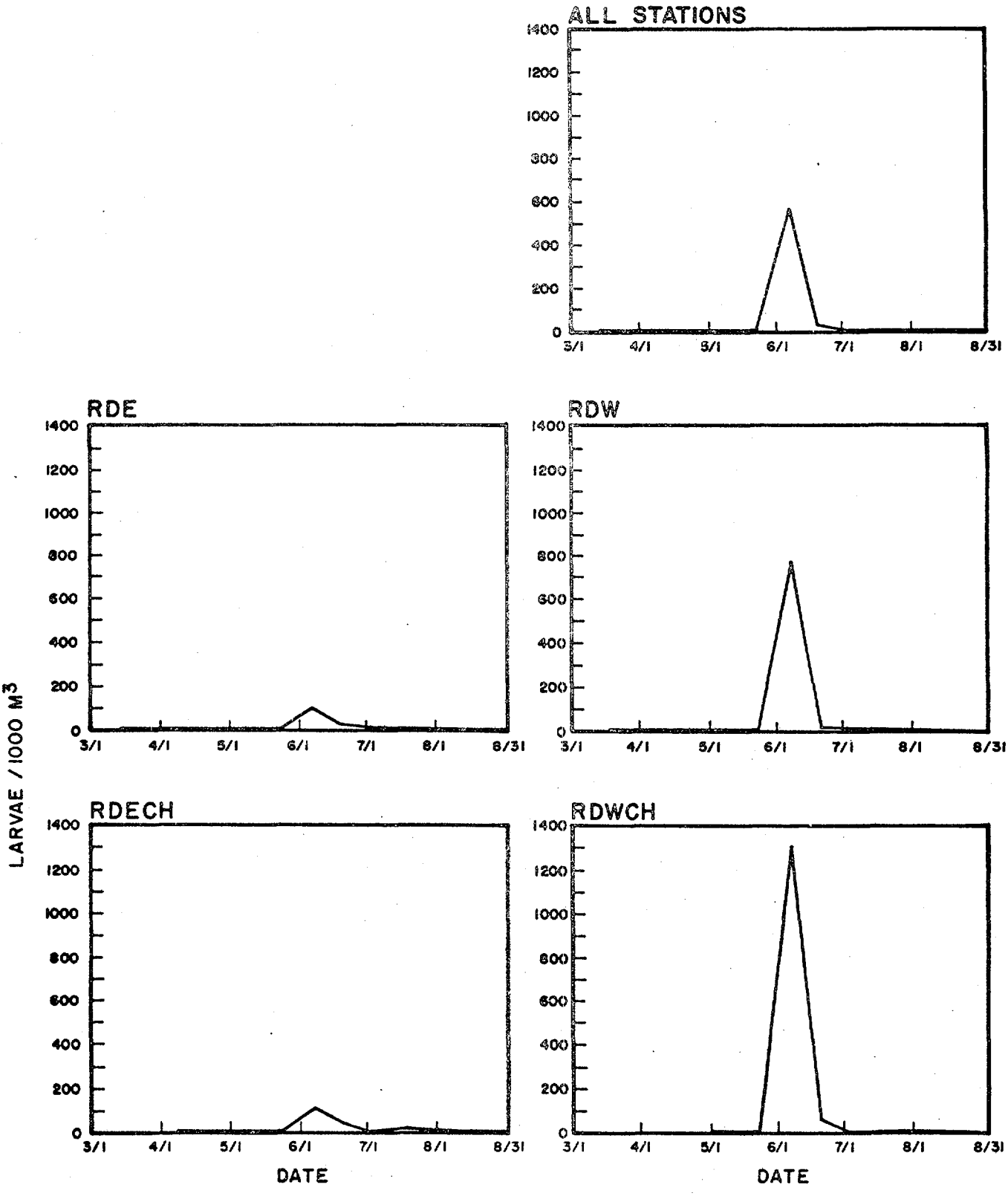
Number of Larvae/1000m^3

	TRANSECT				
DATE	RDW	RDWCH	RDECH	RDE	Average All Stations
3/13	N/S*	N/S	N/S	0	0
3/21	0	N/S	N/S	0	0
4/11	0	0	0	0	0
5/3	0	N/S	N/S	N/S	0
5/10-11	1	1	1	0	1
5/22-23	2	8	1	2	3
6/7-8	764	1306	110	97	569
6/19-20	16	59	41	31	37
7/2-3	8	1	2	19	8
7/17-18	2	8	15	7	8
7/31-8/1	1	0	½	2	1
8/14-15	0	0	2	0	0
8/29	0	0	0	0	0

Note: N/S Denotes No Samples

FIGURE V-3

HUDSON RIVER FISH LARVAE ABUNDANCE: 1972-1973
SPECIES: STRIPED BASS LARVAE
ROSETON/DANSKAMMER POINT VICINITY



STRIPED BASS LARVAL LENGTH DISTRIBUTION

ROSETON/DANSKAMMER POINT VICINITY

1973

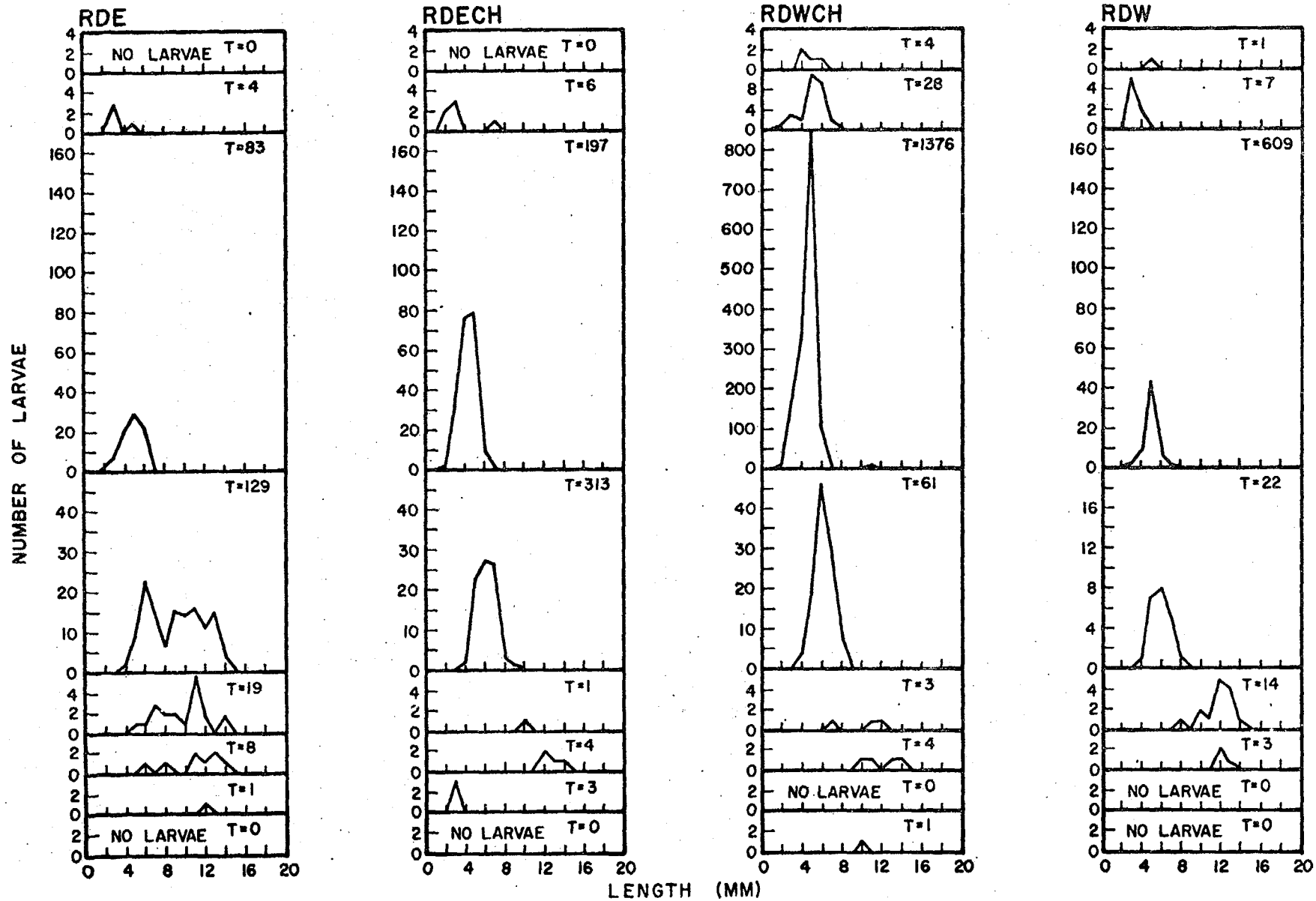


FIGURE V-4

drifted into the area by the net water flow of the Hudson River. Larvae collected on June 19-20 averaged approximately 6.0 mm in length. During July and early August, length distribution indicated several different age groups, some from later spawning times. Absence of striped bass larvae from the collections after August 14-15 was possibly due to active avoidance of the plankton net, lower concentrations or preference for areas not sampled.

Comparison of day-night collections on a monthly basis showed that overall 94% of the striped bass larvae were collected during night sampling. Except for RDWCH during May this was true for each transect during each month.

Table V-4 lists the depth distribution of striped bass larvae collected during day and night hours. For both day and night the greatest concentration of larvae occurred at the mid-depths. Fewer larvae were collected during the day by surface tows than were collected at night.

(ii) White Perch (Morone americana)

White perch are the dominant resident species in the Roseton/ Danskammer Point area of the Hudson River (Quirk, Lawler & Matusky Engineers, 1973a). Larvae of this species were collected from May 10 through August.

TABLE V-4

STRIPED BASS DEPTH DISTRIBUTION BY TRANSECT AND MONTH, 1973
ROSETON/DANSKAMMER POINT VICINITY

Number of Larvae/1000m^3

Month	Depth	RDW	RDWCH	RDECH	RDE
MAY	Surface	0 (11)	155 (10)	0 (5)	0 (0)
	Mid	5 (5)	21 (3)	19 (311)	0 (6)
	Bottom	0 (11)	0 (4)	4 (0)	0 (10)
JUNE	Surface	0 (1190)	0 (1966)	5 (10)	0 (352)
	Mid	55 (1641)	222 (5279)	103 (552)	32 (20)
	Bottom	38 (803)	13 (894)	47 (74)	15 (218)
JULY	Surface	0 (0)	0 (6)	0 (0)	0 (0)
	Mid	9 (8)	14 (35)	20 (99)	0 (236)
	Bottom	27 (61)	9 (5)	32 (9)	11 (30)
AUGUST	Surface	0 (5)	0 (5)	0 (5)	0 (30)
	Mid	0 (0)	0 (0)	0 (28)	0 (0)
	Bottom	0 (5)	0 (3)	0 (30)	0 (0)

Note: ( ) Denotes Night Collection

Table V-5 presents the average number of white perch larvae collected by date and by transect; the average abundances are shown in Figure V-5 by date for each transect. Peak abundance occurred during the June 19-20 sampling effort (approximately two weeks after the peak for striped bass).

The average peak abundance found during 1972 (Quirk, Lawler & Matusky Engineers, 1973a) occurred around the beginning of June and was of greater magnitude than the 1973 peak abundance. The average number of larvae/1000m^3 for the 1973 peak was 174, while in 1972 the corresponding abundance was greater than 700 larvae/ 1000m^3. Larvae persisted in the area longer in 1972 than in 1973.

The largest average number of white perch larvae by transect were collected at the Roseton/Danskammer Point West Channel; RDW and RDECH were similar in abundance; the least number were collected at RDE. In 1972 greater numbers were found at the east transect, which had twice the abundance of the western transect (Quirk, Lawler & Matusky Engineers, 1973).

A one-way analysis of variance was conducted to determine if any significant differences existed between the average numbers of white perch collected at each transect. There was no significant difference between transects at $\alpha = 0.05$. The test table is presented below:

TABLE V-5

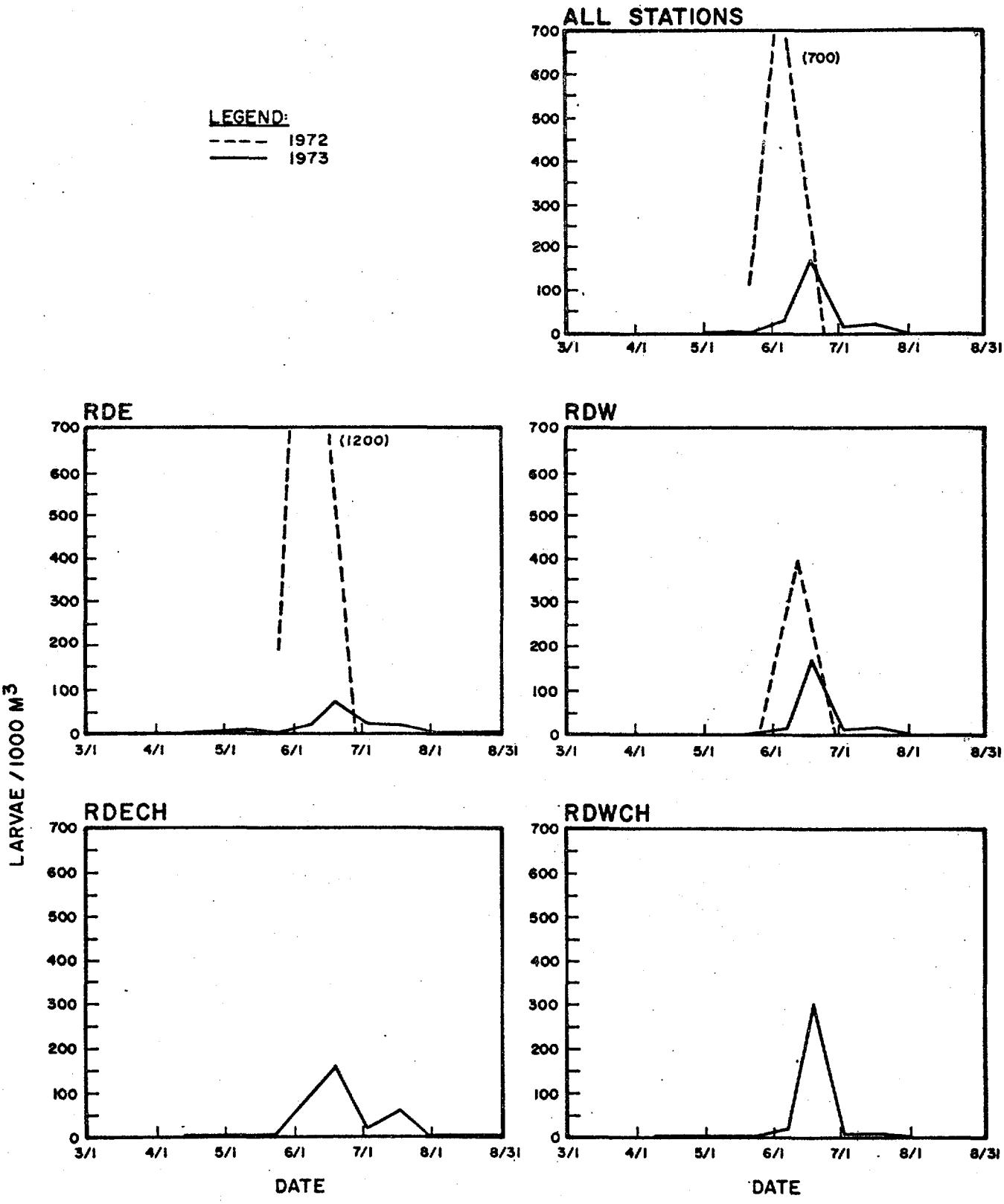
AVERAGE CONCENTRATION OF WHITE PERCH LARVAE, 1973
ROSETON/DANSKAMMER POINT VICINITY

Number of Larvae/1000m^3

DATE	TRANSECT				Average All Stations
	RDW	RDWCH	RDECH	RDE	
3/13	N/S	N/S	N/S	0	0
3/21	0	N/S	N/S	0	0
4/11	0	0	0	0	0
5/3	0	N/S	N/S	N/S	0
5/10-11	2	1	2	8	3
5/22-23	1	0	2	0	1
6/7-8	10	20	85	19	34
6/19-20	169	292	162	71	174
7/2-3	13	5	17	26	15
7/17-18	16	7	58	19	25
7/31-8/1	1	0	1	2	1
8/14-15	0	0	0	0	0
8/29	0	0	0	0	0

Note: N/S Denotes No Sample

HUDSON RIVER FISH LARVAE ABUNDANCE: 1972-1973
SPECIES: WHITE PERCH LARVAE
ROSETON/DANSKAMMER POINT VICINITY



Transect Comparison of White Perch Larvae/1000m^3

Source	Degrees of Freedom	Mean Square	F-Ratio
Stations	3	0.152	0.149
Error	36	1.025	
Total	39		

Table V-6 lists the number of white perch larvae collected at surface, mid-depth and bottom by day and night for the four transects. During May, the majority of the larvae were collected during the daylight hours at surface and mid-depth; very few were collected from the bottom stations. In June, the number of larvae increased dramatically with the same trend of greater numbers during daylight hours at surface and mid-depth. In July, the number collected during the night sampling increased, and there was a shift in preference from the surface mid-depth to the mid-depth bottom zone. The few specimens collected during August were collected at night.

Mansueti (1964) stated that immediately after hatching white perch larvae try to assume a surface orientation, but upon tiring slowly sink, only to resume the activity after resting. The swimming activity combined with the turbulence could maintain the young off the bottom as indicated by the present data. He reported the more mature larvae assumed a more benthic life style. The larvae were also found to be positively phototactic.

TABLE V-6

WHITE PERCH DEPTH DISTRIBUTION BY TRANSECT AND MONTH, 1973
ROSETON/DANSKAMMER POINT VICINITY

Number of Larvae/1000m^3

Month	Depth	TRANSECT			
		RDW	RDWCH	RDECH	RDE
MAY	Surface	0 (15)	4 (0)	8 (406)	3 (0)
	Mid depth	15 (0)	10 (6)	21 (44)	28 (0)
	Bottom	5 (0)	0 (4)	4 (0)	0 (0)
JUNE	Surface	741 (72)	132 (35)	32 (46)	0 (17)
	Mid depth	418 (57)	2423 (98)	1035 (302)	138 (66)
	Bottom	106 (22)	0 (61)	72 (239)	108 (315)
JULY	Surface	6 (26)	0 (6)	0 (4)	0 (0)
	Mid depth	13 (114)	20 (44)	93 (370)	140 (414)
	Bottom	106 (71)	40 (7)	96 (81)	108 (302)
AUGUST	Surface	0 (10)	0 (0)	0 (0)	0 (5)
	Mid depth	0 (4)	0 (0)	0 (17)	0 (0)
	Bottom	0 (5)	0 (0)	0 (24)	0 (0)

Note: ( ) Denotes Night Collection

Length frequency distributions were calculated for larvae collected on each collection date and are presented for the four transects in Figure V-6. The earliest collection containing white perch larvae was May 10-11. The larvae collected during the two May samplings averaged approximately 5.0-6.0 mm in length with the smallest larvae around 2.0 mm and the largest 8.0 mm. Larvae are around 3.0 mm upon hatching (Mansueti, 1964), and at upwards of one month old are 8.0 mm. This would suggest that some larvae in the study area were hatched and existed with larvae that had hatched several weeks earlier within the area or at a different spawning site.

The average larval length in June was 4.3 mm. The decline in the average length is probably due to a spawning period covering several weeks. Larvae of the smaller size were still being collected during the first weeks of July; however, these were few in number, the majority of larvae were approximately 10.0 to 12.0 mm in length. Larvae were not collected after the first week of August.

(iii) Alosa spp.

The Alosa group consists primarily of three species: blueback herring (Alosa aestivalis), alewife (Alosa pseudoharengus) and American shad (Alosa sapidissima). These three species are anadromous, migrating up the estuary to freshwater to spawn during the spring. Alewives are usually the first to begin the spring spawning migration (early March) and are followed closely by the shad. Blueback herring are usually the last to enter the estuary for spawning migration,

WHITE PERCH LARVAL LENGTH DISTRIBUTION

ROSETON/DANSKAMMER POINT VICINITY

1973

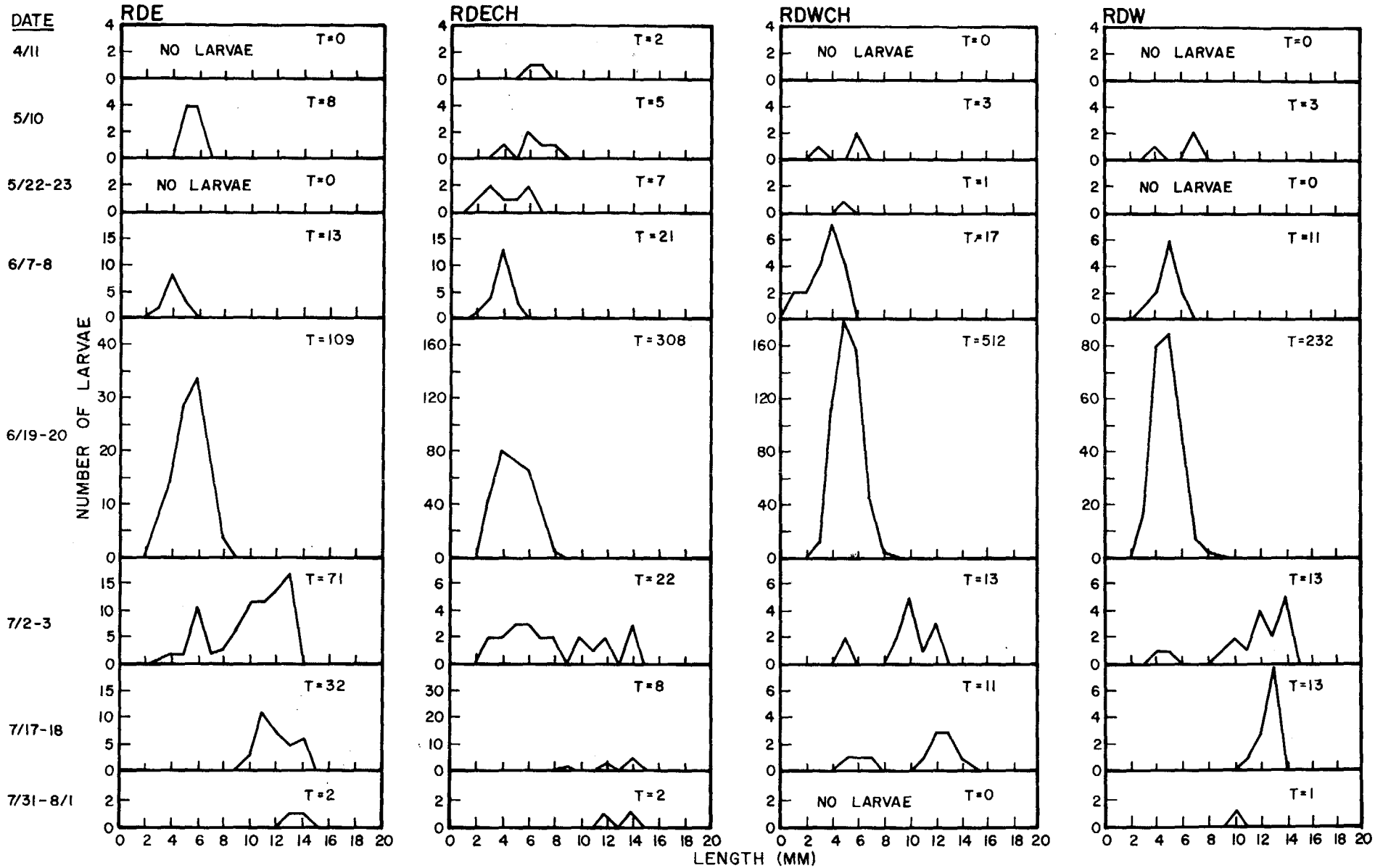


FIGURE V-6

starting around the end of March or early April (Hildebrand and Schroeder, 1972). The initiation and duration of spawning and number of eggs spawned is controlled by environmental conditions and varies each year.

In the Roseton/Danskammer Point area larvae identified as Alosa spp. were first collected on May 3; the last were collected on August 15, 1973. The average number of Alosa larvae collected by date and transect is listed in Table V-7 and shown graphically in Figure V-7.

The peak concentration was found during the May 22-23 collection with the greatest abundance at RDE and the least abundance at RDWCH. The east transects exhibited an overall greater abundance of Alosa throughout the study period.

The area north and adjacent to the east transects is very shallow with large amounts of rooted aquatic plants. This is an excellent area for spawning and early development of Alosa spp. (Bigelow and Schroeder, 1953) which could account for the greater numbers along the eastern transects. The duration of large numbers of Alosa larvae over the study period was much longer than Morone spp., extending from May 10 through July 2-3; this is due partially to the inclusion of three species with different spawning times in the analysis.

Comparison of the average number of larvae collected at each transect was conducted using a one-way analysis of variance. The results are presented below:

TABLE V-7

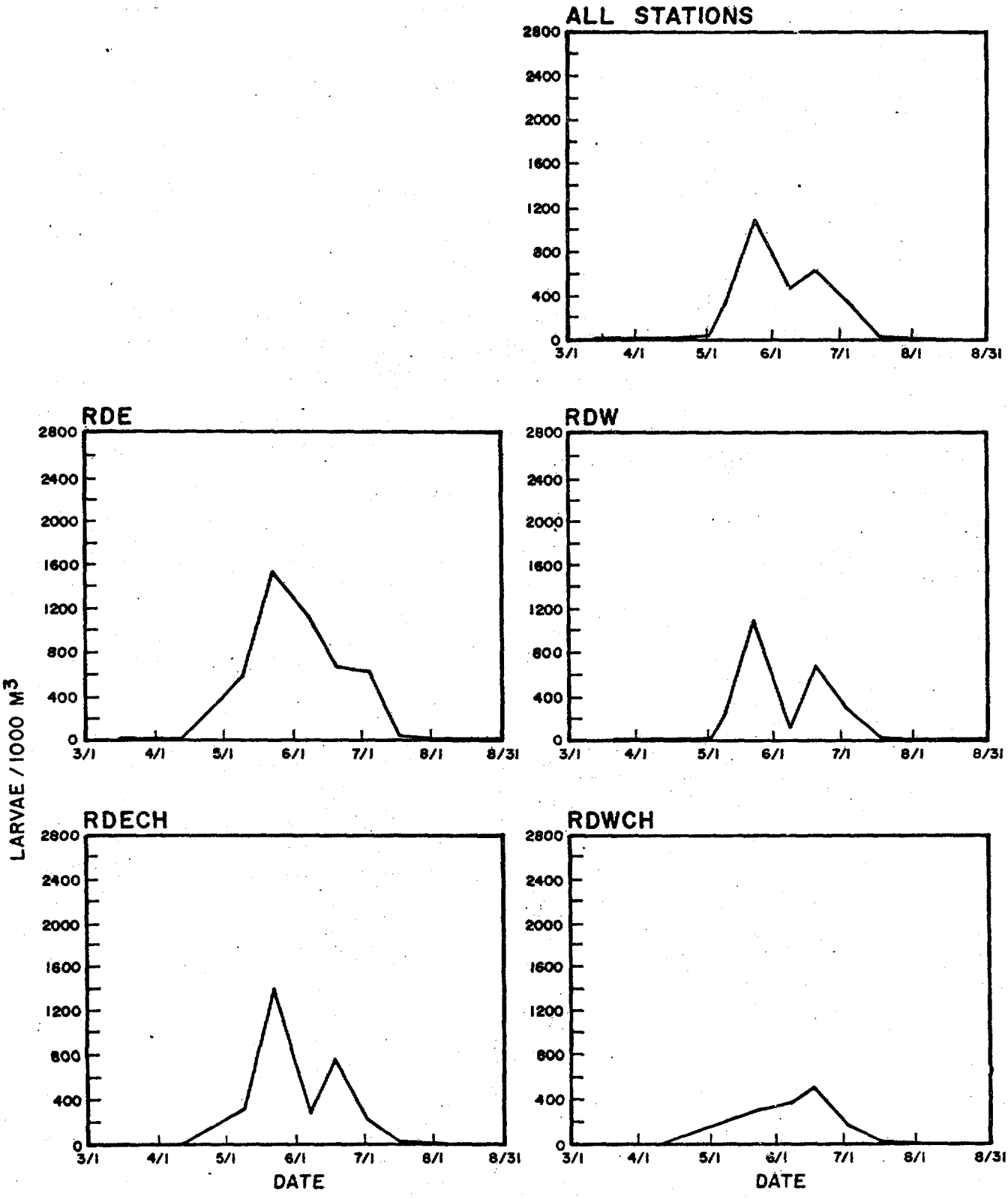
AVERAGE CONCENTRATION OF *ALOSA SPP.* LARVAE, 1973
ROSETON/DANSKAMMER POINT VICINITY

Number of Larvae/1000m^3

DATE	TRANSECT				Average All Stations
	RDW	RDWCH	RDECH	RDE	
3/13	N/S	N/S	N/S	0	0
3/21	0	N/S	N/S	0	0
4/11	0	0	0	0	0
5/3	38	N/S	N/S	N/S	38
5/10	238	202	332	596	342
5/22-23	1096	307	1410	1517	1083
6/7-8	120	366	282	1116	471
6/19-20	685	504	769	671	657
7/2-3	310	179	235	628	338
7/17-18	24	22	23	26	24
7/31-8/1	5	5	11	8	7
8/14-15	1	1	3	0	1
8/29	0	0	0	0	0

Note: N/S Denotes No Sample

HUDSON RIVER FISH LARVAE ABUNDANCE: 1972-1973
SPECIES: ALOSA LARVAE
ROSETON/DANSKAMMER POINT VICINITY



Transect Comparison of Alosa spp. Larvae/1000m^3

Source	Degrees of Freedom	Mean Square	F-Ratio
Station	3	0.446	0.207
Error	36	2.253	
Total	39		

The average values were not significantly different between transects.

Although sampling commenced at a later date in 1972, comparison of data between 1972 and 1973 indicated that the duration of Alosa larvae abundance was longer in 1973 than in 1972 and had a higher peak of abundance (Quirk, Lawler & Matusky Engineers, 1973). However, in 1972 the average value was higher between the beginning and end of the greatest larval concentration. A greater abundance was found along the western transect than the eastern transect; the reverse of the 1973 results. There was also a difference of approximately two weeks in the peak abundance by transect in 1972 that was not observed in 1973. This difference could be the result of selectivity of the sampling gear relative to the differential spawning time of the Alosa.

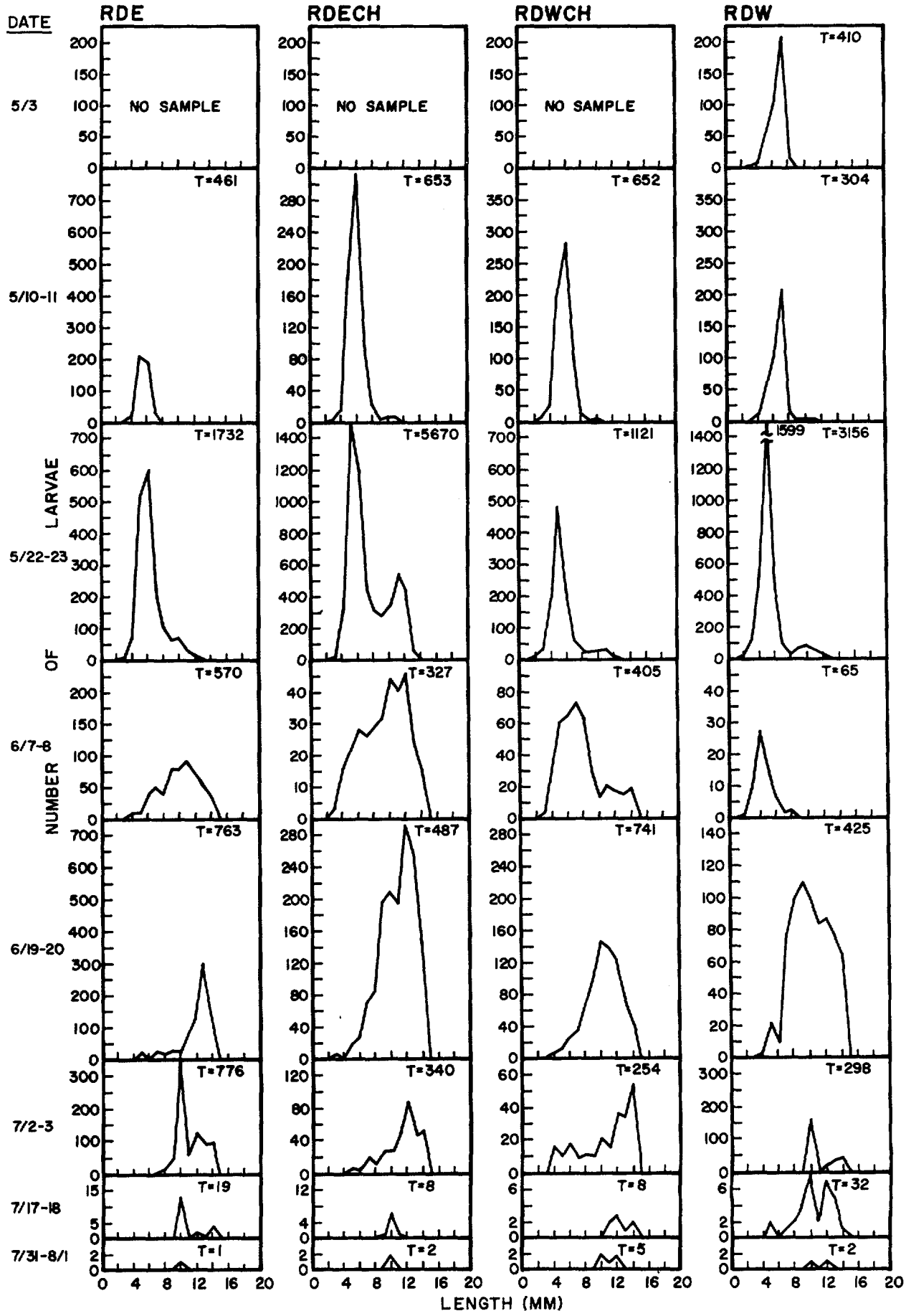
Alosa length frequency graphs for the four transects and average length frequency are presented in Figure V-8. Alewives range from 3.5 to 5.0 mm. at hatching; blueback herring from 3.5 to 4.0 mm. and American shad between 7.0 to 10.0 mm. (Mansueti and Hardy, 1967). The yolk sac is absorbed in three to five days after hatching.

ALOSA LARVAL LENGTH DISTRIBUTION

ROSETON / DANSKAMMER POINT VICINITY

1973

FIGURE V-8



During early May, the larvae collected were approximately 5.5 mm to 6.5 mm in length, indicating larvae probably in the yolk sac stage. At all transects except RDW the larvae exhibited a rapid increase in average length through the middle of June. The decrease noted at RDW could be the result of larvae hatching in the immediate vicinity of the transect along the west side of the river. The hatching area is probably the shallow cove area just north of Danskammer Point.

A decrease in the average length was found at all transects around the first of July. The length frequency graphs show that larger numbers of smaller Alosa were collected. These smaller larvae were probably blueback herring which were spawned later than the other two species. Absence of larvae from collections after the end of July indicate avoidance of the plankton nets or movement of the maturing larvae from the area of investigation.

Depth distribution of Alosa spp. over the duration of the study is presented in Table V-8. The greatest numbers of individuals were collected during daylight hours from the surface and mid-depth station during May. At this time the larvae were the most abundant and are in a yolk-sac or early post yolk-sac stage of development.

In June, a preference for surface water during daylight hours was noted; there was a more even distribution in the water column at night. This same trend was found in July. The few larvae

TABLE V-8

ALOSA SPP. DEPTH DISTRIBUTION BY DATE AND TRANSECT, 1973
ROSETON/DANSKAMMER POINT VICINITY

Number of Larvae/1000m^3

		TRANSECT			
Month	Depth	RDW	RDWCH	RDECH	RDE
MAY	Surface	2278 (9353)	4308 (520)	5179 (6142)	5540 (1426)
	Mid	3918 (1570)	5840 (1675)	24636 (1937)	5566 (1920)
	Bottom	910 (218)	926 (4)	821 (15)	(1584)
JUNE	Surface	1453 (1173)	117 (856)	1324 (784)	3502 (1627)
	Mid	690 (1624)	2435 (1202)	1676 (4090)	327 (2463)
	Bottom	23 (952)	142 (1480)	52 (718)	84 (1824)
JULY	Surface	638 (282)	338 (286)	543 (246)	1065 (116)
	Mid	116 (1248)	37 (1111)	579 (464)	2237 (3121)
	Bottom	20 (891)	36 (158)	27 (830)	57 (574)
AUGUST	Surface	0 (5)	0 (5)	0 (92)	10 (23)
	Mid	3 (22)	17 (85)	99 (129)	
	Bottom	8 (13)	6 (67)	25 (48)	

Note: ( ) Denotes Night Collection

collected and identified in August have a definite mid-depth to bottom preference during daylight hours, occurring in the surface waters at night.

This depth pattern suggests larvae that prefer the upper water levels after hatching, gradually assuming a more demersal existence with maturity. A diurnal pattern was also observed in the older larvae, preferring the demersal waters during the daylight hours and moving to the surface waters at night. This pattern is probably associated with feeding preference for zooplankton.

(c) Vertical Distribution. Day and night differences were tested for larval concentrations of striped bass, white perch and Alosa spp., at surface, mid-depth and bottom at each station for each sampling period*.

For the period May 22 through August 1, daylight hours was defined as 0445 hours to 1915 hours. Station designations were: RDW and RDE, 0' = surface; 30' = bottom; all other depths = mid-depth. At the two channel stations, 0' = surface; 50' = bottom; all other depths = mid-depth.

*1. If a sample was collected and not analyzed or if no sample was collected on a specified date, a dash was entered on the table.
2. If a sample was collected and no larvae of any species were collected, the sample was considered as having been analyzed for species.
3. For those samples analyzed, an average for the date was entered. For example, if 5 night samples on a certain date were analyzed for species, but 60 white perch were found in only 1 sample, the average (12) was recorded.

(i) Surface, Mid-Depth and Bottom Larvae Concentrations

Since diurnal migration over a 24-hour period has been documented for a number of species of fish larvae, day and night abundances of larvae at surface, mid-depth and bottom were analyzed to investigate such occurrences. The null hypothesis that there were no significant differences in the occurrence of larvae (expressed as number of larvae per $1000m^3$ of water) of striped bass, white perch or Alosa spp. larvae during day or night collections at the surface, mid-depths and bottom for all dates was tested using one-way analysis of variance. The results are presented in Table V-9.

Only two significant differences were found: striped bass larvae found in night collections at RDECH and white perch larvae found in night collections at RDE showed unequal vertical distribution.

Those two results were further analyzed to ascertain which depth was significantly different from the other two depths. In both instances the surface samples had significantly fewer larvae of the species noted than did mid-depth or bottom samples (Table V-9).

(ii) Diurnal Migration

Where homogeneity of variance was proven, tests were conducted to detect possible differences in the concentration of each species of fish larvae at a station between day and night samples. Therefore, day (surface) concentrations of striped bass were compared with night (surface) concentrations of striped bass for

TABLE V-9

STATISTICAL TEST RESULTS: CATCH VARIATION WITH DEPTH, 1973
ROSETON/DANSKAMMER POINT VICINITY

A. Results of One-Way Analysis of Variance to Test for Significant Differences in Number of Larvae/ $1000m^3$ at Surface, Mid-Depth and Bottom Collections.

SPECIES	TIME	STATION	F-RATIO	Fr_1, r_2 =
Striped Bass	Day	RDW	2.654	$F_2, 9 = 4.26$
		RDWCH	0.019	$F_2, 8 = 4.46$
		RDECH	2.775	$F_2, 9 = 4.26$
		RDE	1.676	$F_2, 8 = 4.46$
	Night	RDW	0.139	$F_2, 12 = 3.88$
		RDWCH	1.414	$F_2, 11 = 3.98$
		RDECH	6.588	$F_2, 10 = 4.10$*
		RDE	1.232	$F_2, 11 = 3.98$
White Perch	Day	RDW	0.071	$F_2, 9 = 4.26$
		RDWCH	0.888	$F_2, 10 = 4.10$
		RDECH	2.123	$F_2, 10 = 4.10$
		RDE	2.150	$F_2, 9 = 4.26$
	Night	RDW	0.832	$F_2, 11 = 3.98$
		RDWCH	0.423	$F_2, 11 = 3.98$
		RDECH	0.705	$F_2, 10 = 4.10$
		RDE	5.292	$F_2, 11 = 3.98$*
Alosa spp.	Day	RDW	0.363	$F_2, 10 = 4.10$
		RDWCH	0.029	$F_2, 9 = 4.26$
		RDECH	0.163	$F_2, 10 = 4.10$
		RDE	0.242	$F_2, 8 = 4.46$
	Night	RDW	0.078	$F_2, 10 = 4.10$
		RDWCH	0.078	$F_2, 10 = 4.10$
		RDECH	0.307	$F_2, 10 = 4.10$
		RDE	1.297	$F_2, 12 = 3.88$

*Significant difference at $\alpha = .05$

B. Result of Student-Newman-Keuls Test

			1	2	3
Striped Bass	Night	RDECH	0.492	1.37	1.591
			S	M	B
			1	2	3
White Perch	Night	RDE	0.514	1.2	1.829
			S	M	B

all dates at each station, and for a combination of stations where comparable data existed*. Similar comparisons for white perch and Alosa spp. were also conducted.

The results of these comparisons are presented in Table V-10. In the three instances where the variance was non-homogeneous, a Wilcoxon Sign Rank Sum Test was conducted to test for significant differences in comparable day and night samples. These results are also shown in Table V-10.

The combined results of both statistical tests showed only one significant difference: the night collections at mid-depth at RDW had significantly more Alosa spp., larvae/1000m^3 of water than contained in the day collections.

2. Plant Sampling

(a) Danskammer Point

(i) Concentration of Larvae.

Samples were collected from May 22 through August 30, 1973 in the Danskammer Point intake channel and discharge. These samples were collected concomitantly with river collections. The concentration of total larvae and of striped bass, white perch and Alosa spp. larvae over the sampling period at the intake and the discharge is presented in Table V-11. Average total larval abundance at each location and the abundance of dominant species at the two sampling locations are presented in Figure V-9.

*There were only two instances where sample size was too small for analysis: station RDE (striped bass, surface) and station RDE (white perch, surface).

TABLE V-10

STATISTICAL TEST RESULTS: CATCH VARIATION WITH DAY/NIGHT
ROSETON/DANSKAMMER POINT VICINITY

A. Paired t-Test to Test for Significant Differences in Number of Larvae/1000m^3 at a Station Between Day and Night Collections

SPECIES	STATION	DEPTH	t-VALUE	df	p-VALUE
Striped Bass	RDW	S	-2.365	4	0.050≤p≤0.100
	RDWCH	S	-1.177	3	0.200≤p≤0.400
	RDECH	S	-0.484	4	p≤0.500
	ALL STATIONS	S	-1.314	17	0.200≤p≤0.400
	RDWCH	M	0.171	4	p≤0.500
	RDECH	M	-2.015	4	0.100≤p≤0.200
	RDE	M	-0.815	4	0.400≤p≤0.500
	ALL STATIONS	M	-0.962	19	0.200≤p≤0.400
	ALL STATIONS	B	-0.302	4	p≤0.500
White Perch	RDW	S	-1.237	4	0.200≤p≤0.400
	RDWCH	S	0.178	4	p≤0.500
	RDECH	S	-1.683	4	0.100≤p≤0.200
	ALL STATIONS	S	-1.837	19	0.050≤p≤0.100
	RDW	M	0.265	4	p≤0.500
	RDWCH	M	0.975	5	0.200≤p≤0.400
	RDECH	M	0.675	5	p≤0.500
	RDE	M	-0.896	4	0.400≤p≤0.500
	ALL STATIONS	M	0.634	21	p≤0.500
	ALL STATIONS	B	-0.651	3	p≤0.500
Alosa spp.	RDW	S	-0.466	4	p≤0.500
	RDWCH	S	-0.852	3	0.400≤p≤0.500
	RDECH	S	2.257	4	0.050≤p≤0.100
	RDE	S	1.558	4	0.100≤p≤0.200
	ALL STATIONS	S	1.013	18	0.200≤p≤0.400
	RDW	M	-3.102	4	0.025≤p≤0.050*
	RDWCH	M	-0.910	4	0.400≤p≤0.500
	RDECH	M	-0.489	5	p≤0.500
	RDE	M	-1.081	4	0.200≤p≤0.400
Striped Bass	RDE	S	Sample Size too Small		
White Perch	RDE	S	Sample Size too Small		

*Significant Difference

B. Wilcoxon Sign Rank Sum Test for Significant Differences in Number of Larvae/1000m^3 at a Station Between Day and Night Collections

SPECIES	STATION	DEPTH	T^+	T-	T	n	CRITICAL RANGE
Striped Bass	RDW	M	12.0	3.0	3	5	0<T<15 = α0.062
	ALL STATIONS	B	0.0	10.0	0	4	0<T<10 = α0.124
Alosa spp.	ALL STATIONS	M	WRST - Large Sample z = 0.973				CRITICAL/VALUE Z_c = 1.96

TABLE V-11

AVERAGE LARVAL CONCENTRATION FOR TOTAL LARVAE AND
FOR DOMINANT SPECIES AT DANSKAMMER POINT INTAKE AND DISCHARGE
1973

ROSETON/DANSKAMMER POINT VICINITY

DATE	SAMPLES COLLECTED	AVERAGE LARVAL CONCENTRATION/1000m^3			
		STRIPED BASS	WHITE PERCH	*ALOSA SPP*	TOTAL
A. INTAKE					
May 22-23	57	5	4	668	2087
June 7-8	31	104	10	116	554
June 19-20	30	18	34	565	1420
July 2-3	38	12	21	66	398
July 17-18	51	6	11	12	46
July 30-August 1	39	1	4	8	13
August 14-15	54	0	0	0	1
August 29-30	39	0	0	0	2
B. DISCHARGE					
May 22-23	13	0	1	181	187
June 7-8	5	69	17	76	256
June 19-20	7	16	23	352	492
July 2-3	8	4	10	45	124
July 17-18	10	1	1	1	8
July 31-August 1	12	1	1	4	6
August 14-15	11	1	0	0	1
August 29-30	10	0	0	0	0

Note: Larvae identified as "others" not shown.

AVERAGE LARVAL ABUNDANCE: 1973

DANSKAMMER POINT INTAKE AND DISCHARGE

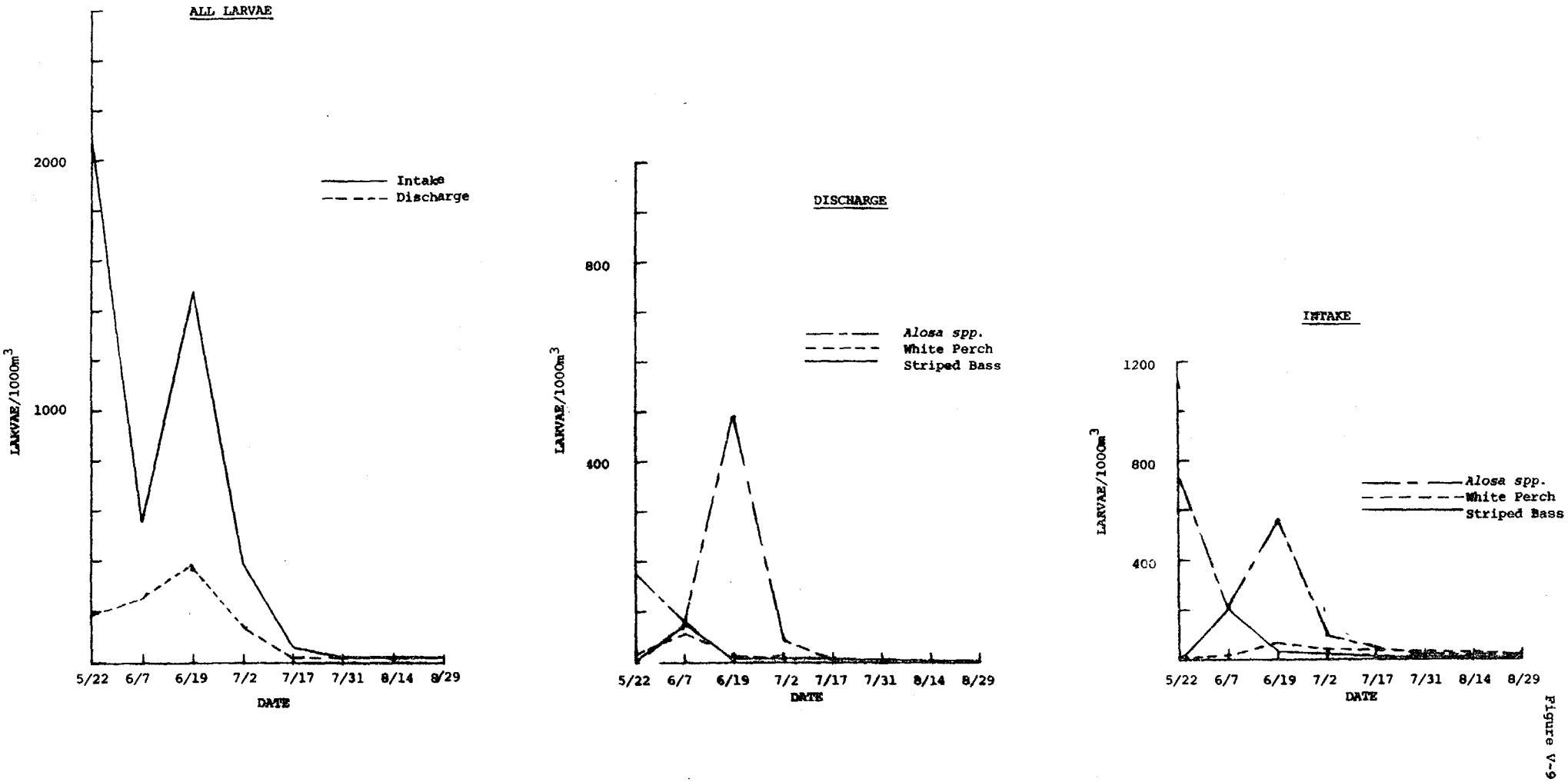


Figure V-9

Intake entrainment sample data, representing the average concentrations calculated from both one meter and one-half meter net collections, show a bimodal concentration of larvae. The sampling conducted on May 22-23 indicated that large numbers of larvae were present in the study area. This early abundance declined during the first weeks of June; abundance then increased to a second peak on June 19-20. Following the mid-June sampling peak, the numbers of larvae collected decreased, and few larvae were collected during late July and August.

The single peak in abundance noted for discharge collections coincided with the peak abundance at the intake (June 19-20). However, unlike the pattern recorded at the intake, the discharge data indicate neither a May 22 peak in larval abundance nor a decline in abundance after mid-June.

Intake samples were collected in the channel prior to distribution of the water to the four generating units, and therefore yielded larval concentrations for all intake cooling waters. The discharge samples are representative only of the cooling water from Unit 3. The location of the intake for Unit 3, the location of larvae in the water column of the intake in front of Unit 3 and use of only one part of the available intake water by Unit 3, i.e., patchiness problems, explains in part the disparity between the average larval concentration from the intake and discharge.

The average concentration of striped bass larvae reached a peak abundance in both intake and discharge collections during June 6-7. Very few striped bass larvae were collected before or after this date. Peak abundance was recorded on the same date for river collections; however, the average concentration was higher for the western transect stations than the plant samples. The maximum number of larvae collected at the discharge was not as high as the maximum number collected at the intake.

White perch were most abundant in the intake samples on June 19-20, corresponding to peak abundance in the river collections. Peak abundance was found two weeks earlier in the discharge samples. The discharge abundance on June 7-8 was higher than the average river concentration of white perch and higher than the average abundance at the two western transects. The maximum intake concentrations on June 19-20 were lower than the corresponding abundance in the river.

The average larval concentrations for intake and discharge samples containing Alosa spp. showed similar variations. Both sampling locations exhibited a peak concentration on May 22-23 with the highest abundance found in the intake samples. The highest abundance of Alosa spp. in the river also occurred on May 22-23. The average concentration of Alosa spp. larvae declined by June 6-7. Abundance had again increased on June 19-20 when the magnitude of the intake and discharge abundances were very similar, both corresponding to a second peak observed in Alosa abundance

in the river samplings. The abundance of Alosa larvae declined rapidly after the June 19-20 sampling date.

(ii) Time of Day and Depth Patterns of Larvae in the Intake

The placement of the plankton nets within the intake channel and the scheduled times of sampling resulted in observations on the depth distribution of larvae both by day and at night. The average larval concentrations for surface and bottom one-half meter and one meter nets for day and night collection are presented in Figure V-10.

The one-half meter nets yielded similar general trends of larval abundance in surface and bottom samples for both day and night collections. The surface net collected slightly greater numbers during the first sampling dates for both day and night; the number of larvae collected by the bottom nets increased during later sampling dates. Greater numbers of larvae were found in surface than in bottom nets during the day of the last sampling date.

During the daylight hours the numbers of larvae collected in one meter nets were dissimilar for the first three sampling dates; thereafter both followed the same trend, with the bottom net exhibiting the greatest abundance. During the sampling on May 22-23 the average larval abundance collected in the daylight surface net was 2750 larvae/1000m^3, while the bottom net yielded 260 larvae/1000m^3. The average abundance for the surface net

LARVAL ABUNDANCE: DAY/NIGHT - 1973
DANSKAMMER POINT INTAKE

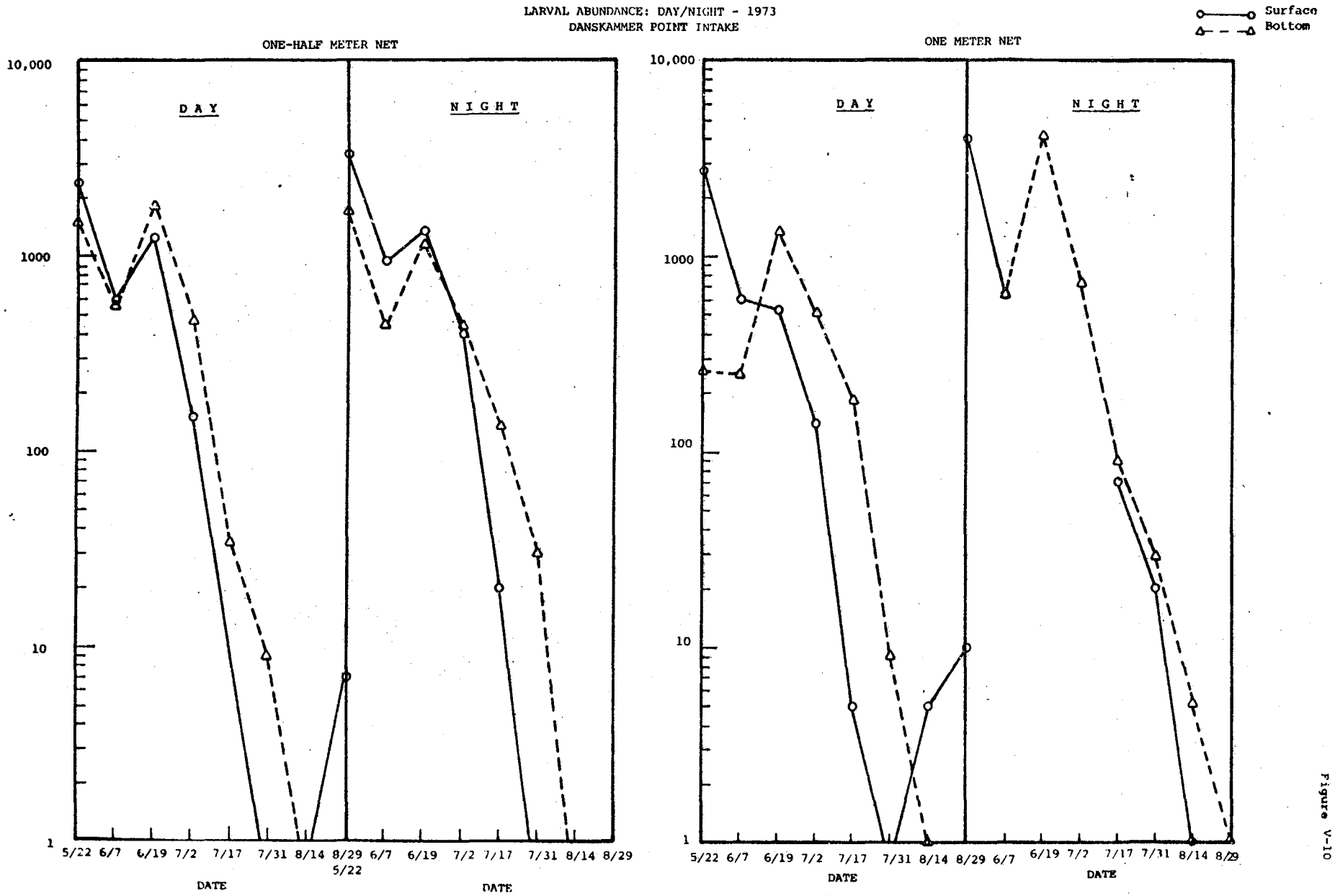


Figure V-10

declined between successive sampling dates. Bottom net abundance remained the same for the May 22-23 and June 7-8 samplings and increased to a peak value during the June 19-20 sampling. Following the June 19-20 collection the numbers of larvae collected decreased rapidly. The same increase noted for the one-half meter net on August 29-30 was also observed for the one meter surface net; however, in this case an increase was also noted during the August 14-15 sampling.

The depth of the intake channel at low tide precluded sampling with the one meter surface net at this time. Lack of comparable night samples from the early collections is due partially to this tidal problem and also to large amounts of detritus which clogged the nets. Day and night collections appeared to follow the same trend in abundance throughout the study period with only minor differences during the earlier sampling periods.

The data was further divided into six hour intervals for each sampling date (Table V-12). The fewest larvae were collected during the time period from 1201 to 1800, compared to other time periods; this was possibly due to negative phototaxis by the ichthyoplankton. In general the time period from midnight (0000 hours) to 0600 hours yielded the most larvae; however, the overall period between sunset and sunrise (0600 to 1800) also appeared to indicate high larval abundance.

TABLE V-12

AVERAGE LARVAL CONCENTRATION BY TIME PERIODS FOR EACH SAMPLING DATE
DANSKAMMER POINT INTAKE CHANNEL
1973

ROSETON/DANSKAMMER POINT VICINITY

Nos/1000m^3

DATE	TIME	Net Size			
		One Meter		One-Half Meter	
		Surface	Bottom	Surface	Bottom
May 22-23	0601-1200	2825	626	3852	1630
	1201-1800	441	81	214	284
	1801-0000	1167		1123	282
	0001-0600	4895		3881	1756
June 7-8	0601-1200	1109	219	577	994
	1201-1800	94	260	613	105
	1801-0000	1144	651	1000	651
	0001-0600	368	609	875	239
June 19-20	0601-1200		2762	2276	3321
	1201-1800	532	597	209	328
	1801-0000		4083	2266	2087
	0001-0600		1233	945	716
July 2-3	0601-1200	164	676	199	627
	1201-1800	119	266	149	348
	1801-0000		915	406	516
	0001-0600		169	229	371
July 17-18	0601-1200	1	35	0	40
	1201-1800	13	38	0	20
	1801-0000		68	0	189
	0001-0600	97	104	20	99
July 31-August 1	0601-1200		10		10
	1201-1800	0	0	0	0
	1801-0000		20		33
	0001-0600	20	40	0	20
August 14-15	0601-1200	0	0	0	0
	1201-1800	7	5	0	0
	1801-0000	3	7	0	0
	0001-0600	0	3	0	0
August 29-30	0601-1200	-	0	0	0
	1201-1800	10	0	10	0
	1801-0000	0	2	0	0
	0001-0600	-	0	0	0

Average day-night larval concentrations were calculated for the surface and bottom one meter and one-half meter intake nets during the different sampling dates (Table V-13). All possible combinations of nets or comparisons were tested to determine the difference with respect to location. Table V-14 lists each comparison and the results of each test. A significantly greater number of larvae were collected during night sampling hours than during the daylight hours.

(iii) Length Frequency of Entrained Fish Larvae

Larvae length frequencies for striped bass, white perch and Alosa spp. collected at the intake and discharge on the separate study dates are as shown in Figures V-11, V-12 and V-13, respectively. Mean total lengths for the individual length-frequency categories are also shown on these figures. Length-frequency data for the different larval groups collected on comparable dates from the Hudson River at the RDW transect are shown for purposes of comparison between plant and river populations.

Striped Bass

On the first plant collection date, May 22-23, striped bass larvae were collected only by the intake nets. Larvae from this collection date ranged in size from 3.0 mm to 7.0 mm in total length. The larvae collected had an average total length greater than those collected at RDW on the same date. Mean total length of

TABLE V-13

AVERAGE LARVAL CONCENTRATION BY DAY AND NIGHT
AT DANSKAMMER POINT INTAKE CHANNEL
1973

DATE	TIME PERIOD	Net Size			
		One Meter		One-Half Meter	
		Surface	Bottom	Surface	Bottom
May 22-23	Day	2756	263	2439	1052
	Night	3981	-	3326	1710
June 7-8	Day	602	250	595	550
	Night	627	623	937	445
June 19-20	Day	532	1344	1242	1824
	Night	-	3133	1385	1173
July 2-3	Day	142	512	151	474
	Night	-	729	404	442
July 17-18	Day	5	185	0	34
	Night	71	89	20	135
July 31-August 1	Day	0	9	0	9
	Night	20	29	0	30
August 14-15	Day	4	1	0	0
	Night	1	5	0	0
August 29-30	Day	10	0	7	0
	Night	1	1	0	0

Note: Concentrations expressed as number of larvae/1000m^3.

TABLE V-14

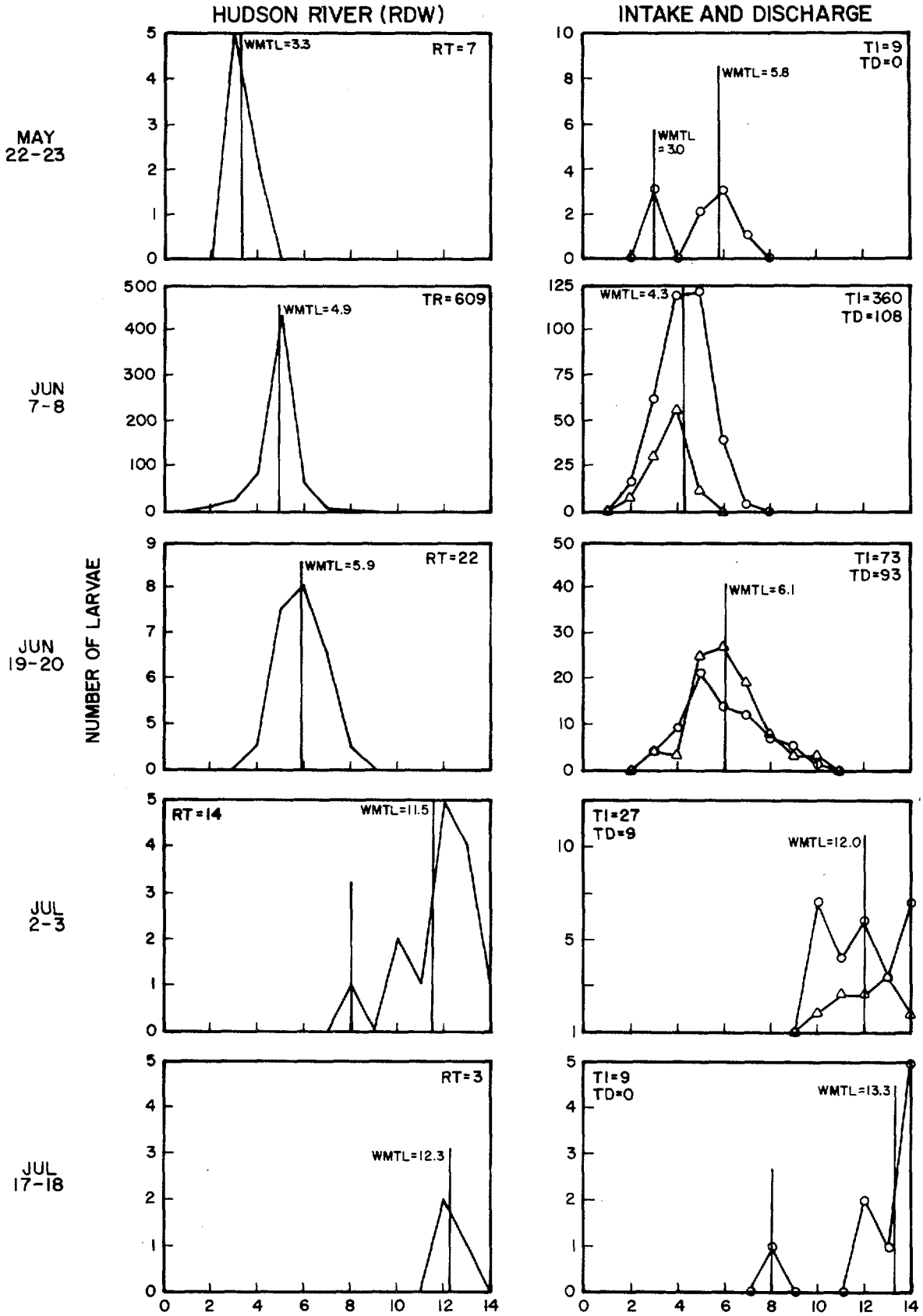
TOTAL LARVAL COMPARISONS FOR DAY AND NIGHT
DANSKAMMER POINT INTAKE, 1973

TYPE OF SAMPLING	COMPARISONS	DEGREES OF FREEDOM	CALCULATED T	PROBABILITY
1. Day; bottom	0.5 meter vs. 1.0 meter net	7	0.013	p > 0.500
2. Day; surface	0.5 meter vs. 1.0 meter net	7	-1.169	0.2 p 0.4
3. Night; bottom	0.5 meter vs. 1.0 meter net	6	-2.040	0.05 p 0.100
4. Night; surface	0.5 meter vs. 1.0 meter net	5	-1.877	0.1 p 0.2
5. Day; 1.0 meter net	Surface vs. bottom	7	-0.231	p 0.500
6. Day; 0.5 meter net	Surface vs. bottom	7	-0.874	0.4 p 0.5
7. Night; 1.0 meter net	Surface vs. bottom	4	-1.647	0.1 p 0.2
8. Night; 0.5 meter net	Surface vs. bottom	7	-0.938	0.2 p 0.4
9. Surface; 0.5 meter net	Day vs. night	7	-0.708	p 0.500
10. Surface; 1.0 meter net	Day vs. night	5	-0.724	p 0.500
11. Bottom; 0.5 meter net	Day vs. night	7	-1.223	0.2 p 0.4
12. Bottom; 1.0 meter net	Day vs. night	6	-2.512	0.025 p 0.05*
13. Day; surface and bottom	0.5 meter vs. 1.0 meter net	7	-1.168	0.2 p 0.4
14. Night; surface and bottom	0.5 meter vs. 1.0 meter net	4	-1.831	0.1 p 0.2
15. Surface; day and night	0.5 meter vs. 1.0 meter net	5	-2.171	0.05 p 0.100
16. Bottom, day and night	0.5 meter vs. 1.0 meter net	6	-2.013	0.05 p 0.100
17. 1.0 meter; day and night	Surface vs. bottom	4	-0.034	p 0.500
18. 0.5 meter; day and night	Surface vs. bottom	7	-0.631	p 0.500
19. 1.0 meter; surface and bottom	Day vs. night	4	-0.289	p 0.500
20. 0.5 meter; surface and bottom	Day vs. night	7	-0.406	p 0.500

LARVAE LENGTH DISTRIBUTION: STRIPED BASS-1973
HUDSON RIVER, DANSKAMMER POINT INTAKE AND DISCHARGE

NOTE: RT- RIVER TOTAL
TI - INTAKE TOTAL
TD - DISCHARGE TOTAL
WMTL - WEIGHTED MEAN TOTAL LENGTH

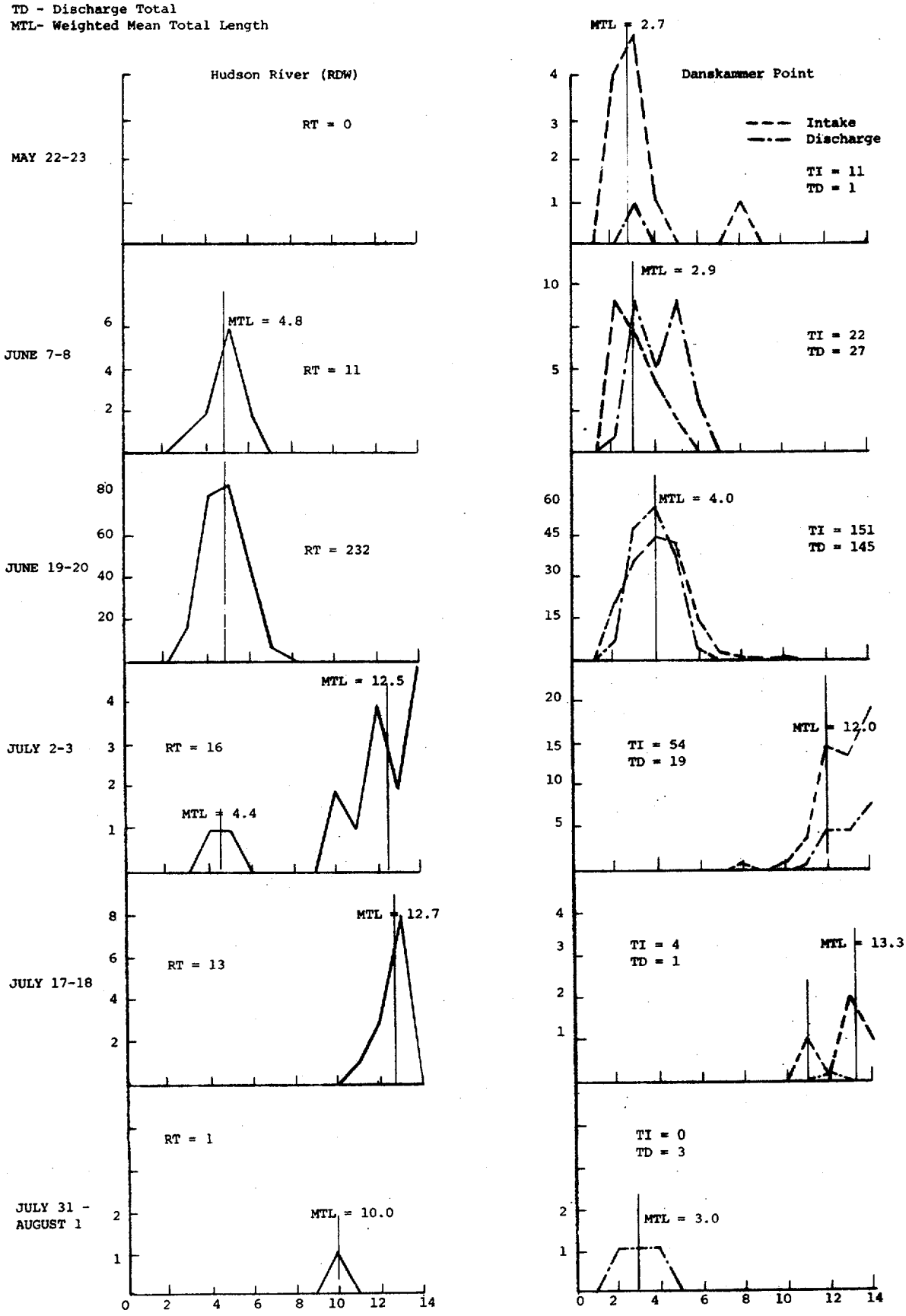
LEGEND
O—O DANSKAMMER POINT INTAKE
Δ—Δ DANSKAMMER POINT DISCHARGE



LARVAL LENGTH DISTRIBUTION: WHITE PERCH - 1973

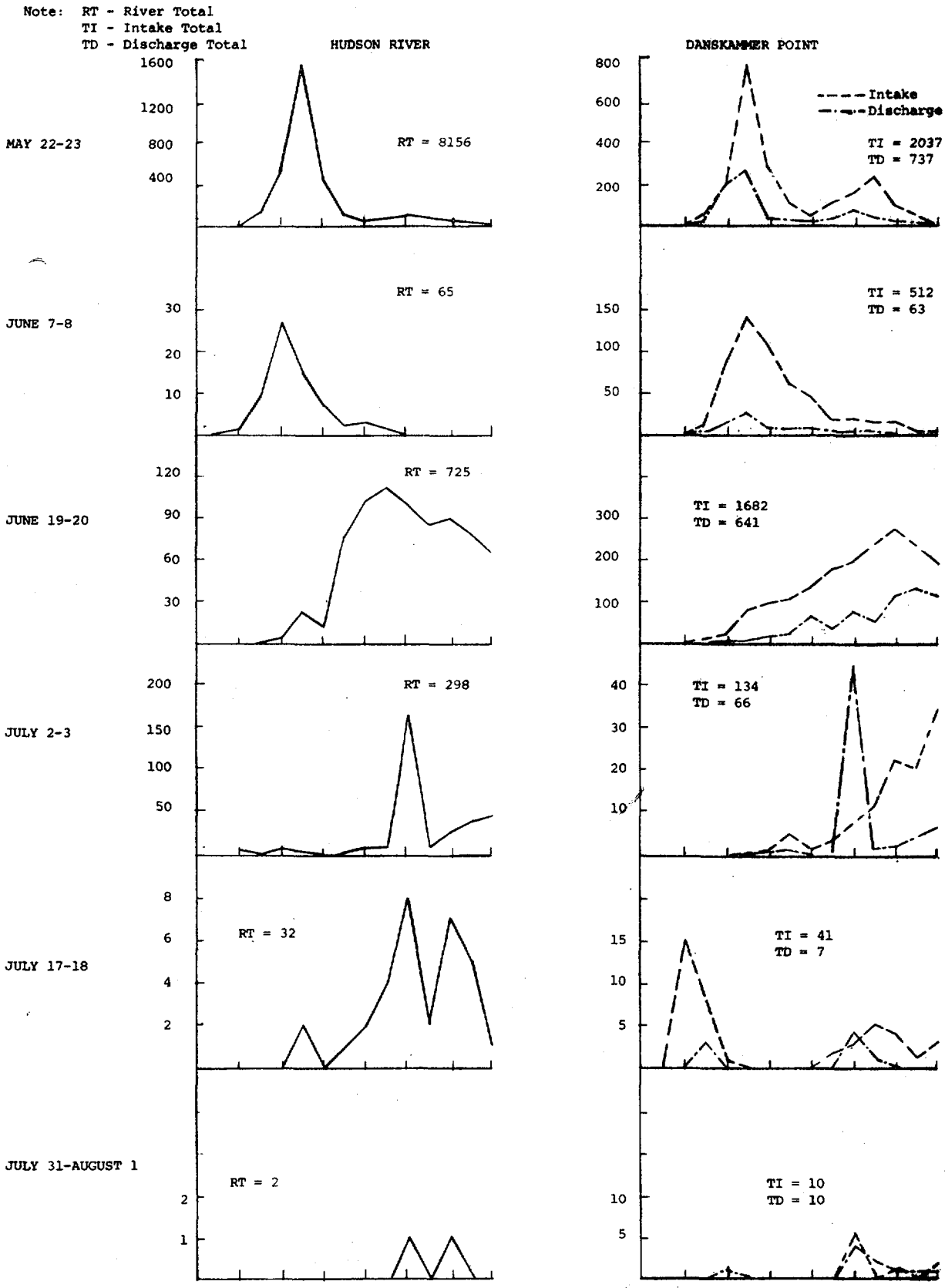
HUDSON RIVER, DANSKAMMER POINT INTAKE AND DISCHARGE

Note: RT - River Total
TI - Intake Total
TD - Discharge Total
MTL- Weighted Mean Total Length



LARVAL LENGTH DISTRIBUTION: *ALOSA SPP.* - 1973

HUDSON RIVER, DANSKAMMER POINT INTAKE AND DISCHARGE



larvae for sampling dates June 7-8 and June 19-20 were approximately the same for plant and river, indicating that the same population became entrained as was located in the river near the plant.

Striped bass larvae collected in the plant during sampling on July 2-3 had a mean total length slightly greater than the larvae collected in river sampling. The difference in mean total length for the last striped bass collected in the plant (July 17-18) was even greater, with the river fish averaging 12.3 mm and the intake fish 13.3 mm.

White Perch

White perch larvae were collected from May 22-23 through the July 31-August 1 sampling dates at the Danskammer Point plant. Mean total length of larvae from the first collection was 2.7 mm, indicating that the larvae entrained were newly hatched (Mansueti, 1964). Larvae collected during plant sampling on June 7-8 had a mean total length similar to those collected on May 22-23. Larvae collected from the RDW river station on June 7-8 had a mean total length of 4.8 mm, 2.1 mm greater than those from the plant. The same trend was observed, i.e., greater mean total length from river collections compared to plant collections, for June 19-20 and July 2-3 sampling.

Between June 19-20 and July 2-3 the average mean length of white perch collected from the plant and river increased from approximately 4.5 mm to 12.3 mm, an average length increase of 8 mm. Mansueti (1964), working in the Chesapeake Bay area, noted that 5 mm larvae were approximately one week old, and those 12 mm in length were one month to six weeks of age. The difference in mean total length between the two sampling dates suggests sampling of two separate groups, one spawned in another area of the Hudson River and a second group spawned nearby.

Further evidence of different spawning times was observed during collections on July 2-3, when larvae with a mean total length of 4.4 mm were collected in the river. Collections during July 17-18 from both the plant and river yielded larvae averaging 13.0 mm in mean total length. Very few larvae were collected on July 31-August 1, and those white perch larvae collected at the intake location were young, with a 3.0 mm mean total length.

Alosa spp.

Mean total lengths were not calculated for the Alosa group. General trends are used to compare the plant collection to the available river population.

Length for the larvae collected on May 22-23 were approximately 5.0 mm; a second smaller peak (more noticeable in plant collections) occurred at 10.0 - 11.0 mm. The predominant length for June 7-8 collections was similar to the figure for the May 22-23 collection;

however, fewer fish larvae were collected and a greater range of length intervals was found in the plant collections.

An increase in abundance was observed during sampling on June 19-20; most individuals were around 10.0 mm in length. Larval lengths were clustered around the highest length numbers during sampling on July 2-3, although a small peak at the smaller lengths indicates the beginnings of later spawned population members.

In the mid-July (17-18) plant collections two distinct length intervals were exhibited, possibly representing two distinct larval populations. The smaller group was around 2.0 mm to 3.0 mm in length and probably newly hatched (Mansueti and Hardy, 1967). The older group averaged approximately 10.0 mm - 11.0 mm in length. River collections at this time indicate the majority of the fish larvae in the older age group and none from the newly hatched category. The difference in plant and river collections suggests the possible use of the cove area just north of the Danskammer Point plant as a spawning area.

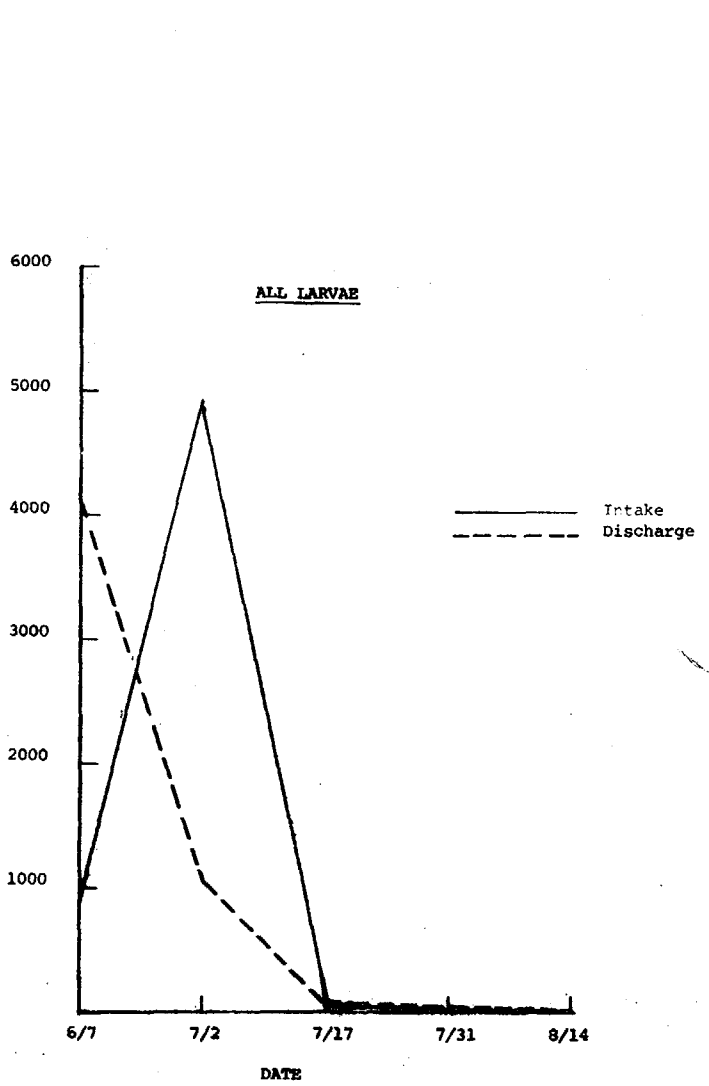
(b) Roseton

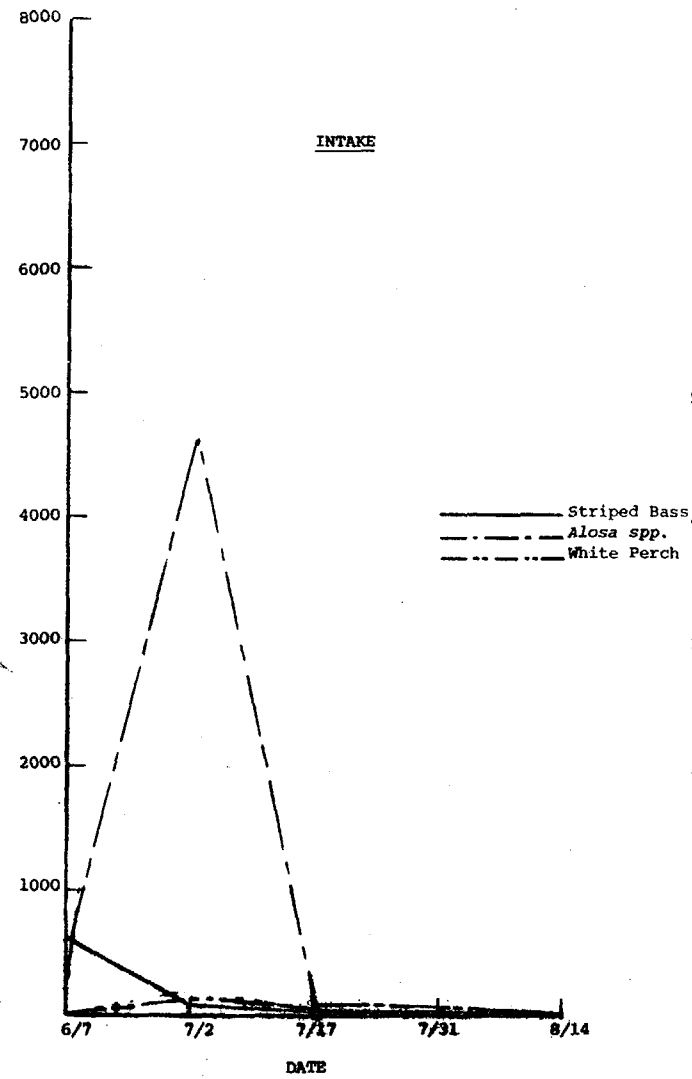
(i) Concentration of Larvae

Larval entrainment sampling was conducted from June 7 through August 15 at the Roseton intake and discharge concomitant with Danskammer Point entrainment and river sampling.

The concentration of total larvae and of striped bass, white perch, and Alosa spp. larvae at the intake and at the discharge

AVERAGE LARVAL ABUNDANCE: 1973
ROSETON INTAKE AND DISCHARGE





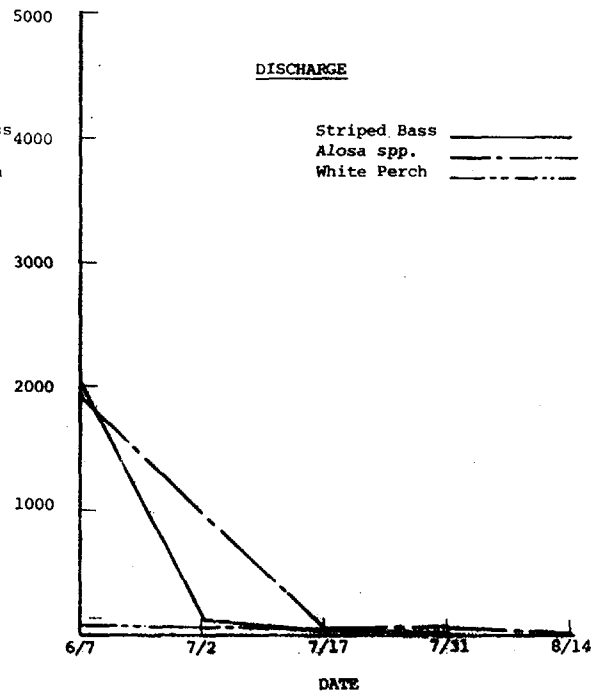


Figure V-14

TABLE V-15

AVERAGE CONCENTRATION OF DOMINANT FISH LARVAE
SPECIES AND TOTAL LARVAE AT ROSETON INTAKE AND DISCHARGE
1973

SAMPLING DATE	TOTAL SAMPLES COLLECTED	AVERAGE NUMBER LARVAE/1000m^3			
		ALOSA SPP	STRIPED BASS	WHITE PERCH	TOTAL
A. INTAKE					
June 7-8	5	203	608	0	878
July 2-3	27	4544	41	129	4842
July 17-18	37	26	5	32	88
July 31-August 1	25	24	0	7	37
August 14-15	22	0	0	0	1
B. DISCHARGE					
June 7-8	10	1917	2022	72	4108
July 2-3	8	837	104	66	1062
July 17-18	12	13	1	14	41
July 31-August 1	12	9	0	0	9
August 14-15	6	0	0	0	0

Note: Larvae identified as "others" not shown.

is presented in Table V-15. Figure V-14 graphically displays the temporal variation in abundance of total striped bass, white perch and Alosa spp. larvae at the intake and discharge of the Roseton plant.

For comparable sampling dates the average larval concentration was higher at Roseton than at the Danskammer Point plant. Peak values also occur at different times at the two plants.

Peak abundance of striped bass occurred on June 7-8; similar data were found for striped bass at Danskammer Point. Comparable dates were not sampled for white perch and Alosa spp. peak abundance at the two plants.

(ii) Length Frequency

Length frequency by sampling date for the three major species, striped bass, white perch, and Alosa spp., is presented in Figure V-15. In the June 7-8 collection striped bass exhibited a mean total length of 5.0 mm. This was similar to findings in river collections at RDW and slightly higher than figures from Danskammer Point. For the next comparable dates, July 2-3 and July 17-18, the mean total length found at Roseton was almost the same as the river and Danskammer Point. The size ranges were very comparable on all dates except July 2-3, when a smaller number of striped bass larvae with a smaller length were collected at Roseton.

LARVAL LENGTH DISTRIBUTION: STRIPED BASS, WHITE PERCH AND *ALOSA SPP.* - 1973

ROSETON INTAKE AND DISCHARGE

Note: RIT - Roseton Intake Total
RDT - Roseton Discharge Total
MTL - Mean Total Length

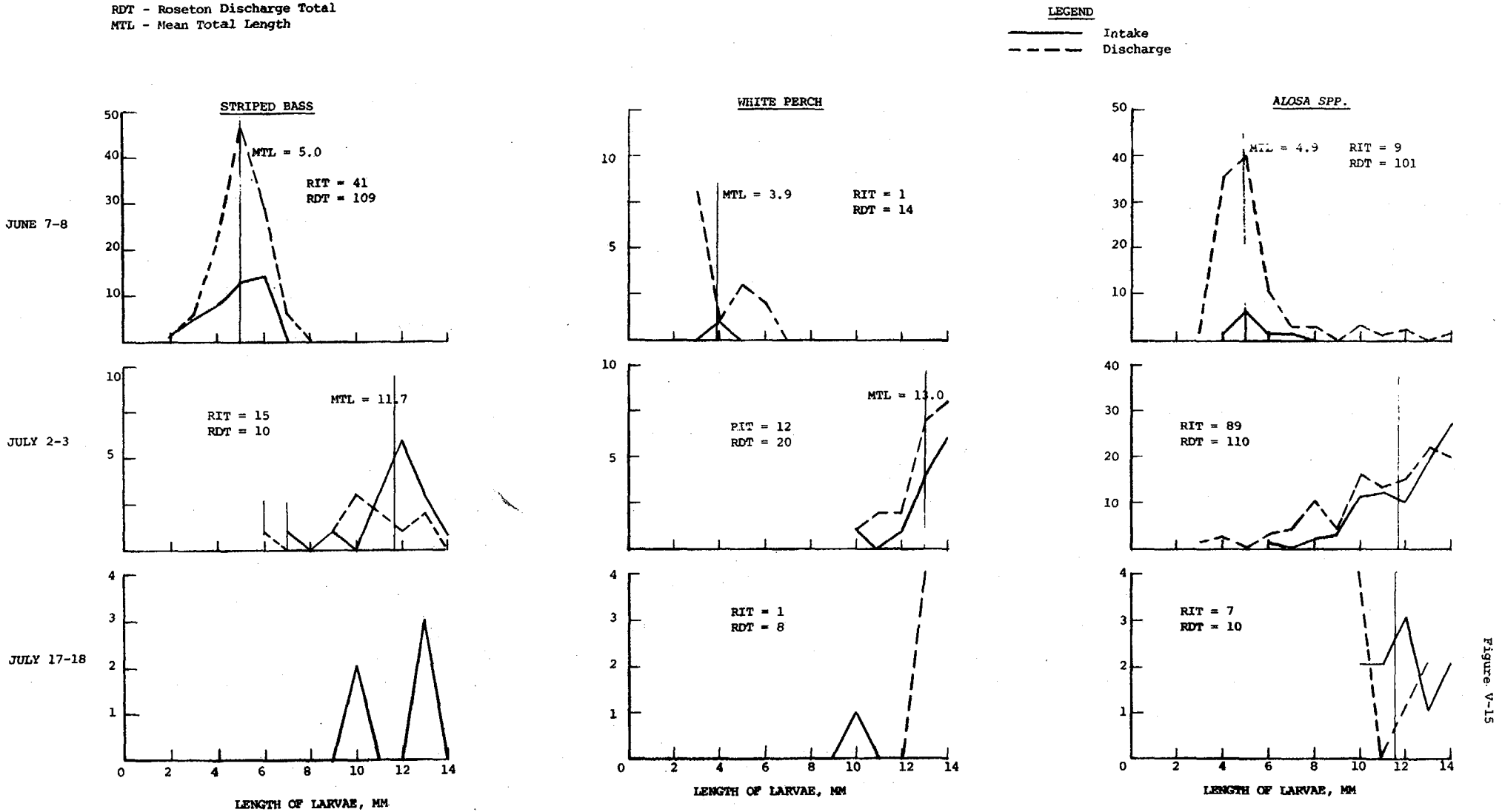


Figure V-15

The size range and mean total length of white perch collected at Roseton were not similar to comparable measurements at Danskammer Point and in river collections. The mean total length of 3.9 mm was intermediate between the 2.9 mm and 4.8 mm at Danskammer Point and RDW, respectively. The smallest range of length was also recorded at the Roseton plant locations. The remaining two sampling dates were similar in both range of length intervals and mean length values, suggesting the same population present in this area of the Hudson River.

Alosa spp. from the river and the Danskammer Point plant had generally the same peak length frequencies and length intervals as recorded at Roseton, except for July 17-18. On this date Roseton samples were composed exclusively of larvae within the size range of 10.0 mm to 14.0 mm, while both other locations had additional larvae from a smaller size range.

The data indicate very little difference between the Roseton sample and those from RDW and Danskammer Point. This suggests non-selective entrainment of the population present in the vicinity of the intake structure. The differences that do exist occur mainly with larvae of smaller size, and this could be related to the patchy distribution of the larvae in the water column.

(c) Viability Studies. To test for larval viability, short duration net samples were collected at the intake and discharge locations at both Danskammer Point and Roseton plants. Sampling periods of short duration (approximately 2 minutes) were used to reduce damage or mortality to the larvae as a result of the collection procedure; heavy detritus

loads in the river were an additional reason for the short time periods. The method of sampling was to collect the larvae at the different locations and transfer them immediately to an enamel pan in which ambient water temperature was maintained in a flowing water table. Samples were distributed evely among the pans.

Larvae were then categorized as live, dead or stunned and were separated from the sample and placed in vials containing 70% ethanol. Further analysis for species in each category was done in the laboratory. The integrity of the sample was maintained and, for fish larvae not observed under field conditions, further analysis was performed in the laboratory on all viability samples.

The major fish larval species or groups (Alosa spp., striped bass, white perch) were identified in all viability samples collected. Collection data for intake and discharge for Danskammer Point and Roseton are presented in Tables V-16 and V-17, respectively.

The greatest number of fish larvae were collected at the Danskammer Point intake and discharge during sampling on June 19-20. These larvae were primarily Alosa spp. and unidentified others. The least number of larvae were collected on August 14-15.

Approximately 87% of the larvae collected in the Danskammer Point intake samples on June 7-8, June 19-20, and July 2-3 were categorized as dead. This value dropped to 37% on July 17-18 and increased to 50% during July 31-August 1 sampling. During the early sampling dates the

TABLE V-16

DANSKAMMER POINT VIABILITY COLLECTION
1973
ROSETON/DANSKAMMER POINT VICINITY

SAMPLING DATE	SPECIES												TOTAL LARVAE COLLECTED IN EACH CATEGORY			PERCENT OF TOTAL IN EACH CATEGORY		
	ALOSA SPP.			STRIPED BASS			WHITE PERCH			OTHERS								
	L	D	S	L	D	S	L	D	S	L	D	S	L	D	S	L	D	S
A. INTAKE																		
June 7-8	3	61	0	2	7	0	0	0	0	14	84	2	19	152	2	11	88	2
June 19-20	20	293	15	7	6	0	2	12	0	33	327	19	62	638	34	8	87	5
July 2-3	22	245	13	1	1	0	3	2	1	26	264	13	52	512	27	9	87	4
July 17-18	8	13	4	1	2	4	9	0	0	18	15	8	36	30	16	44	37	19
July 31-August 1	9	7	0	0	0	0	0	1	0	9	12	1	18	20	1	46	51	3
August 14-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. DISCHARGE																		
June 7-8	0	160	0	0	8	0	0	3	0	0	85	0	0	256	0	0	100	0
June 19-20	0	233	0	0	18	0	0	15	0	7	328	2	7	594	2	1	98	1
July 2-3	4	41	0	0	0	0	0	0	0	4	43	0	8	84	0	9	91	0
July 17-18	1	4	0	0	0	0	0	1	0	1	5	0	2	10	0	17	83	0
July 31-August 1	0	7	0	0	0	0	0	1	0	1	7	0	1	15	0	6	94	0
August 14-15	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	100	0

Note: 1. Individual samples on given day are not specified.
2. L denotes Live
D denotes Dead
S denotes Stunned

Quirk, Lawler & Matusky Engineers

TABLE V-17

ROSETON VIABILITY COLLECTION
1973
ROSETON/DANSKAMMER POINT VICINITY

SAMPLING DATE	SPECIES												TOTAL LARVAE COLLECTED IN EACH CATEGORY			PERCENT OF TOTAL IN EACH CATEGORY		
	ALOSA SPP.			STRIPED BASS			WHITE PERCH			OTHERS								
	L	D	S	L	D	S	L	D	S	L	D	S	L	D	S	L	D	S
A. INTAKE																		
July 2-3	6	22	9	2	0	1	2	2	1	14	26	12	24	50	23	25	51	24
July 17-18	8	11	4	0	4	2	1	6	0	15	18	7	24	39	13	32	51	17
July 31-August 1	5	6	0	0	0	0	0	0	0	5	1	0	10	7	0	59	41	0
August 14-15	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0	0	100	0
B. DISCHARGE																		
July 2-3	0	86	0	0	2	1	0	10	0	14	86	1	14	184	2	7	92	1
July 17-18	0	8	0	0	0	0	1	7	2	1	15	2	2	30	4	6	83	11
July 31-August 1	0	6	0	0	0	0	0	2	0	0	2	0	0	10	0	0	100	0
August 14-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Individual samples on given day are not specified.
2. L denotes Live
D denotes Dead
S denotes Stunned

Quirk, Lawler & Matusky Engineers

larvae collected were very small in size. As the larvae grow, their ability to withstand stress increases; this may explain the observed increase in live and/or stunned larvae in later collections.

A great percentage of the larvae collected (more than 80%) from the discharge was categorized as dead. However, the relatively high percentages of dead larvae recorded before entrainment suggests collection techniques killed a substantial fraction of the dead larvae collected at the discharge. The problem of net kill will be further investigated during 1974.

During the Roseton entrainment study the plant was not operational; however, circulating water pumps were operating during sampling periods. This yielded data on mechanical stress during passage through the cooling water system without thermal input. The numbers of larvae collected from intake and discharge locations declined from a peak found on the first sampling date. The majority of these larvae were Alosa spp. and unidentified.

Larvae collected at the Roseton intake exhibited increased viability with time. In discharge samples the greatest percentage (more than 80%) were found to be dead; however, the same small peak found at Danskammer Point for live and/or stunned larvae during sampling on July 17-18 was observed.

The higher percentage of non-viable fish larvae found at the Roseton discharge compared to intake collections would suggest that, aside from damage due to the collection device itself, mechanical damage was the major cause of death to fish larvae entrained through the

cooling water system. March (1973) working on entrained fish larvae at a Connecticut River power plant, found that mortality due to mechanical damage ranged between 72 and 87%, averaging approximately 80%. The remaining 20% mortality was attributable to thermal shock.

The results of the entrainment viability sampling suggest that collection techniques were the primary cause of mortality for young or newly hatched larvae. As the larvae matured and grew, the ability to withstand damage caused by the collection nets also increased, resulting in a higher percentage of viable organisms. The percentage mortality in discharge samples exceeded 80% on all collection dates, and was above 90% on all but one date (July 17-18) at both plant sites. The greater proportion of the discharge mortality is most likely due to mechanical net induced stress and a smaller percentage to thermal stress.

3. Fish Egg Entrainment

During 1973 the ichthyoplankton sampling program was conducted to determine the vertical and horizontal distribution of fish eggs in the Hudson River and the corresponding relationship to fish egg entrainment at the Danskammer Point generating station.

Samples were collected at the intake (DI) and discharge (DD) channels of the Danskammer plant and along four north-south transects in the river (Figure III-1). Fish egg collections were conducted on 7, 8, and 19 June at surface, mid and bottom depths at the plant and along the river transects.

The average number of eggs per $1000m^3$ varied from 42 during 7 June (DD) to 225 during 8 June (DI). During these periods, corresponding river collections showed highest concentrations along the Roseton/Danskammer West Channel transect ($55/1000m^3$) on 7 June and Roseton/Danskammer West transect ($32/1000m^3$) on 8 June. During the sampling period, greater numbers of eggs were collected in the intake channel which may indicate either egg rupture during passage through the condensers or reduced sampling efficiency in the form of egg destruction during net capture at higher velocities in the discharge tunnel. Generally, greater numbers of eggs were collected at bottom depths during the night at the river and Danskammer plant stations. Furthermore, a comparison of fish egg concentration in relation to tidal currents indicated a general increase in egg concentrations in the vicinity of the Danskammer plant with the incoming (flood) tide. This observation may indicate that fish eggs were transported into the area from other river locations during a particular tidal period.

4. Special Study: Comparison of Catch Between One-Half and One Meter Nets

Sampling for ichthyoplankton during 1972 and 1973 in the Roseton/Danskammer Point study area was conducted using two different plankton nets. During 1972 collections made in conjunction with a fish larvae distribution program in the Hudson River relied on a 0 mesh (571 microns) conical net having one-half meter mouth opening. The 1973 river collections were made using a Hensen style net having 0 mesh and a one meter mouth opening.

The design, construction and method of use determines to a large extent the efficiency of a plankton net and its applicability to an ecological program (Hopkins, 1963; McGowan and Fraundurf, 1966; Schwoerbel, 1970; Barkley, 1972). Fish larvae exhibit a patchy distribution or form tight schools which necessitate an extensive sampling program for more accurate evaluation of the community structure (Cassie, 1962; Schwoerbel, 1970). As fish larvae mature, their swimming abilities and awareness of the environment becomes more advanced, increasing avoidance of the collection gear (Bridger, 1956; Fleminger and Clutter, 1965). Several studies have been conducted which indicate that nets of different design are selective in collection of populations present in the study area (McGowan and Fraundorf, 1966; Barkley, 1972; Quirk, Lawler & Matusky Engineers, 1974b). The interrelationship of these variables affect the results of an ichthyoplankton survey and must be considered when making final conclusions.

To test for possible differences between the numbers of ichthyoplankters collected by separate nets, selective simultaneous tows of one meter and one-half meter nets were conducted throughout the 1973 study period. Larvae concentrations were calculated per volume of water filtered ($1000m^3$) and the numbers compared using a Student-t Test. This statistic was chosen as the values were found to have homogeneity of variance. The results of the test are presented below:

Comparison of One Half and One Meter Nets Using Student-t Test.

Station	Date	t-Value	Degrees of Freedom	p-Value
RDW	all	1.962	84	$0.050<p<0.100$
RDWCH	all	0.304	115	$p>0.500$
RDECH	all	1.242	107	$0.200<p<0.400$
RDE	all	1.607	83	$0.100<p<0.200$

At each station sampled by the different nets, over the period of the entire study, no significant differences in number of larvae, calculated per 1000 cubic meters of water filtered, was found.

The data did suggest that there was a difference in the numbers of the dominant fish larvae collected by the two nets. This observation was tested for striped bass and Alosa spp. using the Students-t Test and white perch using the Wilcoxon Signed Rank Test. A significantly greater number of white perch and Alosa spp. were collected by the one meter net than by the one-half meter net. No significant difference was noted for striped bass.

These comparisons suggest that community estimates based on total larvae might not be altered significantly using either net in an ecological survey. However, if the study was primarily directed at population dynamics the one meter net might yield values significantly different from the one half meter net.

In addition to the gear comparison tows conducted along the four river transects, placement of the one meter and one-half meter nets in the intake channel at Danskammer Point enabled additional direct statistical

evaluation of the collection data. The net comparability studies for total abundance and direct collection comparisons for total larvae and dominant species/1000m^3 were conducted using the Paired-t Test.

Surface and bottom one meter net collections and surface, mid-depth and bottom one-half meter net collections were compared for differences in vertical distribution of larvae at the collection location in the intake channel. No significant difference was noted in the number of larvae/1000m^3 collected at the two stations.

The average of the surface and bottom one meter nets was compared to the average of the surface and bottom one-half meter nets. No significant difference in abundance was found between the two intake channel stations.

The surface collections for one meter and one-half meter nets and the bottom collections for the one meter and one-half meter nets were compared for difference in abundance. There was no significant difference for larval abundance between the bottom one meter and one-half meter nets, however, there was a significant difference found for the surface nets. The number of larvae/1000m^3 was significantly greater for the one meter plankton net compared to the one-half meter net. The test table for the four total larval abundance comparisons is given in Table V-18.

Collections for the one meter nets occurred at approximately the same time as the one-half meter nets. The total number of larvae collected by surface and bottom one meter nets and one-half meter nets and the

TABLE V-18

TOTAL LARVAL ABUNDANCE NET COMPARISONS
1973
ROSETON/DANSKAMMER POINT VICINITY

COMPARISONS	PAIRED T CALCULATED	DEGREES OF FREEDOM	$\alpha = 0.05$ T TABLE VALUE	PROBABILITY OF LARGER VALUE
One meter surface and one bottom vs. one-half meter surface and bottom	1.974	25	2.06	$0.005<p<0.100$
One meter surface and one-half meter surface vs. one meter bottom and one-half meter bottom	0.572	21	2.08	$p>0.500$
Surface one meter vs. surface one-half meter	2.619*	41	2.021	$0.01<p<0.025$
Bottom one meter vs. bottom one-half meter	0.951	54	2.004	$0.2<p<0.4$

*Significant difference.

TABLE V-19

SIMULTANEOUS NET COLLECTION COMPARISONS TOTAL LARVAE AND DOMINANT SPECIES

ROSETON/DANSKAMMER POINT VICINITY

NET DEPTH	SPECIES COMPARED	PAIRED T CALCULATION	DEGREES OF FREEDOM	$\alpha = 0.05$ T TABLE VALUE	PROBABILITY OF LARGER VALUE
Surface	Striped Bass	1.830	21	2.08	$0.05 < p < 0.10$
Surface	White Perch	0.652	21	2.08	$p > 0.5$
Surface	*Alosa spp.*	1.676	19	2.093	$0.1 < p < 0.2$
Surface	Total*	2.551	28	2.048	$0.01 < p < 0.025$
Bottom	Striped Bass	0.860	38	2.023	$0.2 < p < 0.4$
Bottom	White Perch	-2.518	38	2.023	$0.01 < p < 0.025$
Bottom	*Alosa spp.*	1.093	38	2.023	$0.05 < p < 0.10$
Bottom	Total	1.305	52	2.006	$0.1 < p < 0.2$

*Significant difference.

dominant species (striped bass, white perch, Alosa spp.) were compared on a collection to collection basis. This would minimize the effect of time of day and tidal cycle differences on total abundance comparison. The test statistics for the different comparisons are listed in Table V-19.

As noted for the total larval abundance collected over the study period, the total larvae collected by simultaneous surface nets were significantly different*. The one meter surface net collected a greater number per volume filtered than the one-half meter surface net. White perch was the only dominant species with a significant difference in collection; more being take by the bottom one meter net than the bottom one-half meter net.

D. EFFECT OF ROSETON PLANT OPERATION ON THE HUDSON RIVER STRIPED BASS POPULATION

1. Introduction

At certain times of the year, the early life stages of Hudson River fishes, including the egg stage, the larval stage and the very early juvenile stage, are subject to entrainment or carriage into the circulating water system, since these stages are at least partially subject to prevailing currents in the river.

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*QLM is currently engaged in studies of net efficiency, velocity profiles and meter accuracy on a seasonal basis and including various plant operating modes, to determine the reasons for the differences observed. Further information may be issued at a later time with appropriate calibration corrections if required.

These organisms are subject to rapidly changing mechanical, thermal and pressure variations as the water moves through the intake, the circulating water pumps, the condenser and the discharge line. As the water is lifted up to the condenser, the pressure drops rapidly below atmospheric pressure, and as heat is transferred from the spent steam, the temperature rises rapidly. These rapid changes in the variables of mechanical abrasion, pressure and temperature are thought to have an adverse effect on many of the organisms contained in the circulating water.

In addition to the entrainment of these early life stages of fishes, some later juvenile stage fish in the drafted water with sizes greater than the 3/8 inch mesh screens (installed at the cooling water intakes to keep the debris from entering the cooling system) are susceptible to impingement on the screens.

The impact of the stresses on the young fishes entering the generating stations on the Hudson River may have some bearing on the fish population in the river. The impact of the Roseton Generating Station on the Hudson River striped bass population is the subject contained herein. Although these processes of entrainment and impingement affect other species of fish in the Hudson River, the striped bass will be analyzed because mathematic models of the life cycle of the striped bass have been developed for recent hearings and other studies.

Basically, three separate models of the effects of power plants on the striped bass have been developed in the past. These models were used for prediction of power plant impact on Hudson River striped bass population during the Atomic Safety and Licensing Board Hearings concerning Con Edison's Indian Point Unit 2 nuclear reactor. These models can be applied to the Roseton station since the modelling efforts are for the entire Hudson River and take into account all the power plants on the river. An example of the versatility of the models can be seen by the QLM model which has been used to calculate the effect on the striped bass due to the proposed Cornwall pumped storage station and the Bowline station.

Detailed descriptions of the models will not be given in this section as the discussions are lengthy and can be found in the various references listed. However, because of disparity of the models, some of the assumptions made for each model will be discussed and what effect it has on the results. The disparities arise mainly because of the ability or the lack of ability to correctly model the complexities of the life cycle of the bass. Although the gross life cycle behavior of striped bass is well known the details of each early life stage (mortality of each stage, predation rates, migration behavior) are not well defined. Briefly the following points of uncertainty exist in regard to the life cycle of the striped bass in the Hudson River:

(a) Although the general location of spawning areas are known, the exact location for a given year is not known.

(b) River concentrations of the various life stages are needed for comparison, however, the collection gear utilized have only relative efficiencies which are not completely known.

(c) The vertical diurnal migrations of the larval bass are known, however, the effect of such non-uniform distribution on the downstream movement of the larvae, as well as their availability to entrainment needs further investigation.

(d) Further investigation is needed to determine if the marked preference of early juveniles and possible later larvae to certain areas of the river will control the number available for entrainment and/or impingement by power plants.

(e) The distribution of early bass within a lateral section of the river is not uniform and will affect the abundance of early bass subject to entrainment and impingement.

Additionally, current evidence indicates appreciable survival of entrained stages through the power plant which varies with the stage considered. Further studies are required to quantify this survival adequately enough to permit accurate assessment of entrainment impact (Lauer, 1973a, b, c, d).

The aforementioned represents only a partial list of inadequacies in current knowledge. Each of the models developed have addressed these problems to varying degrees.

(a) Clark Model. This model utilizes a direct computational procedure based on empirical estimates of early stage abundance from survey data (Clark, 1972a, 1972b, 1972c).

Populations of early stages are estimated from midpoints of plots of abundance versus time, and reductions of each stage survival are computed by multiplying the intake flow rates of the power plants by the average abundance of the stage in about a 10 mile segment within which the particular plant is located.

The amount entrained is deducted from the total end of stage population estimates, computed from the observed data, in order to calculate the percent reduction of the population.

Impingement is computed by multiplying impingement rates (numbers impinged per day) per unit intake flow (measured at the power plant or extrapolated from other power plants) by the actual plant flows and the duration of the impingement period.

The amount impinged is deducted from the remainder after entrainment, and then a total entrainment and impingement percent reduction is computed.

This methodology considers neither differences between abundances in the River and abundances in the intake water of the plant, nor the effect of drawdown on continued organism entrainment by the plant. One hundred percent mortality of entrained organisms is assumed.

Furthermore, collection gear efficiency is not considered, which makes the entrainment estimates relative, since they are based on river sampling

collections, and the impingement estimates absolute, since they are based on physical counts of fish impinged.

This computational scheme is useful for rapid, although conservative, estimates of plant impacts. Adjustments of the procedure for collection gear efficiency, assumed condenser mortality and actual intake concentrations allow the procedure to be used as an efficient method for "ball parking" plant impacts.

However, the procedure is restricted to actual or assumed stage concentrations and distributions, and is of limited use for consideration of other than historical data.

(b) Goodyear Approach. The second model (AEC/Goodyear 1972a, 1973a, 1973b) is developed from a material balance approach. It considers the river as broken into a series of segments along its course, each segment (within the salinity intrusion zone) being split into an upper layer and lower layer.

A spawning distribution as a function of time and river temperature, is used as input as well as freshwater flow variation and natural mortalities of the entrainable stages.

An assumed average distribution of organisms between the two layers is assumed to account for non-uniform distribution of larvae during daytime hours, and an average tidal flow is assigned for each layer such that organisms in the upper layer always move downstream and organisms in the lower layer always move upstream.

The model, therefore, views averages over a daily period.

The model has been put into use by assuming a spawning magnitude and time and location distribution, and computing the resultant organism age, concentration and distribution as a function of time for a period of eight weeks (entrainment period), both without power plants operating and with power plants operating, and using the difference in resultant populations at the end of the entrainment period as the plant impact. Plant impacts beyond the entrainment period are not considered.

The entrainment mechanism is similar to the first model in that it withdraws organisms at the average segment concentration, but it makes provision for plant entrainment mortalities of less than 100%, as well as avoidance of the plant intake by organisms at an increasing rate as they progressively age and become less passive.

Organisms are actively transferred between segments by convection at the average tidal (and freshwater) flows in each layer, and transferred between layers to maintain an assumed fixed distribution.

Avoidance of convection by organisms at an increasing rate with age is also provided in a similar manner to plant intake avoidance. Natural survival rates which vary with age of organisms are included in the model, and a provision is made for decreased growth rates (aging) of organisms as a function of temperature.

(c) QLM Model. The third model (Lawler, 1972a, 1973a) developed for prediction of plant impact also begins from a material balance viewpoint

and extends through the adult life stages to complete the feedback loop with subsequent reduced spawning due to reduced recruitment of young-of-the-year to adult year classes because of plant entrainment and impingement effects; the model predicts long term reductions.

The model consists of a series of segments along the river course without the layering included in the second model. The first year of life is broken into a series of discrete age groups (eggs, larvae, juvenile I, II & III), each with constant parameters (survival, etc.) as opposed to the continuous (daily) distribution of the egg, larval and juvenile I stages.

As in the second model, spawning is introduced as a distribution in space and time, but the amount of eggs spawned is computed from the adult population level and age distribution and fecundities (number of eggs spawned/female).

Eggs and larval stages are transported in the model between segments by freshwater flow movement and dispersion. The latter accounts in an average implicit manner for the tidal motion and non-uniform distribution of tidal velocities in time and space. Dispersion, therefore, represents the gross movement of organisms above the freshwater flows.

Explicit accounting of the vertical migration of larvae is not included.

The juvenile stages are modeled as active stages: the organisms are assumed to be able to overcome convective and dispersive transport and migrate actively between segments to achieve relative abundances between segments at different periods of time, as measured from field surveys and used as input data.

Entrainment of early stages (eggs, larvae and juvenile I's) are modeled similarly to the second model, with the exception of a group of multiplying factors accounting explicitly for non-uniform distribution in space (within the cross section of a segment containing a power plant) and time (day/night variation of vertical larval distributions). These factors convert average segment abundance into average intake entrainment concentration as well as accounting for partial survival of entrained early stages.

Impingement is handled in analogous fashion, with a partial survival factor indicating an avoidance by some of the later stages of intake velocities. Impingement factors are chosen such that the total numbers of impinged agree with observed results, after being corrected to relative numbers to account for the absolute efficiency of collection of impinged organisms.

An additional mechanism included in this model but not included in the other models is compensation. This factor accounts for increased survival of the remaining organisms with reduced abundance, and conversely decreased survival of the remaining organisms with increased abundance. It simply implies a non-linear natural mortality mechanism. Compensation permits a population to dampen an adverse impact which otherwise, however small, would eventually collapse it altogether. By decreasing survival in over-abundant population levels, it prevents unlimited growth of a population.

As will be seen in the next section, QLM believes that their model of striped bass best represents the life cycle of the bass and can more

accurately determine the effect of the Roseton Generating Station. As such, in Section II, a more detailed description of the model inputs and parameters will be discussed as it applies to the model runs applicable to the Roseton station.

(d) Comparison of Model Results. During the Indian Point Unit 2 Atomic Safety and Licensing Board hearings the three models were used to predict the effect of two unit operation at Indian Point on the striped bass population in the Hudson River. These Indian Point estimates will be used to compare the results obtained using these approaches.

The large number of differences between the various predictions reflects the various modeling approaches and the wide range of physical and biological parameters used as previously described. The most obvious difference in predictions is that the range of values computed by LMS is significantly lower than the range of values computed by Goodyear and Clark.

Results of the three approaches for prediction of the impact of two-unit operation at Indian Point for one year on the reduction of Year Class-1 recruitment are presented in Tables V-20 through V-23*.

In addition to depicting the impact results as generated by the three approaches and presented by Clark, Goodyear and Lawler, these tables show the effect of the various assumptions used on the final results. These

*A more detailed description of the input parameters (referred to in these tables and mentioned in this section) used and concepts simulated in these models is given in the reference.

TABLE V-20

POTENTIAL EFFECT OF OPERATION OF INDIAN POINT UNITS 1 AND 2
ON HUDSON RIVER STRIPED BASS POPULATION
- LAWLER'S POSITION -

Year Class	Percentage Reduction in Striped Bass Population After Indicated Number of Years of Plant Operation		
	After 1 Year	After 5 Years	After 10 Years
1st Case	State of Knowledge at This Time		
Year Class One	3.42%	5.40%	9.98%
All Adults	2.40	4.80	9.64
2nd Case	Consistent Entrainment and Impingement Loss Calculations		
Year Class One	2.0%	3.0%	5.0%
All Adults	1.0	3.0	5.0

TABLE V-21

PERCENTAGE REDUCTION IN STRIPED BASS POPULATION RESULTING FROM TWO-UNIT OPERATION AT INDIAN POINT - BASED ON LAWLER'S MODEL

Approach	Percentage Reduction in Striped Bass Population (One-Year-Olds) After One Year of Operation of Indian Point Units 1 and 2 - Based on Lawler's Model
I. Lawler's Position Using His Model and Parameters	
1. As used by Lawler	
a. Current best estimate of impact parameters	2.5%
b. Apparent maximum impact	4
2. As used by Lawler but with effect of gear efficiency included	2
3. As used by Lawler	
a. Same as item 2 but greater migration and no gear efficiency factor	3.5
b. Same as item 2 but with moderate compensation	2.3
c. Same as previous item but no "f" factors	3.3
II. Lawler's Model Using Other Than Lawler Parameters	
4. Input parameters approximating Goodyear's input parameters	
a. With impingement but no compensation and no "f" factors	15.41
b. Same as previous item but without impingement	13.85

TABLE V-22

PERCENTAGE REDUCTION IN STRIPED BASS POPULATION RESULTING FROM TWO-UNIT OPERATION AT INDIAN POINT - BASED ON GOODYEAR'S MODEL

Approach	Percentage Reduction in Striped Bass Population After One Year of Operation of Indian Point Units 1 & 2 - Based on Goodyear's Model
1. As used by Goodyear and presented in FES	30% - 50%
2. As used by Goodyear and presented in multi-plant testimony (all modeled flow years)	14.4 - 42.8
3. As used by Goodyear (outer limits)	7 - 50
4. As used by Goodyear (1967 flow)	26.8
5. As used by Goodyear and presented in FES	25
6. Previous item but modified by Lawler to treat time-averaging properly	18
7. Previous item but modified by Lawler to recognize intake location (withdrawal from the upper layer)	6
8. Previous item but modified by Lawler to incorporate influence of condenser mortality less than 100% as indicated in Dr. Lauer's Testimony of February 5, 1973	3
9. Item 1 but with Lawler modifications given in items 6 and 7 above	7 - 10
10. Previous item but with Lawler modification given in item 8 above	3% - 6%

TABLE V-23

PERCENTAGE REDUCTION IN STRIPED BASS POPULATION RESULTING FROM TWO-UNIT OPERATION AT INDIAN POINT - BASED ON CLARK'S CALCULATION

Approach	Percentage Reduction in Striped Bass Population After One Year of Operation of Indian Point Units 1 and 2 - Based on Clark's Calculations
1. As used by Clark	40%
2. Modified by Lawler to eliminate inconsistencies in approach only	15
3. Previous item modified by Lawler in order not to debit the effect of Indian Point Unit 1 against the plant twice	11.25
4. Previous item modified by Lawler to include the influence of compensation, intake location, and condenser mortality less than 100%, i.e., application of f factors.	same as Lawler predictions

tables present the results obtained by the three models when used under conditions similar to each other.

In order to effect the final comparison between the three models, changes were made to both Clark and Goodyear models.

In the case of the Clark model, for example, a more rigorous and consistent use of the empirical data and computational methodology was performed.

In the case of the Goodyear model, for example, the model was refined to include hourly average tidal flows as well as explicit migration of larvae between vertical layers.

The tabulation below summarizes the results obtained by the three models when similar input parameters are used under two sets of conditions.

INDIAN POINT UNITS 1 & 2
% REDUCTIONS OF YEAR CLASS-1 RECRUITS

Run	Clark	Goodyear	Lawler
1	11.25	18	15.41
2	3	3	2

The comparison conditions for Run 1 are for no gear efficiency considerations, plant intake concentrations equal to the river concentrations, 100% entrainment mortality and no compensation.

The comparison conditions for Run 2 include compensation, gear efficiency considerations, i.e., effect of collection gear on data quality, non-uniform distribution of organisms including intake avoidance mechanisms, and less than 100% plant mortality.

The resulting differences between the model results stem from the inability to run the models under exactly the same conditions as well as the different formulations inherent in each model.

Recent and ongoing Hudson River biological programs have been designed to provide sufficient information regarding these assumptions. With results to date, it appears that the Run 2 conditions are more realistic than their Run 1 counterparts.

In addition, after a review of these three approaches, the AEC Atomic Safety and Licensing Appeal Board issued a decision on April 4, 1974 concerning Indian Point Unit 2, in which it stated that the transport (Lawler) model "more nearly conforms to reality and is superior to the Staff's (Goodyear) model."

2. Application of LMS Striped Bass Model for the Roseton Plant Operation and Multi-Plant Operation

The QLM Hudson River striped bass life cycle model was briefly described and compared to other models in the previous sections. The model input parameters and the results of the model as run for the Roseton Generating Station will be discussed herein. Detailed descriptions of the model, its development, mathematics and all the theories and assumptions can be found in various testimonies of John P. Lawler, Ph.D. (QLM, 1972a, Lawler, 1972a).

(a) Input Parameters. The three principal categories of input parameters required by the Striped Bass Life Cycle Model are:

1. Mass transport parameters.
2. Fish life cycle parameters
3. Plant and impact parameters.

Figure V-16 shows these parameters in more detail. The data sources and computational methods used in evaluating these parameters can be found in the recent testimony by Dr. John P. Lawler before the Federal Power Commission (1974). Parameters directly relevant to the Roseton plant operations are discussed below.

(i) River Parameters

The freshwater flow and dispersion coefficients used in the LMS striped bass model for the simulations were derived from the 1973 data provided by the USGS.* The river was divided into twelve ten-mile segments, from mile point 10 to mile point 130, to facilitate the submission of input parameters to the model. Most of the parameters are functions of space (location on the river) and time and are evaluated on a time scale of one week. The segmentation of the Hudson River is shown in Table V-24.

Using the 1973 sled and tucker trawl data collected by Texas Instruments' (TI, 1973), the fraction of the striped bass organisms found in the bottom four feet of the river was estimated. This fraction was calculated to be 0.58 and 0.20 for the egg and larvae stages, respectively.

*USGS Gauging Station at Green Island, New York.

HUDSON RIVER STRIPED BASS
TRANSPORT MODEL PARAMETERS

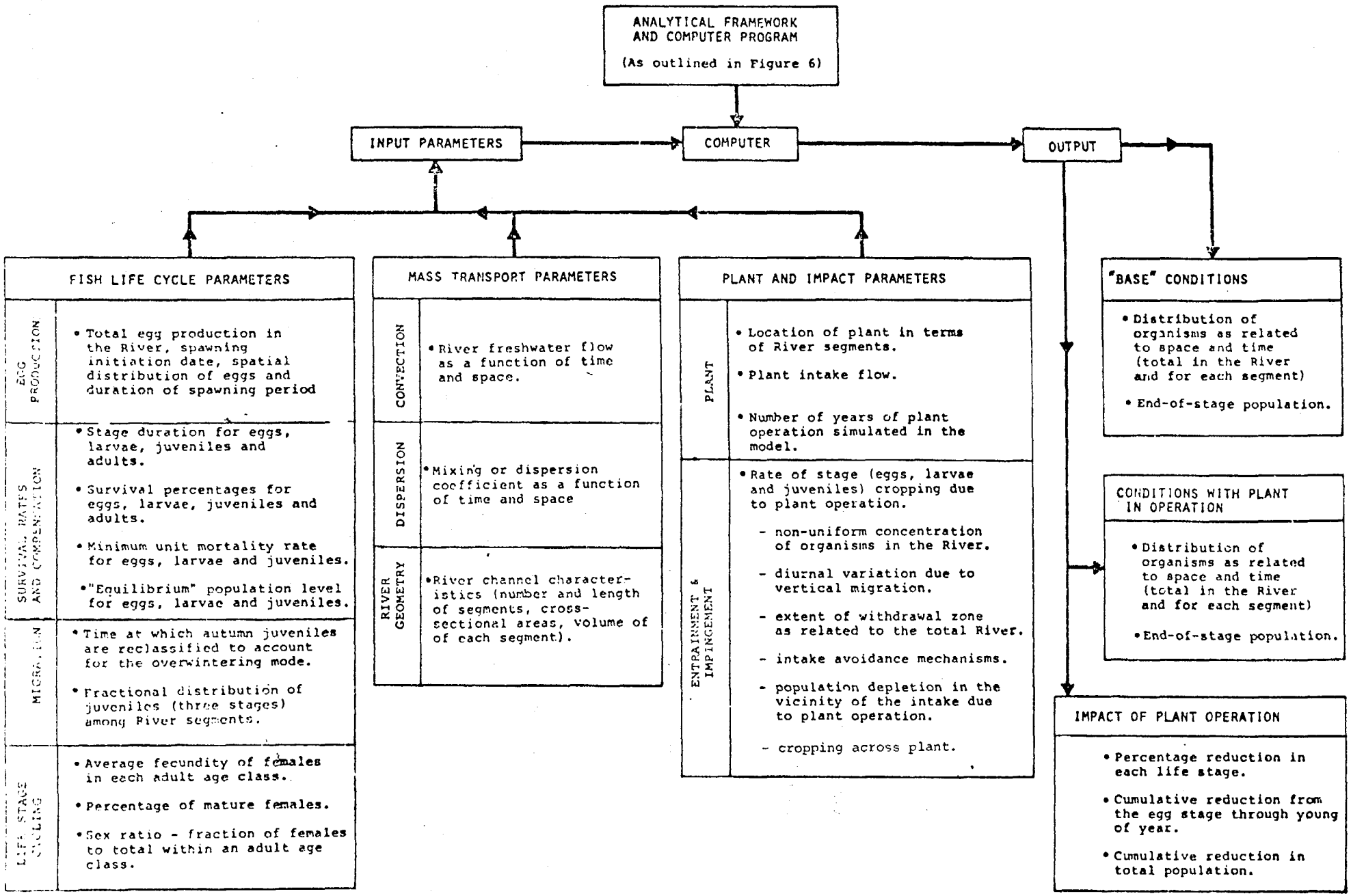


FIGURE V-16

TABLE V-24

SEGMENTATION OF THE HUDSON RIVER
USED IN THE STRIPED BASS TRANSPORT

Segment Number	River Mile Point Range	Plants Within Segment
1	120-130	
2	110-120	
3	100-110	
4	90-100	
5	80-90	
6	70-80	
7	60-70	Danskammer Roseton
8	50-60	Cornwall (Proposed)
9	40-50	Indian Point Lovett
10	30-40	Bowline
11	20-30	
12	10-20	

LMS's fish life cycle model was modified to allow this fraction of organisms to be unsusceptible to the river transport mechanisms.

(ii) Fish Life Cycle Parameters

Data required to calculate fish egg production, maturation rates, sex ratio and fecundity values, were obtained from the Texas Instruments (T.I., 1973) reports summarizing the 1973 programs. The egg production function was calculated using the procedure given in Lawler's testimony. Migration preferences were calculated from the beach-seine data provided in Texas Instruments' reports of October and December 1973. The survival rates used were those given in the testimony of 30 October 1972 and two levels of compensation were used. The level of compensation is indicated by the value of the ratio of the minimum mortality rate to the first order rate K_o/K_E. The two values of this ratio used were 0.5 and 0.8, which are indicative of high and low compensation levels, respectively.

(iii) Plant Impact Parameters

Plant Flow Rates

The plant flow rates used in the model for Roseton plant alone and/or multi-plant impact predictions are summarized in Table V-25. These plant flow rates, along with the following parameters were used to calculate the rates of entrainment and impingement of the young striped bass.

TABLE V-25

PLANT CIRCULATING WATER FLOW RATES (FULL FLOW)

Power Plant	1000 gpm	MGD	cfs	$Mile^3/day$
Bowline Units 1 & 2	768	1106	1711	1.0044×10^{-3}
Indian Point Units 1, 2 & 3	2058	2964	4585	2.6916×10^{-3}
Roseton Units 1 & 2	650	936	1448	0.8502×10^{-3}
Danskammer Point Units 1-4	308	443	685	0.4024×10^{-3}
Lovett Units 1-5	323	465	720	0.4224×10^{-3}

Entrainment Impact Factors

A series of f factors was implemented to facilitate the evaluation of the entrainment rate of organisms. These factors consist of f_1, f, f', f_2, f_3 and f_c and are defined in Dr. John P. Lawler's Cornwall Testimony (QL&M, 1974) and October 30, 1972 Testimony (Lawler, 1972a). The product of these factors, the composite f-factor, defines the overall possible entrainment impact upon the organisms in the river.

Values of the various f factors used to predict entrainment were calculated from data collected by QLM Laboratories, New York University and Texas Instruments at the vicinity of various plants. Brief descriptions of computational procedures for each of the individuals component f-factors are discussed below. Detailed procedures can be found in Dr. Lawler's Cornwall Testimony (QL&M, 1974).

f_1-Factor

The f_1-factor defines the fraction of organisms in the river that may be subject to entrainment. To evaluate this, distributions of organisms at different times and lateral positions near the plant were determined by taking samples at various depths at the three or four river transects in front of the plant intake.

Two methods were employed to compute f_1 factors. Method A assigns double weight to middle channel transect values. Method B assigns

uniform lateral weight to all the transect values. Both methods were used in calculating the f_1 factors at all plants. In Method B the surface and mid-depth samples in the appropriate portion of the transect were used to evaluate the concentration of organisms susceptible to plant withdrawal. Method A includes the surface and mid-depth samples of both the channel transect and either west or east transect, depending on the plant location, in estimating the susceptible portion of the cross-sectional concentration. When transect data were available for several sample dates, the f_1 factors for day and night were calculated as:

$$f_1 = \frac{\left[\sum_{i=1}^{n} (\text{Upper East or West Quadrant Concentration})_i\right]/n}{\left[\sum_{i=1}^{n} (\text{Cross-sectional Concentration})_i\right]/n}$$

where n = number of sample dates.

For the larval stage, the f_1 factor was computed by adding the average quadrant concentrations for the yolk sac and post yolk sac stages and dividing by the sum of the average cross-sectional concentrations of these two stages.

In computing the average quadrant and cross-sectional concentrations only those samples taken during the period of abundance for a given life stage were used. The sample dates included in the average began with the first appearance of a given life stage in either the plant or river samples and ran through the last day on which the life stage was captured.

The f_1-factor calculations for the larval and juvenile I stages for Roseton are shown in Tables V-26 and V-27 respectively. They are computed by dividing the concentrations of organisms near the intake by the river cross-sectional concentrations. For the egg stage, a value of 0.20 for f_1 is used. This is based on the observation of the average striped bass egg behaviour surveyed by Texas Instruments in 1973 (QL&M, 1974).

f_2-factor

The f_2-factor is the ratio of the concentration of organisms in the plant intake and/or discharge samples to that of the organism concentrations in the quadrant immediately adjacent to the intake. The calculation of average concentrations in the intake and/or discharge samples was represented by:

$$C_{AVG} = \frac{\sum_{i=1}^{m} Ni}{\sum_{i=1}^{m} Vi}$$

where: m = number of samples.

Ni = number of organisms of a given life stage captured in the i^{th} sample.

Vi = sample volume for i^{th} sample.

For the larval stage, the yolk sac and post yolk sac organisms captured were added together in determining the total number of larvae captured. When field data for both the intake and discharge were available and applicable, the C_{AVG} values calculated from the intake and discharge samples were averaged with equal

TABLE V-26

ROSETON 1973 STRIPED BASS LARVAL STAGE COMPOSITE "f"* FACTOR
(7 Sampling Dates between May 10 and August 1)

	DAY		NIGHT	
	Method A	Method B	Method A	Method B
River Cross-sectional Concentration (#/TCM)	12.765	10.979	188.737	174.039
Weighted River Cross-sectional Concentration (#/TCM)	7.978	6.862	70.776	65.265
River 24-hour Average Concentration (#/TCM)	78.754	72.127	78.754	72.127
River Concentration near Intake (#/TCM)	12.716	5.439	343.385	247.310
Intake: No. of larvae (ys + pys)	17		14	
Volume strained (TCM)	2.59		1.10	
Concentration (#/TCM)	6.564		12.727	
Discharge:				
No. of larvae (ys + pys)	41		21	
Volume strained (TCM)	1.6		1.35	
Concentration (#/TCM)	25.625		15.556	
Plant Concentration (Average of Intake and Discharge) (#/TCM)	16.095		14.141	
f'	0.162	0.152	2.397	2.413
f_w	0.625	0.625	0.375	0.375
f_1	0.996	0.495	1.819	1.421
f_2**	1.265	2.956	0.041	0.057
f_3**	1.000	1.000	1.000	1.000
f_c***	0.600	0.600	0.600	0.600
$f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c$	0.076	0.083	0.040	0.044
Composite "f"	Method A = 0.116;		Method B = 0.127	

* Composite "f" = $(f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c)$ Day + $(f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c)$ Night

#/TCM = number of organisms per thousand cubic meters

ys = yolk-sac larvae; pys = post yolk-sac larvae

** 1.0 is assumed for lack of data.

*** Conservative estimate, based on NYU studies.

TABLE V-27

ROSETON 1973 STRIPED BASS JUVENILE I STAGE COMPOSITE "f"* FACTOR
(4 Sampling Dates between July 2 and August 15)

	DAY		NIGHT	
	Method A	Method B	Method A	Method B
River Cross-sectional Concentration (#/TCM)	1.025	0.890	2.304	2.760
Weighted River Cross-sectional Concentration (#/TCM)	0.641	0.556	0.864	1.035
River 24-hour Average Concentration (#/TCM)	1.505	1.591	1.505	1.591
River Concentration near Intake (#/TCM)	0.578	0.660	0.491	0.028
Intake: No. of Juvenile I				
Volume strained (TCM)				
Concentration (#/TCM)	-	-	-	-
Discharge:				
No. of juvenile I				
Volume strained (TCM)				
Concentration (#/TCM)	-	-	-	-
Plant Concentration (Average of Intake and Discharge) (#/TCM)	-	-	-	-
f'	0.681	0.559	1.531	1.735
f_w	0.625	0.625	0.375	0.375
f_1	0.564	0.742	0.213	0.010
f_2**	1.000	1.000	1.000	1.000
f_3**	1.000	1.000	1.000	1.000
f_c***	0.700	0.700	0.700	0.700
$f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c$	0.168	0.181	0.086	0.005
Composite "f"	Method A =	0.254;	Method B =	0.186

* Composite "f" = $(f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c)$ Day + $(f' \cdot f_w \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_c)$ Night

#/TCM = number of organisms per thousand cubic meters

** 1.0 is assumed for lack of data.

*** Conservative estimate, based on NYU studies.

weighting to give the final estimate of the concentration of organisms entering the plant. The goal was an estimate of the numerator of the f_2-factor.

The dominator of the f_2 factor was set equal to the numerator of the f_1 factor. The product of f_1 and f_2 becomes simply the ratio of the intake concentration to the river cross-sectional concentration.

Averaging of data from several sample dates was performed over the same period of abundance as used in computing the f_1 factor. The calculations of f_2 factors for the larval and juvenile I stages at Roseton are shown in Tables V-26 and V-27.

f_3-Factor

This factor recognizes that the depletion of organisms in the immediate vicinity of the intake may not be immediately replenished. An f_3-factor equals to unity would indicate a continuous immediate replenishment of the depleted population in the intake vicinity. This is unlikely to be the case. Several factors may govern the replenishment of the population. These include the lateral mixing of the river water, the availability of organisms near the intake vicinity, the possible recirculation of organisms from the plant discharge to the intake area, and so forth. At the present, no data are available to allow the evaluation of these factors. Thus, a conservative value of 1.0 is selected for the f_3-factor for all three early life stages of the striped bass. Further field and mathematical model studies are needed to permit the evaluation of the f_3-factor.

f′-Factor

The f′-factor recognizes the day-night differences of the river cross-sectional average concentrations. Thus, f'_D, the f′-factor for daytime is the ratio of the river cross-sectional average concentration in daytime to the river cross-sectional average concentration over the 24-hour period and f'_N is the analogous f′- factor for the nighttime.

f_c-Factor

The f_c-factor was evaluated according to the defining formula as:

$$f_c = \frac{\text{(\% Alive in plant intake - \% Alive in plant discharge)}}{\text{(\% Alive in plant intake)}}$$

Data from NYU 1973 studies at Indian Point were used to compute f_c-factors.

The Composite f-Factor

$$\text{Composite f-factor} = (f_1.f_2.f_3.f'.f.f_c)\text{day}^+$$
$$(f_1.f_2.f_3.f'.f.f_c)\text{night}$$

The composite f-factor was evaluated by Method A and Method B as described above and the results from the two methods were averaged to give the final value.

The calculations of f_2, f_3, f, f', f_c, and the composite f-factors for the larval and juvenile I stages at Roseton are shown in Tables V-26 and V-27, respectively. It should be noted,

however, that "f_w" is used in the table instead of "f". The final composite f-factors, which are input to the striped bass model, for various plants are shown in Table V-28.

Impingement Impact Factors

The impingement rates at all plants for the juvenile II and III stages used in the model runs are shown in Table V-28. The following assumptions were made in deriving these estimates:

(a) Full flow conditions.

(b) 0.1 gear efficiency factor.

(c) Impingement numbers at a given plant are directly proportional to plant flow rate.

(d) Fish impinged between May 7 and November 30 were categorized as Juvenile II - all others Juvenile III.

(iv) Results and Discussion

Impact of Impingement at Roseton on the Hudson River Striped Bass Population

The estimates of the striped bass impingement rates at Roseton as shown in Table V-28 were based on limited impingement collections during 1973. Although QLM's striped bass life cycle model is capable of predicting the impact on the striped bass population due to impingement alone at the Roseton plant, the use of the model for such measure was deemed insignificant, because the impact, if any, would be minimal and the data collected did not reflect the possible actual conditions.

TABLE V-28

ENTRAINMENT AND IMPINGEMENT FACTORS
USED IN THE STRIPED BASS MODEL

Power Plant	Entrainment Factor*			Impingement Factor**	
	f_E	f_L	f_{J1}	f_{J2}	f_{J3}
Bowline Units 1 & 2	0.16	0.05	0.41	251	1939
Cornwall	0.18	0.51	0.41	2215	2368
Indian Point Units 1, 2 & 3	0.44	0.13	0.57	331	2732
Roseton Units 1 & 2	0.16	0.10	0.22	788	572

*"Best Estimate" entrainment factors (QLM, 1974)

**A gear efficiency factor of 0.1 is applied to the number of fish impinged under full flow conditions. For Indian Point, a 25% upward adjustment is also applied to account for specimen losses during impingement collections.

Estimate of impact of the impingement of striped bass at Roseton was made in Central Hudson's 316(a) Demonstration with regard to NPDES Permit for the Roseton Generating Station, based on the 1973 Danskammer Point Generating Station impingement values. By scaling the Danskammer impingement impact values by the Roseton to Danskammer plant flow rates ratio, the estimated impingement impact under full flow conditions at the Roseton plant was between 0.02 and 0.3%. These are negligible effects, particularly in that they should not be added to similar estimates at other plants, since the basis of the estimates is the river population within the immediate Roseton area.

Impact of Entrainment and Impingement at Roseton on the Hudson River Striped Bass Population

Using the entrainment and impingement impact factors for Roseton as shown in Table V-28 along with other parameters as input, the LMS Striped Bass Life Cycle Model predicted 0.42% and 0.72% croppings, at the high and low levels of compensation, respectively, in the Hudson River striped bass year class 1 recruits with both units at Roseton running continuously at the full capacity for 10 years. The results are shown in Table V-29.

The results are of insignificant impact upon the striped bass population in the Hudson River. Also the real impact may be lower than the 0.42% or 0.72% cropping in population since this was for 10 years of maximum operation of both units at Roseton.

TABLE V-29

EFFECT OF ROSETON, CORNWALL, INDIAN POINT AND BOWLINE PLANT OPERATION ON HUDSON RIVER STRIPED BASS POPULATION

Percent Cropping in Striped Bass after Years of Operation

Year Class	After 1 Yr.	After 7 Yrs.	After 10 Yrs.
Case 1: With Roseton Units 1 & 2 only; high compensation. (FILE RS731)			
Adult 1	0.31	0.34	0.42
Total Adult	0.21	0.33	0.41
Case 2: With Roseton Units 1 & 2 only; low compensation (FILE RS732)			
Adult 1	0.44	0.52	0.72
Total Adult	0.31	0.49	0.70
Case 3: With Roseton Units 1 & 2, Bowline Units 1 & 2, and Indian Point Units 1-3; high compensation (FILE IBR731)			
Adult 1	1.49	1.63	2.03
Total Adult	1.03	1.59	1.99
Case 4: With Roseton Units 1 & 2, Bowline Units 1 & 2, and Indian Point Units 1-3; low compensation (FILE IBR732)			
Adult 1	2.66	3.07	4.23
Total Adult	1.85	2.94	4.10
Case 5: With Roseton Units 1 & 2, Cornwall, Indian Point Units 1-3, and Bowline Units 1 & 2; high compensation (FILE CIBR1)			
Adult 1	3.07	3.35	4.14
Total Adult	2.13	3.26	4.05
Case 6: With Roseton Units 1 & 2, Cornwall, Indian Point Units 1-3, and Bowline 1 & 2; low compensation (FILE CIBR2)			
Adult 1	5.86	6.74	9.18
Total Adult	4.08	6.46	8.91

This is a very conservative case, as the plant must be shut down for maintenance for some time in the 10 years, and there will be times of reduced flow for emergency repairs.

Impact of Entrainment and Impingement of Multi-Plant Operations on the Hudson River Striped Bass Population

Table V-29 also lists the results of model predictions of the multi-plant operations on the Hudson River. The Lovett and Danskammer plants were not included in the multi-plant model runs because these two plants have been operating on the Hudson for a considerable number of years and their impact, if any, would be minimal and would have been reflected as part of the background information in the 1973 data upon which the impact estimates were based.

As shown in Table V-29, the model predicted that there would be a 9.18% cropping in the striped bass adult 1 population if all the plants on the Hudson River operate at full capacity continuously for 10 years. This is a conservative estimate, because of the unlikelihood that these plants will be operating at full capacity simultaneously for 10 years. It is also probable that the plant load in the latter years of life of the plants will decrease, permitting operation at lower flows and thereby reduce their impact on fish population.

In interpreting the results of the model predictions presented above, it is important to consider the predicted impacts in perspective and to recognize some of the limitations of the

computer model. The cropping percentages predicted by the model are developed under the assumption of unchanging environmental conditions and as a consequent natural, year-to-year fluctuations in the striped bass population are not included in the model. The cropping percentages predicted by the model may be interpreted as reductions in the mean population over a number of years.

It is also important to recognize that fisheries data indicate that natural fluctuations in the striped bass population may be much larger than the model predictions of cropping which will result from power plant activity on the Hudson.

Every application to date of any of the various models of power plant impact on Hudson River striped bass population assumes that population reduction will occur; the only question raised has been: how much? Indeed, all of these models are structured so that plant operation can only reduce population - no mechanism is included to provide for the possibility of an increase. Such a limitation, coupled with the presumption that population reduction is an adverse impact, automatically biases the impact of any plant as negative, as far as the environment is concerned. As a result, the evaluation of predicted populations cropping often is simply reduced to the question: does the numerical cropping prediction represent a significant impact?

On an "a priori" basis, both of these presumptions are without support. The possibility of a net population increase exists. Consider an increase in growth and reproduction rates, due to slightly elevated river temperatures in the presence of thermal plant residual heat, sufficient to offset cropping via entrainment and impingement.

When the complex nature of the interactions of all of man's activity with Hudson River ecology is contemplated, it is difficult to conclude, on the basis of modelling only one aspect of this activity, that population reduction will occur, or, if it occurs, that such is adverse. Some of the potential interactions one might consider include the regulation of up-river storage, its relation to prior generation, water supply and lower river freshwater flow. Couple this with water supply needs for the future, freshwater flow impact on location of the salt front, the impact of salt front location on anadromous fish spawning activity, the potential double use of water for once-through cooling followed by water supply, and a changing thermal picture due to increased urbanization in the Hudson River Valley and one obtains a multiplicity of alternative scenarios, in which the net role the power plant plays with respect to the environment itself may well be positive.

Model runs presented herein assume that eggs, larvae, and early juveniles are susceptible to entrainment through the sixtieth day of life. Preliminary evaluation of plant entrainment data,

however, seems to show significantly lower relative proportions of older larvae and early juveniles in both intakes and discharges, i.e., as age increase, appearance in the plant decreases. Such behavior is presumably due to shoalward migration and residence, and net and screen avoidance. Evaluation of this question is continuing; the possibility exists that the period of full entrain ment susceptibility may be shorter than the 60 day period currently employed. A shorter entrainment period will reduce cropping percentage.

Evaluation of 1973 and 1974 beach seine and trawl data is continuing, to obtain better insight to the migration mechanism. If, for example, significant percentages of the later larvae and early juvenile striped bass populations are truly resident in Hudson River shallows, then the exposure to plant withdrawal would be substantially reduced. Furthermore, more information on the apparent large scale migration to Haverstraw Bay and Tappan Zee is needed, including the time of the year it occurs, the length of time it takes, proportion of the total population so migrating, and the actual manner in which the fish migrate; i.e., on any phase of the tide or on ebb only, at any point in the cross-section, or in the channel bottom only, etc. We expect to develop at least some of this information by continued evaluation of existing data.

E. CONCLUSIONS

Fish larvae collection efforts were conducted from March 13 through August 1973 in the Roseton/Danskammer Point vicinity of the Hudson River and at the intake and discharge structure of the Roseton and Danskammer Point Generating Stations to determine abundance, distribution and composition of fish larvae populations. Similar studies were also conducted in 1971 and 1972. These data will serve as baseline information for eventual comparison with data collected after initiation of commercial operation of the Roseton Generating Station. The results of the 1971, 1972 and 1973 studies indicate the following:

1. Larvae were present in the study area in 1973 prior to the initiation of sampling in mid-March and persisted through early August. Two peaks of larval abundance were noted; one during mid-March, and a second during the first week of June. Few larvae were collected during April or after mid-July.

2. The peak larval abundance in March was due almost exclusively to Atlantic tomcod. Smaller numbers of tomcod larvae were collected in April, indicating either migration from the study area or avoidance of sampling gear.

3. Periods of larval abundance were similar in 1972 and 1973.

4. A general trend over time from greater larval abundance in surface waters to more larvae in bottom samples was observed.

5. Peak concentration of striped bass larvae occurred on June 7-8, 1973, accounting for 42% of total larvae concentrations. Average concentrations two weeks prior and subsequent to this date were less than 10% of the June 7-8 average concentration. Length data indicated that larvae collected on June 7-8 had been hatched 2 to 5 days previously.

6. Day-night comparisons showed that 94% of striped bass larvae collected were found in samples collected at night. Greatest concentrations of larvae occurred at mid-depth stations compared to other depths.

7. Peak abundance of white perch larvae occurred on June 19-20, approximately two weeks after peak abundance of striped bass larvae. Peak abundance in 1972 was approximately four times the peak abundance in 1973.

8. There was no significant difference in white perch larvae concentrations between sampling transects.

9. White perch larvae length data suggests that some larvae in the Roseton/Danskammer Point vicinity were hatched and existed with larvae that had hatched several weeks earlier within the area or at a different spawning site.

10. *Alosa* (blueback herring, alewife and American shad) larvae were collected between May 3 and August 15. Peak concentrations were found during the May 22-23 collection. Eastern transects exhibited an overall greater abundance throughout the study period;

however, this distribution was not statistically significant. The area north and adjacent to the eastern transects is very shallow with large amounts of rooted aquatic plants and provides an excellent area for spawning and early development of *Alosa* larvae.

11. Depth distribution of *Alosa* larvae suggests that larvae prefer the upper water levels after hatching, gradually assuming a more demersal existence with maturity. A diurnal pattern was also observed in the older larvae, preferring the deeper waters during the daylight hours and moving to the surface waters at night.

12. Significant differences in abundance for day and night larvae collections at surface, mid-depth and bottom were found (striped bass larvae night collections at RDECH and white perch larvae night collections at RDE). In both instances surface samples had significantly fewer larvae of these species than mid-depth or bottom samples.

13. Diurnal migration was apparent only in mid-depth night collections of *Alosa* spp. at RDE where night collections had significantly higher concentrations than day collections.

14. Samples collected at the Danskammer Point plant on May 22-23 indicated a large abundance of larvae in the study area; this early large abundance declined during the first weeks of June and then increased to a seond peak on June 19-20. Few larvae were collected during late July and August. A significantly greater number of larvae

were collected at night compared to day for the one meter bottom intake net. All other combinations of intake nets showed no significant differences. Larval concentrations in the Danskammer Point intake canal did not appear to be different than either average river concentrations or concentrations near the western shore transects.

15. Except for a peak in *Alosa* spp. that occurred on June 19-20, average larval abundance in the Roseton intake was similar to average river larval concentrations and to concentrations in the Danskammer Point intake. In general, larval lengths were similar to those collected in the river and at Danskammer Point; suggesting non-selective entrainment.

16. Larval mortalities at the Danskammer Point intake ranged from 37 to 88%; at the discharge mortalities ranged from 83 to 100%. The high mortalities recorded at the intake, prior to passage through the plant indicates the likelihood of the collection technique itself causing a high larval mortality.

17. Larval mortality at the Roseton intake ranged from 41 to 100%; and at the discharge from 83 to 100%. These data again suggest a high mortality associated with the collection techniques.

18. In most cases, no significant difference in total larval abundance was found for 1 meter and 1/2 meter diameter larvae nets in the river.

19. The surface one meter net at the Danskammer Point intake appears to collect significantly more total larvae than the one-half meter net. Significantly more white perch were collected by the one meter bottom net than by the one-half meter bottom net.

20. Three mathematical models have been developed to predict power plant effects on Hudson River striped bass: the Clark, Goodyear, and QL&M models. Of these, the QL&M model, which utilizes a data feedback loop incorporating plant effects on spawning populations, yielded lowest values, which the AEC determined were also most realistic.

21. A conservative cropping estimate, which may be interpreted as a reduction in mean population, of less than 10% was predicted by the QL&M model for striped bass with all Hudson River plants operating at full capacity continuously for 10 years. This estimate does not take into account natural or plant-induced factors which may cause striped bass populations to increase.

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CENTRAL HUDSON GAS & ELECTRIC CORPORATION

1973

HUDSON RIVER AQUATIC ECOLOGY STUDIES AT ROSETON AND DANSKAMMER POINT

VOLUME I

NATURE AND SUMMARY OF THE STUDIES

CHAPTERS I AND 2

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April 18, 1975
File: 176-33,34

Mr. Charles E. Rider,
Vice President
CENTRAL HUDSON GAS & ELECTRIC CORPORATION
284 South Avenue,
Poughkeepsie, New York 12602

Dear Mr. Rider,

Re: 1973 Hudson River Aquatic Ecology Studies
Conducted in the Vicinity of the
Roseton and Danskammer Point Generating Stations

In accordance with contractual authorization from Central Hudson Gas & Electric Corporation we herewith submit our report on the aquatic ecology studies carried out in the vicinity of the Roseton and Danskammer Point Generating Stations in 1973.

The studies described in the report consist of investigations of physico-chemical parameters of the Hudson River, background biological conditions, and power plant river biota interactions.

The report itself consists of six (6) volumes made up of four (4) volumes of narrative text and two (2) volumes of appendices containing detailed data obtained in 1973.

Dr. Robert T. Keegan served as Project Manager for these studies. Mr. Thomas Gustainis, Project Biologist and Mr. Thomas P. Fox, Project Engineer, were responsible for the biological and engineering phases of these studies, respectively. The report was finalized under the direction of Mr. Karim A. Abood, Mr. Edward Maikish and Dr. M. Hank Baslow who served as Project Manager, Engineer and Biologist starting in 1974.

The 1973 program was carried out, and the report was written prior to October 31, 1974 by Quirk, Lawler & Matusky Engineers. Since that date, at which time Thomas P. Quirk withdrew as a partner in the firm, the successor firm of Lawler, Matusky & Skelly has continued and completed the project. The firm name change is reflected on the covers of the report.

Very truly yours,

Karim A. Abood

Karim A. Abood, P.E.
Partner

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME I

TABLE OF CONTENTS

Chapter		Page
	SUMMARY OF FINDINGS AND CONCLUSIONS	
	CHAPTER I	
I.	INTRODUCTION	
	A. Events Leading to the Report..	I-1
	B. Present Environmental Legislation..	6
	C. Description of Study Area	8
	D. Nature of the Studies	10
	1. Time Coverage...	11
	2. Space Coverage..	13
	(a) River-Wide.	13
	(b) Roseton/Danskammer Point..	15
	(c) The Mid-Atlantic Region...	16
	3. Systems Parameters and Analysis	18
	(a) Plankton...	18
	(b) Benthos	22
	(c) Fish Eggs and Larvae.	24
	(d) Fish..	27
	(e) Hydrodynamic Characteristics...	29
	(f) Water Quality...	29
	CHAPTER II	
II.	LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THEIR RELATIONSHIP TO FAR-FIELD CONDITIONS	
	A. Introduction...	II-1
	B. Summary of Study Findings	5
	1. Primary Producers (Phytoplankton)...	5
	2. Zooplankton	12
	3. Benthos	16
	4. Fish..	20
	C. Biotic Support Functions of the Hudson River	29
	1. Support of Periodic Species	29
	2. Migratory Route and Spawning Area...	36
	References Cited	54

LIST OF FIGURES

VOLUME I

LIST OF FIGURES

Figure	CHAPTER I	Preceding Page No.
I-1	1973 Aquatic Ecology Study Area	I-1

SUMMARY OF FINDINGS AND CONCLUSIONS

Studies of the abundance and distribution of fish, plankton and benthos in the Hudson River were conducted during 1973 in the vicinity of the Roseton ard Danskammer Point Generating Station. These studies were a continuation and expansion of similar studies conducted in 1971 and 1972. A summary of the major findings and conclusions of these studies is presented below. A more detailed discussion is presented in Chapters I through VII.

The results of these studies indicate that the ecology of the area did not differ in most ways from that previously described in 1971 and 1972. Although there were some changes in specific abundance of particular organisms and changes in some physical and chemical water quality parameters. However, it is felt that these qualitative and quantitative differences are in fact due for the most part to natural fluctuations expected to occur in any complex environment and are not due to any large degree to power plant impact on the near field ecology.

PHYTOPLANKTON

Seasonal patterns of phytoplankton abundance and species composition were observed. Blue-green algae were found above nuisance levels of abundance (5×10^5 cells/liter) most of the time during the fall. Although both species composition and algal abundance indicated limited eutrophic environmental conditions, healthy phytoplankton production levels provided a solid base for the consumers (including zooplankton, fish larvae and fish) of the aquatic food web.

Monthly samples appeared to be adequate for determination of seasonal trends in abundance.

MICROZOOPLANKTON

Copepods were numerically the most important microzooplankton group in the Roseton/Danskammer Point area; cladocerans were the second most abundant group and rotifers were third in abundance. The seasonal patterns of microzooplankton abundance paralleled the seasonal patterns of diatom abundance and were inversely related to the seasonal temperature pattern. Microzooplankton abundance was dependent primarily upon phytoplankton abundance; microzooplankton grazing influenced phytoplankton abundance.

Microzooplankters were a food source for macrozooplankton and fish larvae, and it is possible that the feeding of these predators may have significantly reduced microzooplankton numbers during mid-summer, causing a depression of microzooplankton abundance. With the exception of temperature, which undoubtedly controlled the timing of the annual cycle of microzooplankton abundance, no chemical or physical factors appeared to be correlated with microzooplankton abundance or distribution.

Total microzooplankton and rotifer abundance, as measured with a 76μ Wisconsin type plankton net, decreased as the depth of water increased. Microzooplankton standing stocks were homogeneously distributed among the four sampling stations in the Roseton/Danskammer Point area.

MACROZOOPLANKTON

Amphipods (Gammarus sp.) and dipterans were similar in abundance, and the most abundant macrozooplankters in the Roseton/Danskammer Point area during 1973. At least one peak of macrozooplankton abundance (in the early summer) occurs in the annual cycle of macrozooplankton abundance.

Macrozooplankters in the Roseton/Danskammer Point area appear to be an important link between the plankton community and planktivorous fishes, and may serve to cycle nutrients between the benthic and plankton communities.

BENTHOS

The benthic community in the Roseton/Danskammer Point vicinity during 1973 consisted of a large variety of organisms within the following categories:

(a) oligochaetes
(b) molluscs
(c) insects
(d) crustaceans
(e) others

The community was dominated throughout most of the year by oligochaete worms.

The overall abundance of benthic organisms increased from the spring through the fall of 1973. Similar increases in abundance were observed in the same location for the years 1971 and 1972. The diversity of the benthic community increased from the spring to the fall during the years 1971, 1972 and 1973. A significant decrease in diversity was noted in all years between fall and winter samples. A longitudinal gradient in species diversity was noted during 1973, and species diversity increased from the North Control transect to the South Control transect. No gradient in species diversity was noted with depth.

Abundance of dipterans and molluscs was found to vary significantly by season with variation in the numbers of dipterans perhaps attributable to the aquatic-terrestrial life cycle characteristics of the dipterans. Seasonal variation in abundance and biomass of the dominant groups composing the benthos were attributed to life history phenomena and to predation by fishes upon the benthos.

Fish support potential of benthos in terms of available biomass varies significantly with season. The greatest fish support potential occurred during the fall in the years 1972 and 1973. Fish support potential in the vicinity of the study area was found to be the lowest of three sites studied in the Hudson River; Kingston (mile point 95), Roseton/Danskammer Point (mile point 66), and Haverstraw Bay (mile point 38).

Species inventory and population abundance characteristics, as well as physico-chemical water characteristics indicates that this sector of the Hudson River is in the transition zone where significant variations in salinity occur on an annual basis. The biological characteristics of the Hudson River identify the area as being within the "species impoverished zone" generally found in estuaries where saline environments exist for only a portion of the year.

Estuarine benthos characteristics of the "species impoverished zone" generally demonstrate a capacity for resistance to environmental impact and resiliency to the effects of predation, environmental stress, population decimation and habitat destruction. The background stress associated with the variable saline environment at Roseton/Danskammer Point may be related to a benthic community capable of withstanding significant environmental impact without harm.

FISH LARVAE

Larvae were present in the study area in 1973 prior to the initiation of sampling in mid-March and persisted through early August. Two peaks of larval abundance were noted: one during mid-March, and a second during the first week of June. Few larvae were collected during April or after mid-July. Periods of larval abundance were similar in 1972 and 1973. Although not statistically significant, higher concentrations of larvae were generally found on the east side of the river.

The peak larval abundance in March was due almost exclusively to Atlantic tomcod. Smaller numbers of tomcod larvae were collected in April, indicating either migration from the study area or avoidance of sampling gear.

Peak concentration of striped bass larvae occurred on June 7-8, 1973. However, there were no significant differences in abundance across the river, at the statistical level of confidence used, even though higher concentrations were found at the western transect. Day-night comparisons showed that most of striped bass larvae collected were found in samples collected at night, suggesting a diurnal vertical migration.

Peak abundance of white perch larvae occurred on June 19-20, approximately two weeks after peak abundance of striped bass larvae. Peak abundance in 1972 was approximately four times the peak abundance in 1973. There was no significant difference in white perch larvae concentrations between sampling transects. White perch larvae length data suggests that some larvae in the Roseton/Danskammer Point vicinity were hatched and existed with larvae that had hatched several weeks early within the area or at a difference spawning site.

Alosa spp. (blueback herring, alewife and American shad) larvae were collected between May 3 and August 15. Peak concentrations were found during the May 22-23 collection. Eastern transects exhibited an overall greater abundance throughout the study period, however, this distribution was not statistically significant. Depth distribution of Alosa spp. larvae suggests that larvae preferred the upper water levels after hatching, gradually assuming a more demersal existence with maturity. A diurnal pattern was also observed in the older larvae, which preferred the deeper waters during the daylight hours and moved to the surface waters at night.

Significant differences in abundance for day and night larvae collections at surface, mid-depth and bottom were found for striped bass larvae in night collections at RDECH and white perch larvae in night collections at RDE. In both instances surface samples had significantly fewer larvae of these species than mid-depth or bottom samples. Diurnal migration was apparent only in mid-depth night collections of Alosa spp. at RDE where night collections had significantly higher concentrations than day collections.

No significant difference in total larval abundance was found for 1 meter and 1/2 meter diameter larvae nets. However by species, a significantly greater abundance of white perch and Alosa spp. was found when collected by the 1 meter net than by the 1/2 meter net. No significant difference was noted for striped bass.

FISH

A total of 32,516 fish representing 39 species were collected in the Roseton/Danskammer Point vicinity during the three year period 1971-1973.

Trawls were the most effective method of collection; bottom trawls generally caught more fish than surface trawls. Two species, blueback herring and white perch, composed 53.6% (17,443 individuals) of the total.

Blueback herring were the most abundant species in 1973, constituting 31.2% of the total; the majority were young-of-the-year fish collected by seines from the shore area or in surface trawls; surface trawl collections also peaked during this time period.

White perch are the dominant resident species in the Roseton/Danskammer Point area and composed 28% of the total catch in each year. Those collected were mainly young-of-the-year and were most abundant in the early fall; as a result, bottom trawl collections were also greatest during this time period.

The nearshore community was composed of spottail shiners, juvenile striped bass, pumpkinseed, sunfish and juvenile herring. Atlantic tomcod, brown bullheads, hogchokers and white perch were the dominant members of the offshore deep water fish community. The collection of marine species such as the white mullet and crevalle jack is associated with salt front intrusion into the study area during periods of low flow.

Due to the presence of adults of migratory species and the low number of year old resident species collected, the average biomass per fish was greatest in the spring and declined during the summer as the community became dominated by young-of-the-year fish. A slight increase in average biomass occurred in the fall-winter period as juveniles grew or migrated to other nursery areas, leaving the more stable over-wintering populations.

Results of trawl and seine collections during different tidal phases indicated that:

(a) Seines collected similar numbers of fish and species, regardless of the tidal stage.

(b) Of the prevalent species in the seine hauls, only the spottail shiner exhibited a significant difference in abundance between ebb and flood catches. More spottail shiners were collected by seine after ebb tide than after flood tide.

(c) Comparison of trawls for ebb-flood differences showed that:

1. At the same station bottom trawls collected significantly more individuals and species than surface trawls on both tidal stages.
2. All ebb bottom trawls and all flood bottom trawls show no significant difference in numbers of fish or species caught.
3. Significantly more fish and more species were caught by ebb surface trawls than by flood surface trawls.

Evaluation of differences in day and night collections by trawl and seine showed that:

(a) The number of fish caught by seines did not differ between day and night and,except for December, the number of species caught was also similar for both day and night collection. In December more species were caught at night than during the day.

(b) Except for collections in July there were no day-night differences between the numbers of fish or species caught by trawl. In July significantly more fish and more species were collected by trawls during the day than at night.

(c) Day-night differences in community structure based on diversity index values showed that:

1. Except for July and December, there were no significant day-night differences in diversity for pooled seine and trawl collections. July day collections had a significantly higher mean diversity than night collections. December night collections had a significantly higher mean diversity than day collections.
2. For all months except November the mean monthly diversity index based on seine collections was similar for day and night collections. In November day collections had a significantly higher mean diversity than night collections.
3. Similar diversity was exhibited in all months except December for day and night trawl collections. Night trawl collections in December were significantly more diverse than daylight trawl collections.

(d) Trawl station diversity values were tested for differences between day and night collections and showed that stations sampled in June had significantly higher daylight diversity values and those in December had higher diversity values for night collections.

(e) Tests to determine whether there was any significant difference between day and night collections by either trawl or seine for the prevalent species showed that significantly more white perch and spottail shiner were collected by day trawls than by night trawls. This was also true for seine collections of spottail shiner.

Community numerical abundance and biomass structure was evaluated for each month using an index of similarity.

(a) Based on numbers and species of fish collected, the community structure was similar during July and August, and during the winter-spring period. During the summer months the community was dominated by juvenile white perch and blueback herring.

(b) June through October were the most similar months based on community biomass structure due in large part to the high numbers of young-of-the-year fish dominating these collections.

(c) The abundance of young-of-the-year fish of several species result in high monthly affinity values for numbers and biomass during the summer-fall period when seines and trawls were compared separately.

Diversity index values for number of organisms and the biomass of the individuals from each seine and surface and bottom trawl collection showed that:

(a) Diversity of seine collections was greatest during the summer months and gradually declined in the later part of the year.

(b) The greatest bottom trawl diversity was found during the fall. Bottom trawl diversity was generally greater than surface trawl diversity which was consistently low throughout the year.

(c) Biomass diversity was much higher for seines than for trawls, indicating a broader distribution of weight among the nearshore species.

Comparisons of species numbers, diversity index and numbers of organisms collected on the various tidal cycles and for the two time periods day and night, at each station showed a great deal of variation in all areas sampled with each station exhibiting faunal assemblages and migratory activity different from the other stations.

Length distribution for striped bass indicated that young-of-the-year, first collected in July, averaged 4 cm. in length. In early fall, at the end of the growing season, a length of approximately 9 cm. was attained. Length data for white perch collected during the spring indicated the presence of adult fish. The first young-of-the-year fish were collected in July and averaged 3 cm. in length. An average length of 8 cm. was reached at the end of the growing season. White perch growth rates were similar in 1971 and 1973 and somewhat lower in 1972.

Analysis of scales to determine age and growth rates showed that the body length corresponding to scale formation in the striped bass was 14.4 mm, with the first annulus formed around the end of June or early July of the following year. Comparison of Hudson River striped bass with those in other estuaries indicates that the Hudson River population had lower growth rates, especially those from the Roseton area.

For white perch from Haverstraw Bay and Roseton/Danskammer Point, body length corresponding to scale formation was 25.3 mm. Female white perch attained greater length during each year than males and for both sexes the greatest growth was in the younger age groups. Hudson River white perch do not appear to reach the same length nor grow as fast as those from other areas suggesting

overcrowding of the population. Based on the coefficient of maturity, spawning of white perch in the Roseton/Danskammer Point area was estimated to occur during June.

Stomach content analysis of fish collected during the spring and fall to determine feeding preference of selected species showed that amphipods were the primary food item for white perch in both seasons with the smaller fish also feeding on dipterans in the spring. Brown bullheads exhibited a more varied dietary pattern with the larger fish feeding on blueback herring young in the spring and switching to amphipods and dipterans in the fall. The smaller bullheads fed on dipterans and amphipods in the spring. Pumpkinseeds feed on dipterans, gastropods and amphipods in both seasons with preference depending on size group of fish. Striped bass of the size examined preferred other fish during both seasons.

WATER QUALITY

On the basis of studies conducted on the Hudson River between 1967 and 1973, there appear to be at least four patterns of yearly mean concentration for water quality parameters. These are:

(a) concentrations not affected by location (NO_3, Fe, Mn, Hg).

(b) concentration increases with increasing proximity to New York City (Ca, K, Na, Mg, Cl, SO_4, TDS, i.e., parameters indicating degree of salt intrusion).

(c) concentration increases with increasing proximity to Albany and to New York City (CO_2, F, MBAS, orthophosphate, total phosphorus, NH_3, NO_2, TKN, COD, i.e., parameters which generally reflect municipal pollution).

(d) concentrations reaching a maximum or minimum at a point between New York City and Albany (Cu and Pb, maximum at about mile point 25; suspended solids, maximum between mile points 70 and 80; Si, minimum between mile points 70 and 100).

The water quality in the study area (mile points 62 to 68) in 1973 was very similar to that expected from review of previous studies. Except for relatively low BOD and NH_3 and relatively high Phenol and suspended solids values, the water quality of the study area in 1973 was not significantly different from that at both mile points 77 and 96 during this year. Several other parameters were relatively high or low compared to one or the other study area, but not to both areas simultaneously.

NH_3 was different in 1973 than the 1967-1970 average for a river segment from MP 60 to MP 71 in that the average value was approximately an order of magnitude less than previous values reported (0.02 mg/l vs. 0.2 mg/l). However, on occasion, levels approaching previously reported levels were found.

Phenol was apparently higher than in previous years (0.03 mg/l vs. 0.01 mg/l) but values for phenol were highly variable, and insufficient data are available from previous studies to permit making definitive statements. Phenol was the only parameter measured with a mean value exceeding existing or proposed water quality standards or criteria; in particular, the mean value of 0.03 mg/l exceeds the standard of 0.001 mg/l established for drinking water.

The major cause of variation in water quality in 1973 was salt intrusion. Based on freshwater flow at Green Island and on Cl and specific conductivity data at various points in the river in 1973, it is estimated that significant salt intrusion occurred approximately 10 to 15 percent of the time at mile point 62 and approximately 5 percent of the time at mile point 68. This intrusion, which occurred mainly during October, was measured during a survey on October 24, 1973 in the study area and caused obvious peaks in concentrations of Cl, TDS, SO_4, TS, total hardness and possibly TVS.

Temperature and dissolved oxygen values exhibited expected annual patterns, with dissolved oxygen decreases reflecting temperature increases. On a monthly average basis percent saturation values varied from about 50 to 70 percent in the July through October period to about 80 to 90 percent during remaining periods.

Several parameters were highly variable, namely NH_3, TSS, Cl, phenol, Zn, and Cr. NH_3 and Cl variations were relatively smooth in response to natural hydrodynamic and biochemical phenomena. TSS, Zn and Cr had relatively low values during the September to November period followed by relatively high values but generally appeared to vary randomly. Phenol values varied within the study area in a manner suggesting a possible input from Wappinger Creek.

The mile point 37-42 area was relatively higher than all other 1973 study areas with respect to TKN, NH_3 and NO_3. Cr values decreased with increasing distance upstream. NH_3 values were lowest at the study area and higher both upstream and downstream. Concentrations in the mile point 37-42 area were quite higher than other 1973 study areas with respect to components directly reflecting salt intrusion, e.g. TS, TDS, TVS, SO_4 and Cl.

Statistical correlations indicated that during salt intrusion there were increases in BOD, COD, temperature and TVS and a slight decrease in pH. Statistical correlations also indicated that the bottom sediment, when slightly disturbed, contributed to relatively high values of COD, BOD, TP and TKN compared to normal values for the river.

A statistically significant negative correlation between pH and SO_4 was attributable to freshwater phenomenon. It appears that sulfate variations in the study area during freshwater conditions may cause relatively minor pH variations.

Analysis of variance techniques did not indicate any important station effects (i.e., significant differences in parameter values attributable to station differences) based on the entire data record. Interaction effects involving stations were largely attributable to slight disturbance of bottom sediments during collecting of four samples. There was a depth effect for dissolved oxygen which indicated that a mean dissolved oxygen value for surface samples 0.4 mg/l higher than that for bottom samples was significant. Effects on different dates were evident for most parameters, except for some of those associated with disturbance of sediment during sampling and for Zn and Cr. Variations in Zn and Cr appeared to be random in nature.

At all depths and at all transects western sediments are generally higher in organic content and usually lower in silt content than eastern sediments. Sand, silt and clay fractions are similar for all depths for total samples; there is little difference between eastern and western sediments attributable to depth of station, except at the 10-foot depths where eastern sediments are comparatively high in silt and low in sand content.

North Control and South Control transects have the most extreme differences in sediment composition. North Control transect sediments are relatively high in silt and clay content and relatively low in sand and organic content (except western stations, which were high in organic content). South Control transect stations were relatively low in silt and clay content and high in sand and organic content. The relatively high organic content of western sediments may be correlated with relatively large particle sizes, since these sediments are generally higher in sand and lower in silt content than eastern sediments.

MODEL STUDIES

Three mathematical models have been developed to predict power plant effects on Hudson River striped bass: the Clark, Goodyear, and QL&M models. Of these, the QL&M model, which the AEC Appeal Board determined "more nearly conforms to reality....", utilizes a data feedback loop incorporating plant effects on spawning populations and yielded lowest impact values. A conservative cropping estimate, which may be interpreted as a reduction in mean population of less than 10% was predicted by the QL&M model for striped bass with all existing and planned Hudson River plants operating at full capacity continuously for 10 years. For the Roseton plant alone, this value is less than 0.7%. These estimates do not take into account natural or plant-induced factors which may cause striped bass populations to increase.

I. INTRODUCTION

A. EVENTS LEADING TO THE REPORT

Central Hudson Gas & Electric Corporation (CHGE) owns and operates a four unit fossil-fueled power plant, the Danskammer Point Generating Station, adjacent to the Hudson River near Newburgh, New York. The plant is rated at 511 MWe and uses water from the Hudson River in a once-through cooling system.

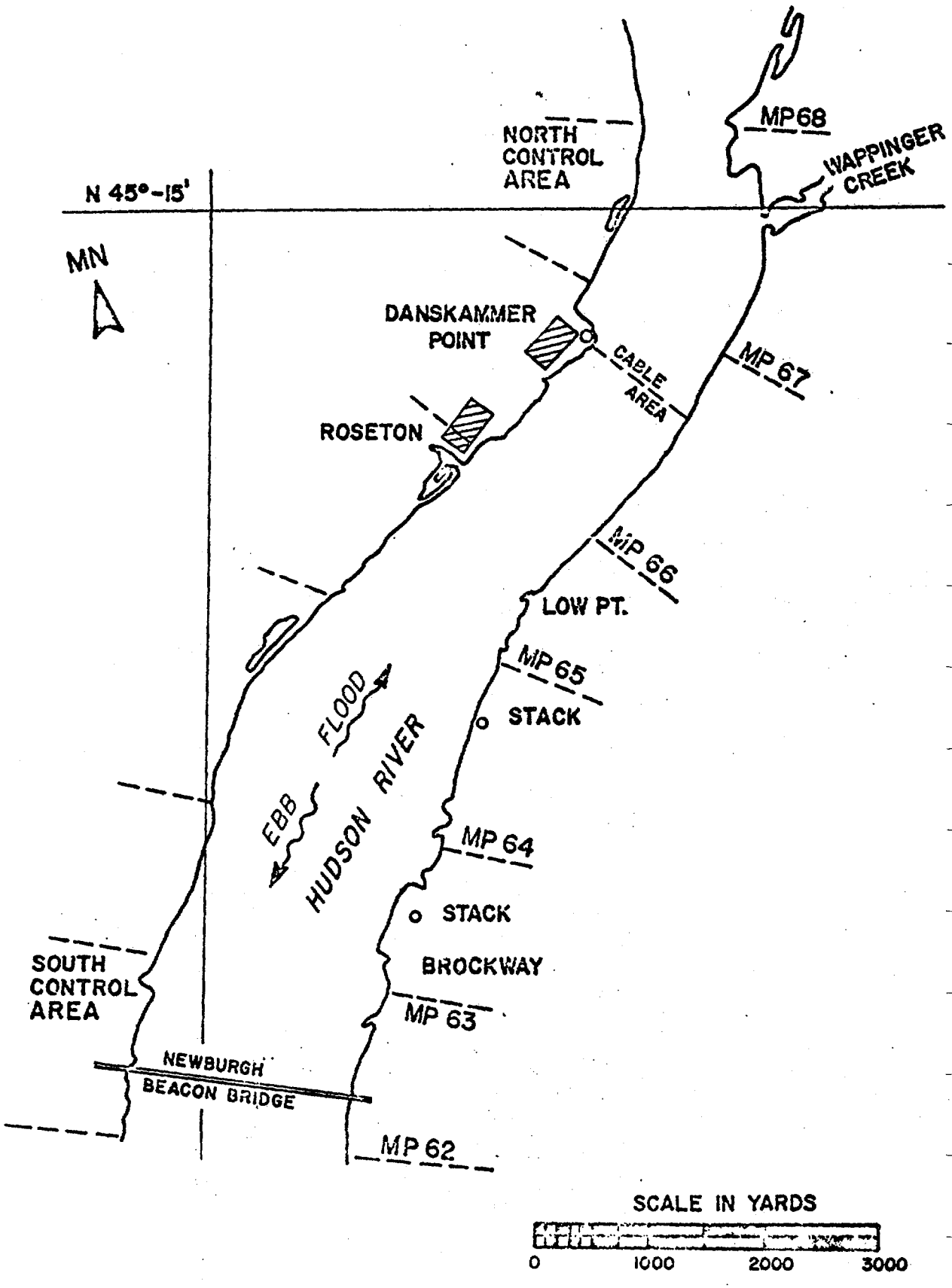
In 1965, Central Hudson publicly announced plans to construct a 1200 MW fossil-fueled plant, the Roseton Generating Station, adjacent to the Hudson River, approximately 1/2 mile south of the Danskammer Point plant. The Roseton plant was to be operated by Central Hudson and jointly owned by Central Hudson, Consolidated Edison Company of New York, Inc. and Niagara Mohawk Power Corporation. A once-through cooling water system was to be used to cool spent steam prior to return to the boiler.

The location of these plants is shown in Figure I-1. The Roseton/Danskammer Point vicinity of the Hudson River is located approximately 66 river miles north of the Battery, New York.

The New York State Department of Health (succeeded by the Department of Environmental Conservation (NYSDEC)) by virtue of New York State Law was empowered to review and issue permits to construct and operate facilities

CENTRAL HUDSON GAS & ELECTRIC CORPORATION
ROSETON/DANSKAMMER POINT GENERATING STATIONS

1973 AQUATIC ECOLOGY STUDY AREA



which discharge wastes into the waters of the State. In reviewing applications for permits to discharge heated liquids, the State Department of Health (prior to formation of the NYSDEC) engaged the State Department of Conservation as a consultant.

The State Department of Health restricted permission to discharge wastes to situations where said discharges would not impair the best usage of the receiving waters, or any other State waters into which the receiving waters might flow.

New thermal discharges were evaluated in accordance with the guidelines and provisions set forth in "Criteria Governing Thermal Discharges (Heated Liquids)" adopted by the New York State Water Resources Commission (NYSWRC) on July 25, 1969.

For estuaries these criteria state the following:

> *"The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point provided further, at least 50 percent of the cross-sectional area and/or volume of the flow of the estuary including a minimum of 1/3 of the surface as measured from water edge to water edge at any state of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or a maximum of 83°F, whichever is less. However, during July through September, if the water temperature at the surface of an estuary before the addition of heat of artificial origin, is more than 83°F an increase in temperature not to exceed 1.5°F at any point of the estuarine passageway as delineated above, may be permitted."*

In April 1969 a meeting was held between Health Department staff personnel and Central Hudson Gas & Electric Corporation to discuss procedures to be followed for the evaluation of the effect of the Roseton thermal discharge prior to formal submission of an application for a permit to construct the once-through cooling water system of the Roseton plant.

At this meeting the State Department of Health requested that Central Hudson present the following:

1. A prediction of the maximum temperature expected to occur at Roseton and the size of the heated zone.
2. Separate evaluation of the Danskammer Point plant thermal effects.
3. A prediction of the mixing characteristics in the area.
4. A listing prepared from existing records of striped bass, white perch and "other" species for the reach of river under study.
5. A tabulation of bottom organisms in the vicinity of the existing Danskammer Point discharge and the proposed Roseton discharge for spring, summer and fall conditions.

As a result of this meeting a program of temperature and bottom organism surveys in the vicinity of the Danskammer Point plant and the Roseton plant was then instituted. The results of these surveys and a proposal for an ecological study of the area were presented to the State Department of Health in August 1969. The State Department of Health accepted this program and requested additional temperature surveys in the vicinity of Danskammer Point to verify mathematical models of temperature distri-

bution and to be used in predicting the temperature effect of the Roseton plant cooling water discharge on Hudson River temperature distribution.

The results of these studies are included in the report: "Effect of Roseton Plant Cooling Water Discharge on Hudson River Temperature Distribution and Ecology", prepared jointly by Quirk, Lawler & Matusky Engineers and Oceanographic Analysts, Inc., December 1969. The report was submitted to the NYSDEC on May 11, 1970 in conjunction with a permit application to construct and operate a thermal discharge diffuser system at the Roseton Plant.

A permit to construct the thermal discharge diffuser system was issued by the NYSDEC on April 16, 1971. Between the date of application and the date of issuance of the permit a series of correspondence and conferences between NYSDEC personnel and Central Hudson and its aquatic consultants resulted in the following commitments:

1. A hydraulic model of the area will be constructed and used to determine the thermal patterns resulting from the Danskammer Point and Roseton cooling water discharges. The construction and operating permit for the Roseton cooling water discharge will be issued without completion of model results. However, if model results show possible adverse conditions, Central Hudson will alter the Danskammer Point discharge prior to or concurrent with the startup of the second unit at Roseton.

2. Preoperational and postoperational biological studies in this area will be conducted and used to determine the effect of the thermal discharges on the aquatic ecosystem.

The hydraulic model was constructed and temperature measurements for various operating conditions were recorded. The hydraulic model was used in conjunction with a previously developed mathematical model to assist in evaluating the cumulative temperature effects from the Roseton and Danskammer Point discharges.

The report was submitted to NYSDEC on May 17, 1972. A detailed analysis of the hydraulic model results was submitted to NYSDEC on September 18, 1972.

On November 22, 1972 a temporary permit was issued by NYSDEC to operate and discharge from the thermal discharge diffuser system at the Roseton plant. Issuance of a permanent permit to operate was made contingent upon:

(a) continued preoperational and postoperational ecological study programs, and

(b) submission to NYSDEC of an engineering report, including hydraulic model verification, and plans and specifications for a sub-aqueous thermal discharge diffuser system at the Danskammer Point plant should the results of the ecological studies show that such a system is necessary.

The schedule set forth in the temporary permit for compliance with these conditions has subsequently been modified by the NYSDEC. The Roseton plant was originally scheduled to be in commercial operation by mid-1972. Unforeseen delays in completion of construction of the plant have resulted in commercial operation being rescheduled for September 1, 1974 for Unit 2 and November 1, 1974 for Unit 1. Since the post-operational studies to be conducted were contingent upon simultaneous operation of both the Roseton and Danskammer Point plants, an extension of the compliance schedule was necessary.

The results of the aquatic ecology studies conducted in 1971 and 1972 were presented in the report: "Roseton/Danskammer Point Generating Stations, Aquatic Ecology Studies, 1971-1972," prepared by Quirk, Lawler & Matusky Engineers, October 1973. Presented herein are the results of Hudson River aquatic ecology studies conducted in 1973 in the vicinity of the Roseton and Danskammer Point plants.

B. PRESENT ENVIRONMENTAL LEGISLATION

The requirements of local, state, and federal regulatory agencies aimed at ensuring environmental compatibility of steam electric generating stations have matured since enactment of the Federal Water Quality Act of 1965. The National Environmental Policy Act of 1969 and the Federal Water Pollution Control Act, Amendments of 1972, have resulted in standards and regulations which assure that society's power needs shall be met while minimizing harm to valuable natural resources, endangered populations and ecosystems which are of economic, social or ecological importance.

Stringent regulations concerning the operation of electric generating stations using once-through cooling are imposed by the Environmental Law of New York State and interpreted and enforced by the New York State Department of Environmental Conservation. During 1973 the guidelines of the New York State Public Service Commission Article VIII Regulations became effective and indicated to utilities which environmental parameters related to the siting and operation of new electric generating facilities must be studied.

During 1974 the Environmental Protection Agency published the requirements to be met by existing and future generating stations in order to be exempted from utilizing recirculating cooling systems for dispersal of waste heat from condenser cooling systems (Section 316(a) P.L. 92-500). The biological standards associated with Section 316(a) are broad-based, requiring detailed studies of aquatic plant and animal responses to all potential thermal and chemical effects of cooling water flow from an electric generating station.

These standards will necessitate comprehensive field studies designed to detect changes in balanced indigenous populations of shellfish, fish, and wildlife in the vicinity of power stations using once-through cooling. Because information is needed on the interaction between electric power stations and aquatic ecosystems, utilities of the Hudson River Valley[1] and various state and public agencies[2] are supporting an expanding program of environmental research and ecological study on the Hudson River.

C. DESCRIPTION OF STUDY AREA

The Roseton and Danskammer Point Generating Stations are located at the northern end of Newburgh Bay. The southern boundary of the bay is found at Storm King Mountain, and the northern end at Danskammer Point. The studies described herein were primarily conducted in the northern section of the bay with the Newburgh-Beacon Bridge marking the southern end of the study area.

Geologically, the bay is of the sedimentary rock type (Broughton et al., 1965) which was eroded more readily than the metamorphosed rock north and south of the bay. This differential erosion led to the formation of a wider, shallower bay.

The study area is characterized as the narrower part of Newburgh Bay, with a deep central channel and very little shallow shore area. Railroad tracks run along both sides of the river and their construction necessitated large quantities of fill. The roadbed fill eliminated the beach or shallow waters from a large portion of the study area. A few tidal waters enclosed by the railroad embankment and having limited exchange with the river are in the study area. Most of these back water areas are small and have heavy aquatic vegetation of the emergent type.

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[1]Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., Orange & Rockland Utilities, Inc., and Niagara Mohawk Power Corporation.

[2]New York State Public Service Commission (PSC), Power Authority of the State of New York (PASNY), the New York State Atomic and Space Development Authority (ASDA), and the New York State Department of Environmental Conservation (NYSDEC).

Shallow (non-channel) areas are located in the southeast section of the study area from the Newburgh-Beacon Bridge to the Chelsea Yacht Club. This area resembles a triangle with the base at the Newburgh-Beacon Bridge and the apex at the Chelsea Yacht Club. A second shallow area on the east side is below New Hamburg around the mouth of Wappinger Creek. A third area on the east side is north of New Hamburg along the shore extending out about 200 feet. On the west side of the river, the cove area north of Danskammer Point and a small section south of the Roseton plant are the only shallow areas of any size.

The channel ranges in depth from 35 to 65 feet, with greater depths near the two plant sites extending north to New Hamburg.

Prior to the construction of the Danskammer Point Steam Station primary use of the study area was for quarrying and brick manufacturing. The Roseton Generating Station was built on the site of one of the two old brickyards in this area. The second brickyard was located in the south east section of the study area at Denning Point. A traprock quarry is presently operating north of Danskammer Point.

The Chelsea Water Intake and a large yacht club are located across from Roseton. Most shore areas are inaccessible to the public due to railroad fill or private ownership (mainly residential in the southern section). Water activity is mainly private pleasure boating or passage for freighters and barge traffic.

D. NATURE OF THE STUDIES

The nature of the studies presented herein derives from a careful examination and understanding of a rather abused word, "ecology." Ecology is a compounded Anglicization of two Greek words: *oikos*, meaning home or place to live; and *logos*, meaning to study. Given that only living beings, either plant or animal, need a "place to live," ecology is, literally, the study of organisms at home.

Every organism performs its life history functions within the context of biotic and abiotic factors describable as its "habitat." All the organisms and environmental parameters in a habitat have an effect upon each organism and on the biotic and abiotic factors which surround it.

Organisms may influence their habitats in numerous ways: chemically, by removing from or adding to nutrient or toxin cycles; physically, by mere presence and utilization of space; and behaviorally, by disrupting, assisting, or consuming other living organisms. The complete description of an organism, the environment's effect upon it, and its effect upon the environment defines the "ecological niche" for a given species.

This report is based upon our knowledge of the Hudson River and its role as a habitat for diverse groups of organisms. The primary data presented herein represent the results of studies initiated in 1971 and carried on through the winter of 1973 at several sites on the Hudson River. Primary attention is given to the Roseton/Danskammer Point vicinity.

The studies reported herein relate to the ecological characteristics of the river area adjacent to Roseton and Danskammer Point and to the interactions of these plants on local biota through the mechanisms of impingement and entrainment.

The data constitute an extended time-series of observations based on a scope of work initiated in 1971 and expanded through and into 1974.

The community approach to ecosystem analysis utilized herein affords an opportunity to assess the conditions of the system as a whole, as well as from the perspective of a single species. Nutrient cycling, seasonal stability, energy flow, and communities in development may be perceived by using the tools of observation, natural history, population biology, and the integrative techniques of community analysis.

1. Time Coverage

Extensive biological and chemical sampling was initiated in 1971 at Danskammer Point, a small promontory located 67 miles upstream from the river mouth (Brooklyn Battery). This report presents an evaluation of Hudson River ecology as it may have been affected by the long-term operation of the Danskammer Point plant and a preliminary definition of environmental conditions existing in the river prior to operation of the Roseton plant.

In response to the need for information and the requirements of regulatory agencies, study efforts at Roseton/Danskammer Point were directed toward obtaining adequate coverage of as many critical biotic and abiotic parameters as possible.

Far-field information has also been gathered on the chemical, physical and biological characteristics of the Hudson River between New York City and Albany. Apart from infrequent studies of isolated aspects of Hudson River biology, no studies of a comprehensive nature had been conducted between 1936 and 1965. Therefore, the Roseton/Danskammer Point studies necessitated establishing an understanding of the Hudson River estuary in 1971-1973, in relation to what it had been several decades ago and in relation to what it was in the late 1960's.

Data from 1971 through 1973 have been analyzed to describe important commercial and recreational species (e.g., blue crabs, white perch and striped bass). Analyses of the chemical and physical factors associated with dominant phytoplankton, zooplankton, fish and benthic species has been performed.

Studies of environmental impact are natural experiments, provided one has had the opportunity to characterize adequately the object of study, i.e., the environment prior to any impact. Given adequate preoperational information, one may characterize effects through continued observation of numeric abundance of organisms, population characteristics, and community structure. By comparison of preoperational and postoperational data, the investigator should discover any alterations in biota or the environment occurring after operation of the facility in question commences.

Adequate sampling procedures are of the essence in such studies; the provision must be made to define and account statistically* for all variables except those plant-induced variables under study. Post-operational evaluation of the ecological effects of steam electric

*Statistical procedures are summarized in Appendix I-A.

generating stations should cover several consecutive years. While evaluation of effects relies upon data comparisons, sufficient data must be gathered in the postoperational phase not only to identify measurable differences in populations or communities, but also to identify whether the changes documented constitute part of natural biological variation or serve as tangible evidence of a trend, showing that the system has, in fact, been affected and is seeking a new equilibrium.

extensively. The river is wide in this area, but has a narrow channel with extensive backwaters and side channels.

South of Coxsackie, the Hudson is confined by the limestone formations of the Catskills and Taconic mountains. For some distance the river runs narrow and deep, except in zones where mountain valleys contain lakes, probably formed after the Wisconsin glaciation. Here the river has eroded the land, back waters, islands and shoal water zones. This condition persists downriver until the confinement of the east bank eases in the vicinity of Peekskill. In this region, the Hudson becomes broad, forming the widest expanses in the system.

South of Piermont the river again narrows, confined on the west by the Palisades and on the east by the diking of Yonkers and New York City.

While characteristic zones exist in the Lower Hudson basin, the quantity and quality of life forms in the system are not differentiated strictly according to geologic zones, but more according to physical and chemical characteristics of the water. For example, in the Lower Hudson basin, two distinct aquatic ecosystems exist: a tidal freshwater river and a "typical" mid-Atlantic estuary. However, the physical characteristics

mid-river; the east and west banks have been stabilized by concrete and granitic rip-rap in areas.

The only major tributary to the Hudson in the vicinity of Danskammer Point is Wappinger's Creek which joins the Hudson on the east shore approximately one mile north of the Danskammer plant. The biota of the Hudson River at Danskammer Point represent the four major components of the Hudson biota: resident estuarine forms, migratory fishes, seasonal estuarine residents and stenohaline freshwater forms.

Many of the important fish species found in the Hudson use this portion of the river as a migratory route (shad, herring, eels); as a summer resident (juvenile striped bass, juvenile herring); as a nursery ground (white perch, striped bass, Atlantic tomcod); and as a spawning ground (Atlantic tomcod). The morphometry of this region and its location in the seasonal pattern of salt intrusion suggest a support function for the river biota at least as important as other zones in the Hudson River estuary.

(c) The Mid-Atlantic Region. An important aspect of preoperational plant studies is the geographic range covered by populations which inhabit the vicinity of the plant site. This range defines the range over which the beneficial or harmful effects of power plant operation may extend. In the case of power stations on the Hudson River, some species present in the river in great abundance as eggs, larvae or juveniles range over a broad expanse of the western Atlantic Ocean.

In the case of the American eel, an abundant catadromous fish in Hudson River waters, spawning migrations may carry adults from freshwater ponds and streams in the Hudson drainage to the depths of the

Sargasso Sea. The anadromous alewife spawns in the Hudson. Alewife juveniles leave the Hudson and go to the sea for about three years before returning to spawn.

The striped bass is a semi-anadromous species which spawns in the Hudson River. The geographic range of striped bass includes the estuarine and coastal waters of the northwestern Atlantic from Newfoundland to Florida and into the Gulf of Mexico. There has been no precise definition of the extent to which individual breeding populations of striped bass contribute to the extensive Atlantic coastal fishery for the species.

A major point in question is whether Hudson River striped bass enter the Atlantic fishery or remain confined to the New York Bight and Long Island Sound. To answer this question and questions regarding populations of eels, alewives and other migratory species, extensive data from outside the Hudson River must be examined.

The objectives of these considerations are, of course, to determine to what extent Hudson River fish populations contribute to the stocks of important species in the middle Atlantic Bight and Atlantic coastal fisheries and to determine whether changes in Hudson River populations could contribute significantly to changes in the entire mid-Atlantic fishery. Studies to determine the relative contribution of the Hudson River to the mid-Atlantic striped bass fishery are being conducted in 1974 by Central Hudson, Orange & Rockland Utilities and Consolidated Edison Company of New York, Inc. on a joint sponsorship basis.

3. System Parameters and Analysis

(a) Plankton. The plankton may be defined as those aquatic organisms living in the water column which possess limited powers of locomotion. Their movements are determined primarily by currents in the body of water which they inhabit. The plankton may be differentiated into the phytoplankton (primary producers) and the zooplankton. Several categories exist within each of these groups, serving to characterize the plankton by size, function, and origin.

The classical description of the plankton as immobile creatures at the mercy of the currents is, to a certain extent, erroneous. Most planktonic organisms, phytoplankton included, are capable of either maintaining their vertical position in the water column or undertaking substantial vertical migrations. Oceanic zooplankton, for instance, are capable of vertical migrations of several hundred meters, spanning distinct current and flow regimes in the process.

In an estuarine system, flow patterns are such that vertical movements of only a few to several meters may place an organism in currents flowing opposite those above or below its original location. Hence, by vertical migration into and out of currents, estuarine plankton may undertake substantial horizontal movements.

The phytoplankton in the Hudson provide part of the basic energy requirements of the system. In most coastal and offshore marine

environments, the phytoplankton, fixed algae, and encrusting algae are the major source of energy-rich organic molecules upon which the system thrives. In large estuaries, however, allochthonous material (material in the system derived from sources external to the system) in the form of detritus may compose an important part of the energy base of the system.

Detritus input to an estuary may come from a variety of sources such as decomposition products from vegetation in the watershed, feed-lot drainage, and domestic waste disposal. Detritus particles commonly remain in suspension throughout the low-saline portions of the estuary, but tend to flocculate along with other suspended particulates when the salt concentration of the estuary reaches five to ten parts per thousand.

Detritus cannot be considered as supplemental to photosynthesis in estuaries. The two sources of energy are complementary due to the interaction of turbidity caused by detritus in suspension and light penetration. Systems carrying a substantial suspended solid load have reduced photosynthetic activity, primarily the result of light limitation. Given the removal of detritus and a concomitant increase in light penetration, any detrital-based estuary could rapidly convert to a photosynthetic-based system.

Phytoplankton is composed of representatives of several plant classes: the blue-green algae (Cyanophyceae), the green algae (Chlorophyceae), the diatoms (Bacillariophyceae), the

golden-brown algae (Chrysophyceae), the dinoflagellates (Dinophyceae), the cryptomonads (Cryptophyceae), the euglenoids (Euglenophyceae), and the yellow-green algae (Xanthophyceae). The most numerous and most ecologically important forms are the blue-green algae, the diatoms, the green algae, and cryptomonads. Blue-green algae, some green algae, and some diatoms are important in their contribution to noxious blooms in enriched water. For the most part, diatoms are desirable forms and diverse diatom communities are generally considered indicative of water of high quality.

The phytoplankton studies described in the present report are primarily species inventories, representing in depth inventory studies necessary to make a full evaluation of baseline conditions in the phytoplankton community. The report documents distribution and abundance data for a large portion of the lower Hudson. Particular attention has been paid to potential nuisance algae, primarily the blue-green algae.

Future studies, whose objective has been defined as the postoperative evaluation of power plant effects on aquatic biota, encompass studies beyond the species inventories and distribution/abundance data presented in this report. Postoperative evaluations will include studies of algal standing crop, productivity and definition of the phytoplankton community structure.

The zooplankton have been divided into several easily differentiated groups based upon size of the organism and the source of origin of the planktonic form.

Zooplankton are composed of the "true" plankton (organisms which spend their entire life history in the plankton) and meroplankton (planktonic creatures which represent life history stages of organisms which are not planktonic as adults). The true zooplankton are forms such as copepods, cladocerans, and some rotifers. Meroplankton represent a variety of fauna whose adult stages may be benthic or pelagic, such as the eggs and larvae of oysters, clams, crabs, worms, snails, and fishes. For the purpose of the present study, the zooplankton have been differentiated into the ichthyoplankton (meroplanktonic fish eggs and larvae), the microzooplankton (primarily true plankton too small to be retained by a 500μ mesh net), and the macrozooplankton (planktonic and meroplanktonic forms other than fish eggs and larvae which are retained by a 500μ mesh net).

Zooplankton represent an important component of the ecological system, including primary consumers and lower secondary consumers, i.e., organisms feeding upon algae and organisms feeding upon the organisms which consume algae. Zooplankton convert very fine particulates of high organic content (e.g., algae, bacteria, and detritus) into animal protein suitable for consumption by organisms at higher trophic levels. Food consumption and assimilation, reproduction, and turnover rate of the true zooplankton are rapid, providing a vital, renewable nutrient resource for filter-feeding adult fishes, larval fishes, and many other life forms.

As vital links in the food web and as forms incapable of extended horizontal movement, populations of zooplankton in a productive estuary such as the Hudson require careful evaluation in relation to the possible effects of power plant operation. At Roseton/Danskammer Point the zooplankton have been studied primarily to establish a species inventory and to describe, in relative terms, seasonal and spatial patterns of distribution and abundance. Future studies will include studies of community structure, rates and mechanisms of secondary production, and definition of standing crop estimates throughout the Lower Hudson estuary.

(b) Benthos. In the past many researchers, attempting to define precisely the effects of an industry, utility, or engineering activity on aquatic biota, attempted to base their evaluations upon a single organism, the indicator species. The indicator species was seen as a generalized organism whose responses to environmental stress would serve to define the responses of any organism of its type to a similar impact.

With increased appreciation of the importance and complexity of communities and increased knowledge of the varying responses of organisms to environmental impact, the concept of the indicator species has been de-emphasized in favor of the indicator community, for which full understanding of responses to impact could, in a realistic manner, be applied to similar communities.

The benthos represent an ideal indicator community for field studies of environmental impact for a variety of reasons:

(1) They are easily sampled.

(2) They are "fixed" or relatively immobile and, as such, cannot help but respond to impacts directed upon them.

(3) Their importance to other communities is readily established.

(4) A benthic community demands a proportionately lower level of effort than other communities to define the results of impact.

As with most other communities, the benthos may be subdivided according to functional or structural characteristics. Benthic communities are composed of benthic infauna (those organisms which live in the sediments) and epifauna (those organisms which live at the sediment-water interface, but whose major activities are performed on the surface of the sediments rather than in the sediments themselves). Many benthic epifauna undergo daily vertical migrations into the water column and, as a result, appear in macrozooplankton samples. Common Hudson River forms which show this behavior are the amphipods or scuds, opossum shrimps, certain harpacticoid copepods, and some insect larvae.

Feeding strategies among the benthos range from primary consumer (e.g., snails feeding on encrusting diatom growths) to detritus feeders (e.g., crabs feeding upon decayed carcasses of other organisms).

As a community, the benthos show perhaps the clearest demarcation of freshwater and saltwater species. Distinctly different species

"replace" one another when freshwater benthic communities merge into the estuarine or marine environs. For example, a top carnivore in the marine or estuarine benthos may be one of the errant polychaetes, such as a clamworm or a sandworm ("seaworms" to the fisherman). In the freshwater benthos, the top-carnivore position would be taken over by insect larvae or nymphs, such as the hellgrammite. The clear demarcation between species of estuarine and riverine benthos is due to the retention of interstitial water in the sediments. Sediment water retention serves to reduce the magnitude of salinity changes in the sediments, thereby producing a more constant environment than in the water column above.

Studies of benthic communities span the length of the Lower Hudson watershed from the Tappan Zee to Kingston, New York. Sampling has been performed with the objective of establishing: (1) an inventory of benthic species, (2) abundance and distribution data for benthic communities at several sites in the river, and (3) measures of standing crop biomass in the benthos on a seasonal basis. Future evaluation techniques will demand few changes in procedure other than increased sample replication to generate as much detail as possible on community characteristics, production, and species abundance in response to plant operation.

(c) Fish Eggs and Larvae. Fish eggs and larvae (ichthyoplankton) are meroplankton, representing the early life history stages of some of the fish species which spawn in the Hudson River. The abundance

of ichthyoplankton on an annual basis is dependent upon the intensity of a given year's spawning activity and those factors in the environment which determine rates of mortality in the larval population. Since fish larvae do not reproduce, ichthyoplankton biomass in itself represents a non-renewable resource for the nutrition of other organisms and to eventual recruitment to the adult fish populations.

In the system overview, fish eggs and larvae serve as a continuous food source to other organisms due to the sequential spawning of several species of fish in the river, and, therefore, represent a seasonally variable renewable resource. The annual spawning activity of a species limits the number of potential adults to be derived from that spawning. Determination of adult abundance for a given species, however, depends not only upon the numerical abundance of juveniles spawned in a given year, but also upon a complex interaction of natural mortality, predation, final distribution, and rate of development which injects density-dependent compensation factors into the equations from which one may try to calculate recruitment from spawning intensity.

The length of time fish eggs and larvae remain planktonic depends upon the species. The eggs of many species of fish which spawn in the Hudson never become planktonic because they adhere to vegetation or stones (e.g., the top-minnows, genus Fundulus) or because the eggs are laid in nests (sunfishes, catfish). The eggs of several important species are either neutrally buoyant or slightly negatively buoyant and become widely distributed in the system through the action of tides and currents (striped bass, shad).

The larvae of many species spawning in the Hudson are, likewise, absent from ichthyoplankton samples or are present in numbers far fewer than one would expect, based upon the numbers of adults and juveniles resident in the river. An excellent example is found in the sunfishes. For several days after hatching, juvenile sunfish are guarded jealously by the adult male. Parental behavior includes herding of the larvae in a tight school and preventing their dispersal until they have reached the age where they can fend for themselves in the dense vegetation of backwater areas. Other larval forms, such as those of the hogchoker, undergo an early metamorphosis and become epibenthic in their habits. The larvae of several of the more important sport and commercial fishes (striped bass, white perch, and American shad) are subject to wide dispersal by currents and tides.

The primary objective of the fish egg and larval studies included in this report is to define the patterns of distribution and abundance of the major groups of ichthyoplankton in the Hudson River. The studies conducted for the preoperational evaluation include determination of distribution, abundance, and length-frequency measurements on larval fish from the months of May through August 1973 at all study sites on the river. In order of appearance through a spawning year the major species represented are: Atlantic tomcod, river herring (composed of an overlapping sequence of American shad, blueback herring and alewife), striped bass, white perch, and bay anchovy.

Assessment of the effects of power plant operation on the ichthyoplankton includes studies of larval abundance in the power plant cooling water flow, determination of the survival potential of larvae after passage through the plant, and the generation of computer models simulating the short and long-term effects of power plants on ichthyoplankton populations in the river.

(d) Fish. Fish populations, particularly populations of desirable sport and commercial species, generally receive the most attention when concerned individuals attempt to evaluate the status or condition of a body of water prior to and after the imposition of some change or stress. In fact, change in fish populations is a major factor in evaluating environmental impact according to the 1972 Amendments to the Federal Water Pollution Control Act, wherein the maintenance of "a balanced indigenous population of shellfish, fish and wildlife" is stated to be a national goal.

The Hudson River estuary maintains large populations of numerous fish species. The species present in the river represent year-round residents, migrants, and summer residents. Several species use the river as a route for spawning migrations, both upstream from the sea (anadromous species) and downstream to the sea (catadromous).

The fish populations of the Hudson River received little attention between 1937 and 1965. Prior to 1937, the New York State Department of Environmental Conservation conducted a biological survey of the Lower Hudson and described a rich and diverse ichthyofauna; but brought attention to potential declines in several species such as

the shad, Atlantic sturgeon, and shortnose sturgeon. From 1937 to 1965, no comprehensive studies of Hudson River fish populations were made. Recent studies dating from 1965 to the present have been conducted primarily at the request of the power industry and state and federal regulatory agencies to determine the potential impact of electric power stations on fish and fisheries in the Hudson.

The present report presents studies of fishes in the Hudson River from three distinct points of view: (1) inventories reflective of the fish species composition in the Hudson today, (2) population dynamics of abundant resident species, and (3) the fish communities in the Hudson demonstrating the stability and diversity of the fish fauna throughout the Lower Hudson watershed. These studies delineate characteristics of the fish community throughout the Upper Hudson estuary. They likewise provide details of the spatial distribution of fishes in the river through seasons over a span of three years. For the Roseton/Danskammer Point sector, the data reported herein present not only a baseline description of fish populations and communities, but also detail the relationship of the fishes in this area to river-wide communities.

Postoperational assessment will include a continuation of river fish studies and will relate plant operations to the fish populations in light of potential thermal effects upon Hudson River fish and effects of entrainment of organisms and impingement of fishes at the power plant intake screens.

(e) Hydrodynamic Characteristics. Flora and fauna of a river system depend for their existence upon a variety of ongoing physical processes to provide suitable habitat, nutrients, routes of dispersal, transport and in some cases, partners for breeding. The eventual understanding of an ecosystem, therefore, is dependent upon being able to relate biological events within the physical determinants of the system. To this end, extensive surveys have been conducted on the Hudson River estuary which document the hydrodynamic features of the environment in relation to the biota.

At the preoperational stage, understanding of hydrodynamics provides a valuable data base against which one can compare biological data and attempt to define which physical parameters limit, control and/or stimulate the estuarine ecosystem.

(f) Water Quality. Studies in the vicinity of Roseton and Danskammer Point have employed extensive surveys for water quality at sites coincident with biological sampling stations. The results of these surveys are not conclusive regarding water quality criteria necessary for the existence of various Hudson River biota, since the biota are already present. They may represent conditions suggestive of recommended changes in presently existing criteria. The chemical observations to date serve to identify a chemical environment within which the observed complexity of plankton, benthos and fish may successfully survive for the duration of their life history, grow to sexual maturity, and reproduce.

The interaction of chemical factors in the environment with the biota may be perceived at two levels: the chemical, i.e., the presence, absence, or level of concentration of a chemical entity affects an organism directly; and the physiological, i.e., an organism's capacity to regulate the effect of the chemical on its system.

Postoperational assessment of plant impact on water quality parameters will serve a dual purpose. First, the direct measurement of water quality parameters will serve to quantify changes in water quality which may occur as the result of plant operation. Second, the values and changes in values for various parameters will be related to the biology of the Roseton/Danskammer Point area.

With these data, an attempt will be made to develop a meaningful mathematical relationship between water quality parameters and the biota to be expressed as an "index of cleanness" or "index of water quality."

II. LOCAL CONDITIONS IN THE VICINITY OF ROSETON/DANSKAMMER POINT AND THEIR RELATIONSHIP TO FAR-FIELD CONDITIONS

A. INTRODUCTION

An estuary is a semi-enclosed, coastal body of water which has a free connection with the open sea and within which seawater is measurably diluted by fresh water derived from land drainage (Pritchard, 1967). Day (1951) defined an estuary as "that region of a river with a variable salinity due to the sea." The Lower Hudson River is a long and narrow estuarine system with a salinity concentration ranging from 30 parts per thousand salts at the mouth to 0.10 parts per thousand in freshwater regions.

Remane (1958) discussed the extensive terminology descriptive of the range of dissolved salts in natural water. On occasion, this terminology has been used to describe estuarine organisms according to the zones occupied. The "Venice System" of classifying estuarine zones is as follows:

Zone	Salinity (o/oo)
Hyperhaline	>40
Euryhaline	40 - 30
Mixohaline	30 - 0.5
Mixoeuhaline	<30
(Mixo) polyhaline	30 - 18

Zone	Salinity (o/oo)
(Mixo) mesohaline	18 - 5
(Mixo) oligohaline	5 - 0.5
Limnetic	<0.5

Reference to an organism in terms descriptive of the estuarine zone in which it is found (e.g., mixohaline, polyhaline), however, may be misleading because the geographic and physiological factors which determine the estuarine distribution of organisms do not necessarily correspond to the parameters used to characterize any single estuarine zone. During the life cycle of the American shad, for instance, some time is spent in each of the aforementioned zones. An adult shad is, variously, euryhaline, mixohaline, and limnetic, depending upon its physiological state, and cannot, therefore, be referred to by any single, descriptive term.

The biota of the Lower Hudson Basin are derived from three major sources: freshwater (limnobiotic component), saltwater (marine component), and land (terrestrial component) (Remane, 1958; Green, 1968). Within each biotic group are found organisms whose osmoregulatory capacities are severely limited (stenohaline) and organisms capable of regulating internal salt concentrations over a wide range of salinities (euryhaline). Within each "source group" of organisms, there exists a wide range of osmoregulatory capacities, defining in physiological terms the portion of an estuary a given organism or population of organisms is capable of inhabiting.

For estuarine biota less motile than fishes, such as benthos and plankton, salinity classifications are descriptive of habitat preferences for species and species groups, although only when interpreted in the broadest sense.

Due to the lack of a classification system of estuarine fishes according to estuarine zones, the classification of fishes must be based upon the frequency of their occurrence within certain zones of the estuary. The groupings of Tyler (1971) provide an excellent system, referring to:

(1) resident species, those species captured in a study zone at all times of the year;
(2) periodic species, those species entirely absent during a portion of the year, and
(3) occasional species, those species present in samples irregularly and in low numbers.

The Hudson estuary functions:

.To support resident populations of fish, plankton, and benthos;
.To support and provide refuge to species not resident in the estuary including a variety of occasional fishes, amphibians, reptiles and waterfowl which need an aquatic habitat for completion of their life-cycle;
.As a migratory route, an aquatic "flyway" as it were, for anadromous and catadromous organisms;
.As a spawning ground and nursery for resident and periodic species;
.To regulate nutrient cycling and energy flow within all communities in the system.

The Lower Hudson Basin (mouth of the estuary to the head of the tide at the Troy Dam) is a very important section of the total Hudson River ecosystem because it is in this area and in nearshore Atlantic waters that exists:

- .most of the detrital organic matter contributing to the system;
- .most of the photosynthetically produced organic matter used in the system;
- .virtually all of the benthic biomass related to nutrient cycling and energy flow in the system;
- .virtually all of the planktonic biomass relevant to Hudson River biota, and
- .the vast majority of the fish biomass deriving support from the Hudson River system.

Because of the wide natural boundaries of the organisms which compose the communities observed in the Hudson River ecosystem, the "global" considerations presented in this report include the Lower Hudson Basin and the nearshore Atlantic waters. "Local" conditions presented herein characterize the Roseton/Danskammer Point area, described as extending from the Roseton/Danskammer Point plant vicinity to a distance upstream and downstream approximating movement of the water mass of the Hudson in one complete tidal cycle. The Roseton/Danskammer Point vicinity is therefore defined as extending from approximately the Newburgh-Beacon Bridge on the south to New Hamburg on the north, a total distance of approximately six river miles.

The discussion below provides a generalized description of the ecological characteristics of the Lower Hudson Basin in the global aspect and a more

detailed assessment of ecological conditions in the Roseton/Danskammer Point vicinity as related to the entire river system.

B. SUMMARY OF STUDY FINDINGS

In this section of the report global and local aspects of the Hudson River ecosystem and its function will be discussed using available data and trends evident in these data. Interpretation of these data and trends are made in light of available scientific literature; however, as a document designed to define baseline conditions and evidence of prior impact, this report will also identify areas of interest which remain poorly defined. In addressing the various functions of the river and baseline conditions relevant to these functions, areas are identified where additional data are necessary.

1. Primary Producers (Phytoplankton)

Data relevant to the quantification of primary productivity in the Hudson estuary are not generally available for the period 1971 and 1972. Preliminary data (CCNY, unpublished manuscript) for the vicinity of Ossining showed that primary productivity during the spring months (March and April 1972) was comparable to values recorded from other mid-Atlantic estuaries (Stross and Stottlemyer, 1965). Quantification of primary productivity on a seasonal basis is necessary in future work on the Hudson.

Phytoplankton data from the vicinity of Roseton/Danskammer Point, although not necessarily suggestive of primary productivity, showed that algal

concentrations were higher during the 1973 sampling period than in 1971 and 1972; cell concentrations attained "bloom" conditions on several occasions in 1973, primarily during the mid- and late summer months.

Algal abundance at Roseton/Danskammer Point reached bloom proportions in 1972 (Quirk, Lawler & Matusky Engineers, 1973a). The dominant algal forms differed between Roseton/Danskammer Point and Bowline, although the inventory of potential nuisance algae was similar for both sites (Quirk, Lawler & Matusky Engineers, 1973a). A major component of the Bowline phytoplankton community, Melosira moniliformis, was not recorded at Roseton/Danskammer Point, presumably due to the preference of this species for more saline waters (Quirk, Lawler & Matusky Engineers, 1974a).

From the available 1973 data, it can be stated generally that phytoplankton were more abundant downstream of the Roseton/Danskammer Point region. A similar pattern was noted for 1972 (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974a). During fall 1972 at Roseton/ Danskammer Point, algal concentrations were nearly twice that found at Bowline (Quirk, Lawler & Matusky Engineers, 1973a, 1974a).

As can best be determined there exists a gradient of decreasing net plankton from the limnetic sectors (Quirk, Lawler & Matusky Engineers, 1973a, 1973b) to oligohaline waters (Lauer, 1972; Quirk, Lawler & Matusky Engineers, 1974a). Patterns further downstream, in

mesohaline and marine waters, have not been investigated to any great extent. However, correlation of phytoplankton abundance with turbidity determinations would suggest a decreased phytoplankton abundance downstream due to light limitation (Howells and Weaver, 1972).

Phytoplankton populations of the Hudson River estuary show wide variation in abundance due to seasonal factors at downstream stations and higher concentrations varying less markedly with season at upstream limnetic stations.

Abundance of algae in the vicinity of Danskammer Point was relatively uniform for a given sampling date, suggesting that discharges from the Danskammer Point plant had no effect on net phytoplankton abundance. While populations at the study area were well above those at Bowline in 1972, data from Kingston, New York (Mile Point 92) where no power plants exist showed phytoplankton concentrations of approximately the same level as the concentrations in the Danskammer Point vicinity.

Investigations of water quality in the Hudson River during the period 1971 through 1973 (Heffner, 1973; Howells and Weaver, 1973; Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974a) showed that nutrient concentrations throughout the estuary were sufficient to support bloom concentration at all seasons of the year. The precise explanation for the upstream-downstream gradient of plankton is unclear, but it may be associated with salinity and/or turbidity.

Seasonal abundance of algae increases above the salt front. Two possible explanations are suggested:

(1) the algae in the estuary may be stenohaline forms unable to survive the salinities of the oligohaline portions of the estuary; or

(2) the decrease in phytoplankton may be due to a trace nutrient (see Goldman, 1966) present in abundant quantities upstream, but possibly removed by flocculation (salting-out) in the oligohaline sector.

The phytoplankton of the Hudson are species found commonly in other Atlantic estuaries (Carpenter, 1971; Lauer et al., 1972; Quirk, Lawler and Matusky Engineers, 1973a, 1973b, 1973c, 1974a); therefore, the likelihood that salinity tolerance firmly controls the abundance of phytoplankton in the system may be discounted.

Algal composition by group (e.g. diatoms, green algae, blue-green algae) showed a pattern of succession at each of the stations sampled in the Hudson estuary (sites at Kingston, Roseton/Danskammer Point and Bowline Point) (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974a). The successional pattern was characterized by a predominance of diatoms during the spring months followed by an increase in the relative abundance of green algae and substantial increases in blue-greens in the late summer and early fall.

The succession recorded for the Hudson was a truncated form of the classic phytoplankton successional pattern of diatom - green algae - blue-green algae described by Pearsall (1932) and discussed by several

authors (Margalef, 1967; Cairns, 1972; Lauer, et al., 1973). In the Hudson at Kingston, diatoms were succeeded by a mixture of green and blue-green algae during the latter part of the summer into early fall (Quirk, Lawler & Matusky Engineers, 1973b). Throughout the 1972 sampling period, phytoplankton concentrations at Kingston did not exceed the criterion for bloom conditions. Algal concentrations at Kingston were similar to those at Bowline; however, the taxonomic list of algae at Kingston more closely resembled that at Roseton/Danskammer Point (Quirk, Lawler & Matusky Engineers, 1973a).

Algal successional patterns depend upon several factors which control the abundance of the various groups, including predation, nutrient depletion, and temperature. Examination of water quality data for Kingston, Roseton/Danskammer Point, and Bowline Point showed no consistent relationship between changes in concentrations of major nutrients (nitrogen and phosphorus) and algal successional patterns (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974a).

A more consistent relationship was noted between temperature and succession. At Kingston in 1972, for example, percent composition of diatoms increased concomitantly with a decrease in water temperature in mid- to late August. At Bowline, the dominance of greens over diatoms was reversed as water temperatures began declining in the fall. Blue-green to diatom reversal occurred at Roseton/Danskammer Point in the late fall.

Margalef (1967) proposed that a combination of nutrient depletion and physiological factors defined the diatom/green alga/blue-green alga (or dinoflagellate) succession in the oceans. Within the Hudson estuary, however, nutrient concentrations rarely showed substantial declines within any growing season. When the concentrations did decline, they generally remained in excess of levels considered suitable for algal growth (see Raymont, 1963; Hutchinson, 1957, 1967). Physiological activities of algae, such as chemical conditioning of water and metabolite release may, in fact, play a significant role in algal succession.

Cairns (1972) discussed algal succession as a function of water temperature. According to his hypothesis, the seasonal progression of increases and decreases in water temperature favors the growth of diatoms, green algae, and blue-green algae in succession. Such appears to be the case in the Hudson River, although the pattern of succession may be partially truncated, resulting in a cycle of diatom - green alga succession, rather than diatom - green alga - blue-green alga succession. As noted at Kingston (Quirk, Lawler & Matusky Engineers, 1973b) and at Bowline (Quirk, Lawler & Matusky Engineers, 1974a), diatoms may be succeeded by a mixture of green and blue-green algae.

The variability of successional patterns in the river system emphasizes the degree of natural variation one may expect in a system as large as the Hudson River.

Stross (1973) suggested that successional patterns in the algal community may be due ultimately to nutritional factors, but that the mechanism is mediated by means of filter-feeding zooplankters. Given the potential for year-to-year changes in environmental factors such as zooplankton populations and temperature, and nutrient fluctuations, one can envision substantial annual variation in algal successional patterns and algal abundance in the Hudson River estuary.

As a baseline condition, primary productivity in the limnetic and oligohaline reaches of the Hudson River is founded upon a community of diatoms and green algae plus substantial populations of blue-green algae.during the early fall. The diatoms dominate the phytoplankton during the spring and early summer. During this period, concentrations of algal cells may be quite low in the oligohaline sectors. Diatoms are replaced by greens and blue-green algae in a successional pattern throughout the estuary as the seasons progress, apparently corresponding to seasonal changes in water temperature, but possibly due to changes in nutrients and the activities of filter feeders.

Successional patterns should be carefully observed and correlated with water quality parameters at the site of phytoplankton collections. Nutrient studies should be conducted on specific water

masses from which plankton are collected to assess the relationship of algal cell abundance, nutrients, temperature, and mixing in the estuary. Recent advances in understanding of phytoplankton ecology dictate that particular attention be given to nutrients such as silica and micronutrients such as manganese, when seeking to understand the determinants of growth, production, and succession in algal communities (Stross, 1973).

2. Zooplankton

The Hudson River supports zooplankton populations throughout its length. Nutrients for the zooplankton are available either as particulate material (phytoplankton or organically rich suspended particulates) or as dissolved organic molecules.

In the Lower Hudson basin, most of the zooplankton are suspension feeders, employing filtration techniques to obtain their food. Some of the zooplankters, e.g., some cyclopoid copepods, are raptorial carnivores.

Many of the holoplanktonic* and meroplanktonic** forms in the Hudson are primary consumers or detritus feeders, capable of filtering particles as small as bacteria from the water. Some of the filter feeders are highly restricted in their feeding habits, selecting particles of a limited size for ingestion (see Marshall and Orr, 1955; Jørgensen, 1966). The size selectivity of filtration is a function of the size of the filtering apparatus employed and, considering the range

*Zooplankters which remain planktonic throughout their life cycles.
**Zooplankters which spend only a portion of their life cycles as plankton, e.g., ichthyoplankton.

of sizes of zooplankters in the Hudson River, it is possible for the filter feeders to have access, in a mechanical sense, to most of the particulate matter suspended in the river.

Zooplankton biomass in the estuary in 1971, 1972 and 1973 was primarily composed of copepods and rotifers. Concentrations of zooplankton at Bowline in 1972 were comparable to those found at Kingston and at Roseton/Danskammer Point. Patterns of zooplankton abundance in the limnetic and oligohaline reaches of the estuary generally followed that of algal abundance and suspended solids, the two primary sources of nutrients for suspension feeding organisms (Hutchinson, 1967; Krey, 1961; Riley, 1959).

At Roseton/Danskammer Point, which is periodically influenced by salt intrusion during low freshwater flows, the most abundant zooplankters were rotifers and copepods. At some stations, rotifers composed 40% or more of the population. At Kingston, rotifers were abundant in large numbers throughout the sampling period, composing as much as 80% of the zooplankton during certain seasons. Copepod nauplii and copepodite stages dominated the oligohaline zooplankton community at Bowline in 1971, 1972 and 1973 (Lauer et al., 1973; Quirk, Lawler & Matusky Engineers, 1974a).

Throughout the river there appeared no firm relationship between total algal abundance and zooplankton abundance. At Kingston high concentrations of diatoms in the early spring apparently presaged an increase

in rotifer and copepod (nauplii) populations at most stations (Quirk, Lawler & Matusky Engineers, 1973b). At Roseton/Danskammer Point, a similar relationship was apparent in 1973 studies, whereas no apparent correlation between abundance of nauplii and adult copepods was observed in 1972 (Quirk, Lawler & Matusky Engineers, 1973a). The Bowline area showed large increases in copepod nauplii during September 1972, but algal concentrations were relatively low at that time.

Fleming (1939) studied the effects of zooplankton grazing on phytoplankton populations and found that zooplankton may be responsible for rapid depletion of algae from the water; however, if grazing rates are equal to or less than the division rates of algae, large concentrations of zooplankton may be supported by a relatively small concentration of algae, if the algae have rapid division and production rates. Steeman-Nielsen (1956) has emphasized that it may be erroneous to believe that dense populations of phytoplankton and zooplankton must alternate with one another.

It is likely that zooplankton populations in the Hudson River graze upon populations of algae which are themselves probably not limited by nutrients. A major factor not included in the 1971 and 1972 Hudson River environmental studies was the abundance and distribution of the nannoplankton, algal cells generally not retained by the finest mesh plankton nets.

At times, estimates of phytoplankton density, as derived from net hauls, may be entirely misleading (Harvey, 1950; Steeman-Nielsen, 1958). Gross et al. (1947, 1950) state that the nannoplankton are perhaps more

abundant and of greater importance in inshore waters. Thus, a direct relationship between algal cell densities and support potential for zooplankton of the Hudson estuary may not be entirely accurate.

Studies conducted in 1974 have incorporated techniques which account for the possible contribution of nannoplankton to production in the Hudson River.

Zooplankton organisms need not necessarily derive their nutrition solely from algal populations. Despite the efficiency of zooplankters such as copepods and cladocerans in filtering algal cells from suspension (Fleming, 1939; McMahon and Rigler, 1965), during periods when zooplankton concentrations are high and algal production is low, the grazers may derive a substantial portion of their dietary needs from detritus (Riley, 1959; Krey, 1961). The possibility that detritus forms an important source of food for Hudson River zooplankton populations cannot be dismissed.

Chemical analyses of the river show that suspended solid concentrations are high, suggesting a heavy detritus load for the river. Future studies should address the question of detritus concentrations in the water column, as well as the question of the extent to which detritus serves as a food source for the zooplanktonic community.

As a baseline condition, it may be concluded that the zooplanktonic community in the Hudson River differs between downriver and upriver sites as the head of the salt front is passed. Oligohaline zooplankton populations resemble the zooplanktonic communities of other

mid-Atlantic estuaries such as Chesapeake Bay (Chesapeake Biological Laboratory, 1970), being dominated by copepods (Acartia spp.) with minor components of cladocerans, rotifers and polychaete larvae. Up-river stations are dominated by characteristically freshwater zooplankton, such as rotifers and cladocerans, and have fewer copepods than the oligohaline zones.

Based on comparison of abundance figures and age class distribution of copepods at Roseton/Danskammer Point with Heinle's (1966) data, it is concluded that the copepod populations, especially the naupliar stages, are critical to system function and may account for the majority of secondary production during the summer months. Other components of the plankton, though present in less abundance, provide the essential complexity and stability to the zooplankton community and account for energy flow and nutrient cycling in those portions of the food web which are isolated from the dominant copepod species.

3. Benthos

Hudson River benthic populations present the clearest demarcation of salt-influenced habitat within the estuary. The populations in the Bowline Point region are representative of oligohaline estuaries (Burbanck, 1962; Sanders et al., 1965). Benthos from Roseton/Danskammer Point (Quirk, Lawler & Matusky Engineers, 1973a) contained some oligohaline forms such as the isopod Cyathura polita, but were dominated by limnetic forms, namely oligochaete worms and dipteran fly larvae. The benthic species found at Kingston, further upstream, were almost exclusively limnetic in origin (Quirk, Lawler & Matusky Engineers, 1973b).

Benthic populations throughout the Hudson estuary from Bowline Point to Kingston show relatively low species diversity, with a tendency,at least on a seasonal basis, for the benthic community to be dominated by a single form. Within the same context, however, it is important to note that the standing crop (biomass) of benthos is substantial throughout the estuary.

The reduced species diversity of the oligohaline zone of the Hudson River estuary is not unusual. Characteristically, the low-saline zones of estuaries demonstrate reduced numbers of species. While the specific cause of the low numbers of species in low-saline waters is not fully understood, it is likely that salinity is a major factor. The displacement of the "species-impoverished zone" toward fresh water is primarily due to the lack of salt tolerance by freshwater organisms (Remane, 1958).

Support for the Hudson River benthic community is derived from the deposition on the bottom of organically rich detritus. The dominant benthic forms in all portions of the river are deposit feeders, i.e., those forms deriving their nutrition by consumption of the rich bottom deposits.

Despite the tendency toward single-group dominance and low species diversity observed within the Hudson River benthos, species inventories from the stations studied show a potential for high species diversity.

Information theory diversity (H') takes into account the numbers of individuals per species and, based on proportional representation in the community, can be used to generate an index of diversity. Calculation of maximum diversity (H max) is basically an exercise generating what the maximum possible diversity, based upon the numbers of species in a community and assuming a homogeneous representation of individuals per species.

The benthic communities in the Hudson River contain many groups, but the communities are dominated by one or two classes which account for up to 90% of the individuals. Thus, information diversity (H') is low. The many other classes present provide for a potentially high diversity (H max), if individuals were more evenly distributed among classes.

MacArthur (1955) developed the hypothesis that community diversity was a direct measure of community stability and, as such, provided an adequate means of projecting the response of a community to environmental change. Analyses of aquatic environments, estuarine benthic communities in particular, suggest that a one-to-one relationship between diversity and stability may not exist per se (Lane, unpublished manuscript; Carricker, 1967; Green, 1968). Admitting that estuarine benthos need more concentrated experimental study, Carricker (1967) proposed that enough stability exists to maintain the community intact in time despite the stresses of the physical (saline) environment in estuaries.

The benthic communities at Roseton/Danskammer Point and at Kingston appear more diverse than those downstream at Bowline Point (Quirk, Lawler & Matusky Engineers, 1973a, 1973b). However, the Bowline Point sector falls within that oligohaline zone of estuaries which characteristically show high productivity, but few species (Remane, 1958). This rather sparse fauna characteristic of low-saline areas of estuaries (less than 10 parts per thousand) has been proposed as constituting a separate and distinct ecosystem, as yet inadequately described (Carricker, 1967).

The baseline benthic condition in the Hudson is proposed to consist of three distinct groups: an oligohaline community found in the vicinity of Bowline Point, characteristic limnetic benthic communities upstream and characteristic euryhaline/marine benthic fauna located seaward of Bowline Point at salinities above 10 parts per thousand.

The baseline benthic conditions for the Roseton/Danskammer Point area are primarily those characteristic of fresh water: dominance by euryhaline freshwater oligochaete worms and dipteran larvae and fewer estuarine forms, such as polychaete worms. The proportion of marine forms suggests that the Roseton/Danskammer Point area rarely experiences estuarine conditions for extensive periods of time.

4. Fish

Resident fish fauna may be defined as:

(1) those which occur in all, or nearly all samples, or

(2) those species which complete their entire life histories within the river system.

By the first criterion, one defines as resident, anadromous fish species which utilize the river system primarily as a migratory route and as a spawning ground or nursery area, should the juveniles of the species remain in the system for several months. While such a species is resident in a temporal sense, the river system does not support the population in the pure sense.

For example, in the Roseton/Danskammer Point and Kingston areas, the anadromous alewife was present in nearly every month's total catch (Quirk, Lawler & Matusky Engineers, 1973b). However, at both sites the alewife catch was primarily juveniles. Alewife young-of-the-year spend the first year in the estuary before migrating to the sea. There they spend two to three years before returning to spawn. From the perspective of river function, the alewife uses the river as a migratory route and nursery and is not a resident form.

At stations upriver from Roseton/Danskammer Point the resident species are primarily freshwater forms (Quirk, Lawler & Matusky Engineers, 1973a, 1973b). Freshwater species are occasionally present downstream at Bowline Point.

In the Roseton/Danskammer Point area, white perch dominated the entire year's catch during 1972 (Quirk, Lawler & Matusky Enigneers, 1973a). Other resident estuarine forms were the tomcod, striped bass, hogchoker, and spottail shiners. Kingston collections (Quirk, Lawler & Matusky Engineers, 1973b) were dominated by white perch and spottail shiners in 1971 and 1972.

The dominant resident fish species occurring in the oligohaline portion of the Hudson in 1971 and 1972 were the white perch, bay anchovy, tomcod, hogchoker, and striped bass. In both years, white perch, a true resident estuarine form, dominated the catches on a percentage basis.

It should be noted that the upstream (freshwater) stations were dominated by fewer resident estuarine forms than the more saline stations downstream.

Spottail shiners became dominant in the upstream stations as the relative abundance of hogchokers, striped bass, and tomcod decreased. The "replacement" of hogchokers, striped bass, and tomcod by the spottail shiner is apparently the result of preference of the shiner for less saline waters rather than an ecological displacement mediated through interspecies competition for food or space (Wass et al., 1973; Mansueti and Hardy, 1967).

In the same sense as previously described for the benthos, the highly variable estuarine environment often imposes considerable stress upon populations (Carricker, 1967). Despite the relative paucity of true estuarine forms (Gunter, 1967; Remane, 1958; Green, 1968), and the tenden-

cy for single-species dominance at certain locations or seasons, resident estuarine fish populations possess the response capacity to persist under stressful conditions, whereas migrant and seasonal forms may be subject to severe limitation by environmental conditions.

In determination of baseline Hudson River conditions, analysis of historical data for all fish species may shed light on the quality of the Hudson River as an environment suitable for the support of fish populations. Morgan et al. (1973), O'Connor (1972), Sherk and O'Connor (1971), and O'Connor and Neumann (1972) have shown that oligohaline estuarine fishes (white perch and hogchoker) possess a remarkable capacity for tolerance of environmental stresses, including sewage waste, industrial waste, and suspended solids loads.

Seasonal estuarine fishes, primarily pelagic species found periodically in mesohaline and oligohaline zones, showed a reduced tolerance to suspended solids (O'Connor, Sherk and Neumann, manuscript in preparation, 1974). If resident and pelagic Hudson River fish populations were under severe stress due to the presence of utility, industrial, and domestic operations, one would expect some significant variance between the annual abundance of estuarine forms and the variation in abundance of seasonal forms.

Data from 1966 to present (Heller and Hermo, 1960; Perlmutter et al., 1969; Quirk, Lawler & Matusky Engineers, 1969, 1973a, 1973b; Raytheon, 1971; Texas Instruments, 1973) showed that fluctuations in abundance of resident fishes varied in unison with seasonal species, a phenomenon

which has not necessarily been true for estuarine ecosystems subject to similar cultural effects (McErlean et al, 1973).

The fish species of the Hudson River derive their nutrition from the plankton, benthos and detrital elements of the river system. Some resident species have feeding habits which overlap to a great extent. Stomach content analyses conducted on three of the major resident species occurring in the Roseton/Danskammer Point area showed overlapping feeding habits. White perch preferred amphipods and dipterans, brown bullheads consumed amphipods, oligochaetes and dipterans but preferred Alosa spp. larvae during periods of availability of that ichthyoplankter. Pumpkinseeds fed mainly on dipteran larvae and amphipods. All three species of fish feed somewhat adventitiously, so that there is no great potential for interspecific competition for food.

Stomach content analyses conducted on striped bass of varying age groups showed a preference for crustaceous plankton by striped bass larvae; striped bass become increasingly piscivorous throughout the juvenile stages and are piscivores as adults (Humphries and Cumming, 1973).

Downstream in the Bowline area, the three most abundant estuarine forms are white perch, tomcod and hogchoker. All three species feed on similar items (Bigelow and Schroeder, 1953); however, concentrations of these three species were isolated in time. White perch were abundant throughout the year except during November and December 1972. Hogchokers were most

abundant during May and June, whereas tomcod formed a substantial portion of the community from September through December 1972. Significant overlap of abundance occurred between hogchokers and tomcod during September and October when total benthic biomass was greatest.

The greatest potential for severe interspecies competition was noted for the month of October when benthic biomass was highest and the numeric abundance of these three benthic-feeding fishes was at its highest. The fall concentration of benthic feeding fishes in the Hudson River may have effects on population of benthic organisms.

White perch and hogchokers from the Bowline region showed a preference for similar food items such as copepods, polychaete worms, amphipods, and opossum shrimp (Neomysis). Tomcod food preference included amphipods, worms and fish fry among others (Hildebrand and Schroeder, 1953). Koski (1971) analyzed the stomach contents of hogchokers in the Hudson River estuary and determined a preference for polychaetes, isopods, amphipods and chironomid larvae.

The feeding preferences of abundant fish populations in any area of the Hudson estuary in the fall may be an ecological factor determining group dominance among the benthos during the winter months and into spring. The distributional characteristics of resident, benthic feeding forms interact such that heavy concentrations of fish may occur within a rather limited area of the estuary. On a year-to-year basis, the quantities of fish in the fall concentration may vary substantially, depending upon considerations such as population abundance, salinity patterns,

temperature, and the timing of upstream and/or downstream migrations. Similarly, the point in the estuary where the fall concentration occurs may vary, depending upon temperature and migratory patterns.

The relationship of fish abundance, overlapping food preferences, and benthic populations applies equally well to any sector of the river which from year to year may harbor the fall concentration.

Future studies on fish food habits, populations, and distributon should include a detailed analysis of predation as a determinant of benthos group dominance. As a baseline condition for resident fish populations, it may be stated that oligohaline forms in the Hudson River are more numerous in the vicinity of Bowline Point, decreasing in numbers of species upstream to the Roseton/Danskammer Point area and Kingston.

The overall abundance of resident species upstream dominates the ichthyofauna in the oligohaline and limnetic portions of the river. Periodic fish species may dominate the first community on occasion, particularly at upriver stations. White perch were concluded to be the most abundant and most ubiquitous of all species in the river in terms of relative abundance and biomass.

The movements of resident and periodically occurring fish in the river vary with season. In the annual cycle periodic fish species affect the composition of the community in different sectors.

The vicinity of Bowline Point, for example, is subject to wide variation in community structure and stability due to upstream and downstream

movements of periodic species. Diversity within a given year varies more widely at the Bowline site than at other stations due to the invasion of marine species during the fall. However, annual variation in diversity does not suggest a polluted system or an unbalanced system. Longterm study of fish communities has shown annual cycles of diversity to be characteristic of temperate estuaries (McErlean et al., 1973).

Analysis of cyclic diversity changes over time has been used to evaluate ecosystem function in the Patuxent River estuary, Maryland. The technique proved valuable in identifying trends in overall diversity, outlining the energetic relationships of the system, and quantifying the stability of the system on a seasonal and long-term basis.

The similarity of biotic components between the Patuxent River estuary and the Hudson River estuary indicates that, with a sufficient time base, such analysis will prove valuable to post operative assessment of fish communities in the Roseton/Danskammer Point area.

The relative abundance of fishes may vary widely from one year to the next throughout the river. Samples collected over the past 10 years from a substantial portion of the limnetic and oligohaline zones of the system have shown a pattern of varying abundance. The years 1967 and 1968 had lower catches as compared with 1966 and 1970. 1971 was also a year of low abundance. Populations increased substantially in 1972, and the trend of increase appeared to be continuing through 1973.

The annual variation in abundance of resident estuarine fishes has yet to be explained. Koo (1970) studied the relative abundance of striped bass over several years and identified a pattern of abundance for this species; however, he found no firm biological evidence of factors limiting year-class success. Koo proposed that annual variations were most likely due to density-independent (i.e., environmental) factors rather than to biotic factors. Workers at the Chesapeake Biological Laboratory (unpublished observations) have noted a gradual increase in the abundance of white perch in the Patuxent River estuary over several years' time, coupled with an apparent decrease in complexity of the system (see McErlean et al., 1973) to an oligohaline system dominated almost entirely by white perch and hogchokers. The factors leading to the increased perch and hogchoker populations have not been determined.

In recent years the physioloqical determinants of survival, growth, and reproduction in estuarine fishes have been under study. Particular attention has been given the relationship of environmental quality to success of estuarine fishes in the mid-Atlantic region (Morgan, 1970; Morgan et al., 1973, Sherk et al., 1973; Burton, 1970, Rogers, 1969; Umminger, 1970). As a result of these studies and the collection of extensive physical-chemical data on estuaries, it is anticipated that some delineation of density-independent factors affecting resident fish populations will occur, and in light of this, the evaluation of power plant aquatic environment effects will be made.

From the point of view of an individual organism, survival, growth and reproduction are determined by density-independent phenomena. Chemical factors in the environment, and nutritional and space resources exist in concentrations and quantities sufficient or insufficient for an individual to perform the vital activities of life.

The allocation and optimal utilization of many resources available to a population, however, may become a density-related phenomenon for the population as a whole. A variety of definitions of competition and competitive interactions exist which depend upon acceptance or rejection of density-dependent phenomena as determinants of population success (Weatherly, 1972; Lack, 1954, 1966; Andrewartha and Birch, 1954).

Among fishes, growth rates are extremely flexible. Population size may be seen as entirely density-independent due to the allocation of minimum amounts of food to each individual within a confined space (see Weatherly, 1966, 1972) generating populations of stable size and individuals of variable size. However, when fishes are not confined in space, individual size and population size may be highly variable over time. Often taken as an indirect demonstration of density-dependent population control, these phenomema may be caused by density-independent phenomena (Koo, 1970).

Weatherly (1972) has outlined the data requirements for deducing whether fish populations are dependent upon density-independent factors or upon the density of their own kind. In performance of postoperative evaluation of power plants, these requirements can be fully met and a formal determination of density-related population effects can be made.

A second baseline condition relevant to resident fish populations must be defined specifically in relation to the Roseton/Danskammer Point area of the river. In an evaluation of estuarine benthos, Carricker (1967) noted the lack of complexity of oligohaline benthic communities, and stated that the community, although having low diversity, retained sufficient diversity to maintain its integrity through time. The oligohaline benthos often showed single-species dominance, which Carricker interpreted as evidence of periodic environmental (osmotic) stress. Given the alternatives for post operative evaluation, particular attention must be paid to chemical analysis of sediments for pollutants, food preferences of fishes in the area, and natural variation in population numbers due to natural environmental factors.

C. BIOTIC SUPPORT FUNCTIONS OF THE HUDSON RIVER

1. Support of Periodic Species

Based upon general estuarine considerations, seasonal succession in some of the holoplankters (particularly the diatoms and copepods) is likely in the lower estuary (salinity greater than 10 parts per thousand). In this mesohaline portion of the estuary the seasonal effects of temperature and salinity lead to substantial populations of some marine algae and copepods for varying periods of time each year (Jeffries and Johnson, 1973; Smayda, 1973).

Smayda (1973) noted that the physical-chemical processes operating at the mouths of estuaries often result in the buildup of nutrients (hence, possibly algal cell populations) in open embayments along the coast. Marine and mesohaline copepod populations generally increase in these areas at the same time and intrude upstream to the capacity of their osmotic and/or thermal tolerance limits. These populations are supported by estuarine and marine nutrient sources during their seasonal residence.

The fishes of the Hudson River estuary are organisms which may remain in the system throughout their life history or which utilize the river system on a seasonal or periodic basis. For the most part, year-round resident fishes range throughout the system, from mesohaline to limnetic waters. Fishes which occupy the estuary on a seasonal basis may be confined to certain sectors or may range throughout the system.

The seasonal residency in estuaries of marine fish species is a phenomenon which, according to Gunter (1961, 1967), defines the major function of an estuary as a nursery ground. Many marine fish species utilize the majority of mesohaline, oligohaline, and limnetic reaches of the Hudson River estuary as a nursery ground, while juvenile fishes spawned offshore use the high levels of estuarine productivity and the protection of enclosed estuarine areas for rapid growth and to increase recruitment to adult stocks.

The Hudson estuary may be viewed as essential to the offshore fishery for those marine species which spawn offshore but which develop and grow in its low-saline waters. The biological influence of the Hudson reaches to the nearshore and offshore waters of the mid-Atlantic and the northeast Atlantic continental shelf. From these waters come the weakfish, spot, croakers, crevalle jack, bluefish, mullet, and many other species which utilize the Hudson River estuary during their life cycles.

The range of influence of the Hudson may be broader still, when one considers those species of anadromous fishes which may be widely dispersed at sea but migrate upstream to deposit their eggs. Species such as the American shad, alewife, and blueback herring move to the Hudson each spring from many miles offshore (Hildebrand and Schroeder, 1928; Bigelow and Schroeder, 1953; Leim and Scott, 1966). The more abundant fish species, including those of greatest economic and recreational importance, may be estuarine throughout their entire life cycle, such as the white perch and hogchoker (Mansueti, 1961; Dovel et al., 1969), or remain in coastal waters adjacent to the estuary, such as the bay anchovy, tomcod, and striped bass (Hildebrand and Schroeder, 1928; Raney, 1952).

In consideration of the vast geographic range of species occurring there, the total range of influence for the Hudson River includes the shelf and abyssal waters of the western North Atlantic. Such a description is beyond the scope of work outlined for this report.

However, a recent publication of the University of Rhode Island Graduate School of Oceanography (Saila, 1973) provides an in depth discussion of the physical, chemical and biological features of western North Atlantic shelf waters relevant to the influence of Atlantic coastal estuaries.

Some species in the Hudson, such as the American eel, represent populations whose natural boundaries extend from the surface fresh-waters of the Hudson drainage basin to the abyss of the Sargasso Sea. Other species found in the Hudson, such as bluefish, spot, and menhaden, utilize the river as a nursery.

Juvenile and pre-adult forms of these species migrate into the estuary seasonally, thereby utilizing the high productivity and refuge afforded by the estuary. Seasonal migratory behavior is highly successful since optimal growth and survival of the young occurs in the estuary.

The common periodic species occurring in the Hudson and the range of their upstream distribution from 1971-1973 were:

Atlantic menhaden:	Not collected north of Bowline Point during 1971; infrequent north of Bowline Point during 1972; 0.01% of the catch in the Danskammer Point area during 1973.
Bluefish:	Not collected during 1971 (Quirk, Lawler & Matusky Engineers, 1973a, b); infrequent at Bowline and rare in the Danskammer Point area (one individual during 1972; absent above Bowline Point in 1973.

Weakfish (trout):	Furthest penetration upstream to Bowline from 1971 and 1973, comprising 0.1% of the total catch in each year; none collected upstream.
Atlantic croaker:	Rare as far upstream as Bowline in 1972 (one individual); not recorded at Danskammer Point or Kingston in 1971-1973 or at any of the three sites in 1971.
Crevalle jack:	Rare at Bowline and rare upstream to Kingston in 1971; not captured at Roseton or Kingston in 1972; comprised 0.1% of Bowline catch for 1972; occurred in the Danskammer Point area (one individual) and at Bowline Point during 1973.

Together these species represent a very small proportion of the river fish biomass, particularly in the oligohaline and more northern reaches of the Hudson River. They may represent an important segment of the fish community, however, in the mesohaline portions of the estuary.

In similar mid-Atlantic estuarine systems, periodic species become abundant during the late summer and early fall. The species make-up of periodic forms is very similar in the Cape Fear estuary, the James, York, and Rappahannock estuaries, the Potomac and Patuxent River estuaries, the Delaware River estuary, the Hudson and the Connecticut River estuaries (DeSylva et al., 1962; Wass, et. al., 1973; Quirk, Lawler & Matusky Engineers, manuscript in preparation). Considerable interest has been expressed regarding whether periodic fishes inhabiting a given estuary represent a distinct population whose juveniles rely upon a single estuary for support of the stock, much as the anadromous salmonids, eels, and clupeids. Few data

exist with which to test this hypothesis. The initial stages of research for location of offshore spawning sites and patterns of juvenile movement after hatching (Clark et al., 1969) and techniques for adequate resolution of population-specific characteristics (Morgan, 1973) have only recently been completed. However, the range of phenological extremes encountered by ocean-spawning forms and the annual variation of numbers of seasonal residents, such as spot, in a given estuary imply that few, if any, geographically distinct populations exist along the Atlantic coast.

The local abundance of juveniles in mid-Atlantic estuaries may vary from year to year according to density-independent phenomena. Scheltema (1974) in his discussion of genetic variation in estuarine benthos discussed in detail the seasonal patterns of currents along the Atlantic coast of North America. The bottom currents flow diagonally toward land and are probably responsible for the transport of oceanic larvae and juvenile organisms into estuaries.

However, the north-south orientation of flow has been shown to vary from year to year, most probably dictating the abundance of ocean-spawned fishes in certain coastal estuaries. For example, during a year when the net flow of offshore bottom currents is from north to south, one would surmise that species such as spot and croaker would be less abundant in the Hudson River estuary than when net flow is from south to north.

Support of the periodic species listed previously and other species recorded from the river but not encountered in 1971 and 1972 (spot, mullet) is derived primarily from benthic and epibenthic forms (polychaete worms, crustaceans, molluscs) except for the menhaden, which is a suspension feeder, subsisting primarily on copepods and phytoplankton.

As a baseline Hudson River condition, periodic fish species are abundant for a relatively short period of time each year, during the late summer and the fall. For the most part, seasonal residents do not utilize the oligohaline portions of the estuary to any great extent. Their incursion into limnetic waters was minimal during 1971, 1972 and 1973. The extent to which important Atlantic fisheries may depend upon the Hudson for support of the seasonal resident forms is unclear.

As mentioned previously, the periodic species inventory for the Hudson is similar to other Atlantic coastal estuaries whose fauna have been studied intensively for several decades. Distribution records for periodic species from the Chesapeake system and from the Delaware show that periodic species are most abundant in mesohaline sectors and become rare or absent in oligohaline and limnetic sectors (Hildebrand and Schroeder, 1928; Mansueti and Hardy, 1967; Wass et al., 1973). If any sector of the Hudson contributes significantly to marine fish stocks by functioning as a nursery area for periodic species, it would be the mesohaline waters south of the Tappan Zee.

The annual variation of numbers of periodic forms is expected to be significant. Among the marine fishes of the Atlantic coast, only one-half the species known to exist there occur consistently from year to year (Saila and Pratt, 1973). Among the species which commonly move into estuaries as juveniles, some species, such as the croaker and spot, show aperiodic cycles of presence and absence.

It is likely that the occurrence and abundance of seasonal residents is controlled by density-independent factors operating offshore in the marine environment. However, the abundance of seasonal forms has been shown to vary in unison with resident estuarine fishes, which are also controlled by density-independent factors, but in this case operating within the estuary. By inference, therefore, the abundance of fishes in the Hudson may be seen to be controlled by a factor or factors which extends its influence far offshore.

2. Migratory Route and Spawning Area

The most numerous and most valuable fishes are of the class Osteichthyes, the bony fishes. Both major classes of fishes, the Chondrichthyes, or cartilaginous fishes (sharks, skates, rays, chimeroids), and the bony fishes apparently arose some 340 million years ago in freshwater or very dilute seawater (Colbert, 1955).

The cartilaginous fishes, some groups of which may have developed from the bony fishes, invaded the marine environment rapidly. Their adaptation to the marine environment was effected by maintaining body fluids iso-osmotic with seawater through the retention of urea in the blood.

The bony fishes remained in their original habitat longer. Invasion of the marine environment was effected by osmoregulatory adaptations of the kidney and gill which enabled them to maintain an internal osmotic environment similar to dilute seawater even in extreme hypersaline environments (Potts and Parry, 1964; Gordon, 1968).

Despite the successful invasion of the sea by most families of bony fishes, many species retained a close association with freshwater and hyposaline environments either as spawning grounds, nursery grounds (or both), or as a habitat for adults.

Some of the most abundant fishes in the Hudson River system are estuarine and marine species which utilize the Hudson as a migratory route and as a spawning ground. These species may be divided into an anadromous group composed of three members of the herring family (the American shad, the alewife, and the blueback herring), the semi-anadromous striped bass, tomcod and anchovy, and the estuarine white perch. A second group, the catadromous group, is composed of the American eel and the hogchoker.

The groupings mentioned above do not necessarily conform to the nomenclature applied to fishes in most texts and papers. For the purpose of this report, the anadromous group is made up of those marine and estuarine forms which tend to migrate toward the limnetic sector of the river for spawning. The catadromous group is characterized by the tendency to migrate toward the marine environment or toward the mesohaline portions of the estuary for spawning.

The anadromous group represents the larger of the two in terms of species, individuals, and intensity of spawning activity in the Hudson River system. There exists within this group a marked seasonal succession in which utilization of the river corresponds to ecological factors vital to the success of spawning and the development and growth of the young.

The tomcod is the first species to spawn in the annual progression of migrating and spawning fishes in the Hudson River. Adult tomcod begin upstream migration from the lower estuary or inshore coastal waters in the fall. This migration carries them to the limnetic sectors of the Hudson, at least as far as Kingston (Quirk, Lawler & Matusky Engineers, 1973a, 1973b). Tomcod spawn in the Hudson from December through late February, when water temperatures in the limnetic zone of the river do not often exceed 40°F. At these temperatures, tomcod eggs may take up to a month to hatch. The peak of spawning usually occurs in mid- to late January; larvae generally appear in late February.

Despite the fact that tomcod larvae appear during the period of lowest productivity in the estuary, survival potential for the larvae is excellent, for none of the other fish species in the system is actively feeding at the time of larval tomcod abundance. Hence, in addition to having few competitors, the larvae likewise have fewer predators.

The sequence of river herring migration follows the tomcod spawning period. Adults of the alewife and blueback herring move into the Hudson in late March and migrate upstream to the limnetic zone for spawning. Adult alewives were present in some abundance at Bowline Point in April 1972, but were not abundant at Kingston until May 1972. A similar but slightly delayed pattern was observed for blueback herring (Quirk, Lawler & Matusky Engineers, 1973b).

Temperature requirements for spawning of river herring (Bigelow and Schroeder, 1953) would suggest spawning occurs for these species in early May through early June in the limnetic zone of the Hudson River. Samples from Kingston (Quirk, Lawler & Matusky Engineers, 1973b) showed larval alewife and blueback herring first occurring in mid-May, when water temperatures at Kingston were approximately 65^{o}F. Peak herring larval concentrations occurred during the first week of June. The size of these larvae (approximately 5mm) suggests that some spawning occurs in the immediate vicinity of Kingston. However, the major concentration of spawning activity is very likely further upstream, where larval concentrations of more than 5,000 per 1,000m^{3} occurred in early June (Quirk, Lawler & Matusky Engineers, 1973b).

Newly hatched herring larvae were observed at Danskammer Point in late May 1972 and early May 1973, suggesting that the early-run herring, the alewife and blueback, spawn from approximately mid-May to early June throughout the limnetic sector. The major concentration of spawning activity occurred upstream in the general vicinity of Saugerties (Green Flats; mile point 100).

The anadromous shad enter the system slightly later and cover essentially the same sections of the river as the alewife and blueback. Herring larval identification may be uncertain because of species similarities within the group; however, peaks of herring larval abundance in late June and July in the vicinity of Saugerties suggest that shad spawn heavily at that site, slightly later than do its congeneric species.

Spawning frequency and spawning sites for the species under consideration may vary markedly from year to year. For example, newly hatched alewife larvae were found in mid-May 1972 (Quirk, Lawler & Matusky Engineers, 1973b). Since development prior to hatching takes some six days at 60°F, spawning evidently started during the first week of May. However, in 1973 Texas Instruments found alewife larvae in samples taken April 23 through 26, suggesting that some spawning had started by April 15, 1973 at least two weeks earlier in 1972.

The temperature requirements for striped bass migration and spawning are approximately the same as for the shad. Striped bass and shad migrations are coincident in the Hudson, except that bass start from within the estuary or from near-coastal areas not far from the

mouth of the Hudson estuary (Raney,1952; Texas Instruments, 1973). The striped bass is considered semi-anadromous by most authorities (Raney, 1952; Mansueti, 1961).

Due to the commercial and recreational importance of Atlantic coast striped bass, the artificial propagation of the species has received much attention. Overall, the conclusion is that the species is very adaptable to environmental change (e.g. displacement from spawning grounds) and flexible in its spawning requirements (Dovel and Edmunds, 1971). Mansueti (1961) concluded that the species is compatible with man and thrives in waters enriched by man's activities.

Throughout the range of the species, the relationship of spawning sites to the freshwater-saltwater interface has proven to be variable. Laboratory tests have shown that low-saline waters (0.9 parts per thousand) actually enhanced egg survival (Albrecht, 1964); salinities up to 4.7 parts per thousand did not decrease survival. Dovel and Edmunds (1971) showed that striped bass spawning at the head of Chesapeake Bay spawn in or immediately adjacent to saline water. Accordingly, the nearness of overlap of the spawning sites and low-saline nursery areas may be advantageous to larval survival.

In river systems, however, spawning generally takes place in fresh water, far above the head of the tide. Within the Sacramento-San Joaquin system, striped bass may spawn 80 to 170 miles above the freshwater-saltwater interface; the distance varies from year to year with environmental factors. Within the Hudson River, striped bass eggs

have been found as far upstream as Coxsackie, 50 to 90 miles above the freshwater-saltwater interface (Rathjen and Miller, 1957; Carlson and McCann, 1969; Texas Instruments, 1973).

As noted by Mansueti (1961) developmental time of the striped bass from embryo to larva is brief, so that the location of eggs may be presumed to be very close to the actual spawning site. Egg collections show that the location of spawning sites for striped bass may be highly variable from year to year and that striped bass spawning sites in the Hudson River are not limited in size, but can cover a range of more than 50 river miles in a given year.

White perch spawn over a broad expanse of the Hudson River estuary from Croton Point to the limnetic sectors of the river north of Saugerties. The spatial distribution of white perch larvae with time in 1972 and 1973 showed a peak of abundance in the vicinity of Roseton/Danskammer Point in early June and relatively high frequency of occurrence throughout the oligohaline portions of the estuary (Croton Point to Con Hook) during the same period (Quirk, Lawler & Matusky Engineers, 1973a). Larval abundance at Green Flats (Mile Point 118) decreased to approximately one-tenth that of the Roseton/Danskammer Point area.

Size frequency of white perch larvae in 1972 samples from Kingston (Quirk, Lawler & Matusky Engineers, 1973b) and Roseton/Danskammer Point (Quirk, Lawler, & Matusky Engineers, 1973a) showed that newly hatched larvae (approximately 3mm) occurred at all sites during the first week of

June. The earliest occurrence of newly hatched white perch larvae was during the last week of May 1972 at Roseton/Danskammer Point (Quirk, Lawler & Matusky Engineers, 1973a).

Throughout the 1972 white perch spawning season, the greatest numbers of newly hatched larvae occurred near Roseton/Danskammer Point. The greatest concentrations of white perch larvae at Bowline Point were observed during the second week of June 1972.

Prior to the appearance of newly hatched larvae at Danskammer Point water temperatures were slightly above 60°F. At this temperature, white perch eggs would be expected to hatch after three to five days (Hildebrand and Schroeder, 1928; Morgan, personal communication). Thus, 1972 and 1973 spawning for white perch apparently began during mid-May in the vicinity of Roseton/Danskammer Point. It should be noted that the initiation of spawning by white perch and its congener, striped bass, was nearly simultaneous in 1972. However, while spawning areas overlapped to a great extent, the concentration of peak spawning activity for the two species was separated in space.

In 1973 intense white perch spawning occurred throughout the river in oligohaline and limnetic waters, but was concentrated at Roseton/Danskammer Point and below. Few white perch larvae were captured at the Bowline Point site prior to the second week of June. Those captured at the site in the first week of June were newly hatched larvae, an indication that some spawning activity took place in the Bowline sector. However, their abundance was far in excess of that in the vicinity of Bowline the week before.

Alternative interpretations may be applied to these results. First, the heaviest concentrations of white perch larvae at Bowline Point were more than one week old. Since few younger larvae appeared in Bowline samples the week before, the larvae collected during the second week of June represent white perch which were spawned upstream of Bowline, i.e., at least outside the Bowline vicinity approximately two weeks earlier.

The second interpretation is that the older larvae captured during the second week of June were the result of spawning activity at Bowline approximately two weeks earlier. The lack of agreement in concentrations during June may well have been due to sampling error or to behavioral characteristics of young larvae which made them unavailable to sampling gear during the first week of June.

A full characterization of spawning sites, larval transport, larval growth, and larval distributional patterns may be made only through integrating the results of all researchers on the Hudson within the context of a simulation model. It is anticipated that a more detailed understanding of the ichthyoplankton community will derive from treatment of all larval data in the fish life cycle model (Lawler, 1972). This tool will not only clarify points of interpretation, but will also be used to estimate the extent to which power plant operation may impact resident and periodic fish species.

The bay anchovy is an estuarine resident fish whose anadromous tendencies lead to an upstream spawning migration during the warmer portions of the summer. Dovel (1971) noted that, in Chesapeake Bay

and environs, peak egg occurrence for the bay anchovy was during the month of July; while eggs were occasionally abundant in oligohaline portions of the Patuxent River estuary, eggs were consistently abundant from year to year in the mesohaline (10-18 parts per thousand)

Larval anchovies in the Hudson were recorded from Croton Point to Indian Point during 1972 in concentrations ranging from less than 1,000 per $1000m^3$ to more than 4,000 per $1000m^3$ at Bowline Point. At the time of appearance of anchovy larvae (July 26), river salinities were increasing, suggesting an intrusion of saltwater, possibly bearing anchovy larvae, upstream.

The length-frequency distribution of anchovy larvae at Bowline Point during the last week of July showed the majority of larvae to be newly hatched. Time to hatching for this species is brief, approximately one day at the temperatures recorded for July (Dovel, 1971). Thus, the appearance of newly hatched anchovy larvae at Bowline implies spawning had taken place, probably downstream in slightly more saline water, about one day earlier.

Anchovy larvae were abundant in the river for a period of only about one month. It has been noted (Mansueti and Hardy, 1967) that bay anchovies spawned early in the season may mature the same season and themselves spawn. Although a full analysis of growth rates for Hudson River anchovies has not been performed, several observations suggest that this may be true for Hudson River anchovies.

The catadromous group of fishes in the Hudson consists of the American eel and the hogchoker. The American eel is a truly catadromous form, growing from the juvenile "elver" stage to maturity in the estuaries and freshwaters of North America. Upon reaching maturity, eels migrate from and through the estuaries to the abyssal zone to the east of Florida and south of Bermuda.

Spawning occurs at sea and the larvae (leptocephalus) migrate back to the estuaries. Juvenile eels, or elvers, enter the estuaries at about one year of age and migrate into fresh water to complete the cycle (Leim and Scott, 1966).

Hogchokers are catadromous in that they show a tendency to move downstream to mesohaline sectors of the river for spawning (Dovel et al., 1969). Hogchoker populations in the oligohaline sections of the river undergo annual movements downstream each year until, after three to four years, they enter the breeding populations. Dovel (1971) and Dovel et al. (1969) noted that in the Chesapeake Bay spawning occurred in the mid-summer in the lower Patuxent River estuary at approximately 9 parts per thousand salinity. Hogchoker larvae became benthic following metamorphosis and moved upstream from the spawning grounds to the oligohaline and limnetic zones of the estuary. Koski (1973) has demonstrated that the life history aspects of hogchokers in the Hudson estuary parallel those described by Dovel et al., (1969) for the Patuxent River.

As a baseline condition, the Hudson River supports an ichthyoplankton population most months of the year, beginning with tomcod (January-March), followed by river herring, striped bass, and white perch (April through July), the bay anchovy (July through September), and the hogchoker (August and September). From the extensive data file for other similar estuaries, it appears that eggs and larvae of other species may occur in the fall, but were not observed in current ichthyoplankton surveys due to the termination of sampling in August.

Reference to Table 6 of Dovel (1971) suggests that over a four-year period, spawning periods of many species, e.g., anchovy, hogchoker, and herring, may cover a total period of eight months or more by beginning late or extending late into the year.

The greatest diversity of larvae may be expected during the period April through July when, at a given time, the eggs and/or larvae of alewife, blueback herring, shad, striped bass, and white perch occur simultaneously throughout the reach from Bowline Point to above Saugerties.

The source of support for this abundance of juvenile fishes is apparent when one examines algal cell concentrations, zooplankton concentrations and larval fish abundance at upriver stations during the spring months.

In the early spring phytoplankton concentrations are likely to reach peak levels at upriver stations. Hudson River ecological studies (Quirk, Lawler & Matusky Engineers, 1973a, 1973b; Lauer et al., 1973) show that by June phytoplankton abundance has decreased. This is possibly the result of cropping by zooplankters which become very abundant during late May and early June. At this time, the larval stages of the herring, bass, and perch were actively feeding. Zooplankton abundance decreased markedly into the early part of July, coincident with the abundance of fish larvae in the area.

Lending credence to this hypothesis, there occurs in the zooplankton data a biological incongruity which requires explanation: in the river zones where copepods are dominant members of the zooplankton, e.g., Roseton/Danskammer Point, heavy concentrations of copepod nauplii are not followed by expected increases in abundance of adult copepods. Possible explanations for this phenomenon are that the nauplii are incapable of developing to the adult stage because of some environmental factor, a physiological deficiency, natural mortality or movement out of the sampling area.

Another interpretation may be based upon the feeding habits of larval fishes. Humphries and Cumming (1973) have shown that larval striped bass less than approximately 10 mm total length preferred the early instars of copepods and cladocerans. Examination of the stomach contents of several species of Hudson River larval fish has shown that the early feeding larvae of all species consume essentially the same foods.

Larval fishes feed upon smaller zooplankton; as a technique of resource allocation and species preference, food selection does not take place until metamorphosis occurs for each species. At metamorphosis, each species assumes its characteristic habits and habitat, generally including a strong food preference.

Despite a decreased abundance of larval species in the river during the mid-summer months, the abundance of larvae downstream, i.e., Bowline Point, is not reduced due to large concentrations of bay anchovy larvae. Phenomena similar to those observed for upstream stations in the spring were observed at Bowline Point in mid-summer.

During the abundance of young anchovy larvae, zooplankton abundance decreased. As the larvae grew, and perhaps changed their feeding preference from copepod nauplii to adult copepods, nauplii increased in numbers rapidly; however, there was no subsequent peak of adult copepods, since they were also being consumed by larger fish larvae.

It would be desirable to describe, as a baseline condition, the expected patterns of fish larval abundance and distribution for each spawning season each year. In point of fact, patterns of larval distribution in space and time are only now becoming clear for Hudson River fishes.

A note of caution regarding larval distributions is well-justified in this context. As with zooplanktonic forms which show patterns of diurnal migration, vertical preference, and spatial concentration (see Raymont, 1963) distribution patterns of larval fishes can only be characterized by statistical means, which provides inference and insight rather than firm conclusions. That is to say, when anchovy larvae are stated as occurring in surface waters, this implies that, on a cumulative percent-by-depth basis, more anchovies were captured in surface samples than in mid-water or bottom samples. The relatively small amount of larval work performed in the Hudson estuary as compared with Chesapeake Bay for example, must be taken into account.

Dovel (1971) noted that frequently observations from a single year's sampling may suggest spatial or depth distribution patterns for larvae which are not verified in other years. The same may be true in the Hudson River. In two years of intensive sampling, Dovel (personal communication, manuscript in preparation) observed patterns of striped bass larval distribution which suggest a much more homogeneous depth distribution than that proposed as a generalization by Rathjen and Miller (1957) and by Carlson and McCann (1969). Recent results from other studies (Quirk, Lawler & Matusky Engineers, 1973a, 1973b and Texas Instruments (Cornwall) 1973) suggest that Dovel's caution is a well taken caveat for studies on the river.

The aforementioned coincidence of abundant larval fish populations with a zooplanktonic community of suitable larval food organisms suggests a predator-prey relationship which may have substantial merit in defining population control mechanisms based on the period of larval development.

Variability in year-class strength of the striped bass has been generally attributed to rather nebulous environmental phenomena which may somehow affect larval survival (Koo, 1970; Dovel and Edmunds, 1971; Sommani, 1972). The utilization of zooplankters as food by larval fish and the ramification of food limitation on populations have only recently been the subject of intense study (Humphreys and Cumming, 1973; Jones, 1973; Jones and Hall, 1973).

Jones (1973) suggested that, during a given larval stage, a larva is restricted to a specific food item which must maintain the larva until growth results in the incorporation of a new food item into the diet.

Although not a density-dependent mechanism in context, the relationship of food supply to the individual larva is dependent upon the numbers of larvae present to consume the same food items. A reduction in food density could cause reduction in rate of growth of a larva, and possibly a change in mortality rate.

This theory is biologically attractive for the Hudson River system for it provides one explanation of how population size may be controlled, and it provides an explanation of sequential population control of sequentially spawning species. Jones and Hall (1973) expanded the theory to test whether the initial density of food organisms at a nursery ground may determine year-class strength in fish populations. Simulated year-class strength in their model was found to depend upon food density, and observed year-class strength variation could be accounted for by realistic changes in natural populations of food organisms.

The implications of these results for Hudson River striped bass populations are enormous in light of the apparent interaction between copepod populations and larval fish populations in the river. The density-dependent nature of this interaction relates directly to the principle of population compensation mechanisms in Hudson River striped bass which has received much attention during hearings related to future power plant siting on the Hudson.

The ultimate cause of year-class success is density-independent and, therfore, cannot be considered as a compensatory mechanism. However, these density-independent phenomena (see Koo, 1970) determine levels of primary and secondary productivity in the river system prior to and during spawning seasons. The availability of food items to an individual larva is dependent upon the density of other

larvae feeding on a food item. The abundance of larvae is dependent upon the number of eggs deposited by females within a given season and is reflective of the population density.

When population density is high, more larvae are produced and critical food densities for larvae would cause more mortality in the larval population. During periods when population is low, the low incidence of larvae results in greater survival rates. Placed in the context of power plant effects, removal of some larvae could have no other effect than to improve the survival potential of the remaining larvae.

It is anticipated that a full development of these principles will take place using post operational data and the fish life-cycle model to evaluate compensation factors and prediction of year-class strength in Hudson River fish populations.

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HUDSON RIVER AQUATIC ECOLOGY STUDIES AT ROSETON AND DANSKAMMER POINT

VOLUME V

APPENDICES (PART 1)

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TABLE OF CONTENTS

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME V
APPENDICES (PART 1)

TABLE OF CONTENTS

Chapter	Appendix No.	Appendix Title
I	I-A	Statistical Procedures
III	III-A	Phytoplankton Cells/Liter Net, Filtrate and Whole Water
	III-B	Microzooplankton
	III-C	Macrozooplankton
IV	IV-A	Benthos

APPENDIX I-A

APPENDIX I-A

STATISTICAL PROCEDURES

ANALYSIS OF COVARIANCE

This might be loosely described as a combination of analysis of variance and linear regression. In analysis of variance, a response is categorized by one or more quantal factors and is thought to be determined by the levels of these factors, along with some unexplained, or random element. In regression analysis, it is thought that the response can be determined by a linear combination of one or more other variables, along with some random element. In situations where the response is highly dependent on such variables, it may be desirable to "adjust" the responses by these variables (called covariates or concomitant variables) when performing an analysis of variance.

The first step would be to test whether or not the covariate(s) significantly contribute towards "explaining" the response and, depending upon the result of this test, either a conventional ANOVA (if they do not) or an ANOVA using the "adjusted" responses (if they do) is then performed.

BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE

Equality of variance in a group of samples is an important precondition for several statistical tests.

Bartlett's test, tests the hypothesis of homogeneity of variance $\sigma_1^2=\sigma_2^2=\ldots=\sigma_k^2$. When $\sigma_1^2=\sigma_2^2=\ldots=\sigma_k^2$ the sampling distribution of the χ^2 statistic is approximated by the χ^2 distribution having (K-1) degrees of freedom. The larger the variation between the s_i^2's the larger will be the value of the χ^2 statistic. When the observed value of the χ^2 statistic is larger than the critical value, the experimental data do not support the hypothesis being tested. The formulae for Bartlett's test for homogeneity of variance are:

$$N-K = \sum_{i-1}^{k} (n_i-1)$$

$$M = (N-K)\ \ln s_p^2 - \sum_{i=1}^{k} \left[(n_i-1)\ln s_i^2\right]$$

$$A = \frac{1}{3(k-1)}\left[\sum_{i=1}^{k}\left(\frac{1}{(n_i-1)}\right) - \frac{1}{N-K}\right]$$

$$s_p^2 = \frac{\sum_{i=1}^{k}(n_i-1)s_i^2}{N-K}.$$

$\gamma_1 = K-1 =$ df for numerator and for χ^2 value

$$\chi^2 = \frac{M}{1+A}$$

FAUNAL AFFINITY

The species and number components of a sample can be compared between dates and locations by use of an affinity index. Affinity values are obtained by calculating the present species composition of each collection and then summing the lowest values between the common species of two collections.

Assuming the total fauna of Station A is 50% alewives and of Section B is 30%, the value (%) common between those two stations is the lower of the two, or 30. This summing of common values is then repeated for each species represented at those stations to obtain the affinity or similarity index. The more similar the distribution of species numbers between two locations, the higher the affinity values. The level at which locations are considered to be similar is subject to individual definition. In the case of fish communities, which show large natural variations in diversity, a value of 50% is considered to indicate similarity and a value of 75% to indicate close similarity.

PAIRED t-TEST

Data frequently occur in pairs. The variation from pair to pair is incidental although probably unavoidable. The main interest is to compare the effects of the two treatments and see if there is a difference between them. To eliminate the effects of treatments only, the method known as Student's paired t-test, is used to take the difference between the two treatments within each pair, as denoted by $d=X_1-X_2$. The variable "d" will be regarded as the variable to be studied.

In particular we want to test the null hypothesis that the true mean value of the variable "d" is zero.

$$t = \frac{\bar{d}}{s_{\bar{d}}}$$

where $d_i = X_{1i} - X_{2i}$

$$\bar{d} = \frac{1}{n}\sum_{i=i}^{n} d_i$$

$$s_d = \sqrt{\frac{\sum_{di}^2 - \frac{\left(\sum_{di}\right)^2}{n}}{n-1}} \qquad s_{\bar{d}} = \frac{s_d}{\sqrt{n}}$$

The calculated "t" statistic is compared to the tabulated t value at the chosen level of significance with (n-1) degrees of freedom, where n is equal to the number of pairs.

The null hypothesis is rejected when t calculated $\begin{cases} \leq -t_{\alpha/2}\ (n-1) \\ \geq t_{1\alpha/2}\ (n-1) \end{cases}$

The null hypothesis is not rejected otherwise.

$$H' = - \sum_{i=1}^{s} \frac{n_i}{N} \log \frac{n_i}{N}$$

Where: n_i = number caught of the i species

N = total number caught

s = number of species

Diversity can also be defined in terms of Brillouin's formula which takes into account the patchy distribution of fishes (Pielou, 1966).

$$H' = \frac{1}{N} \log \frac{N!}{n_1!n_2!....n_n!}$$

Because H' is influenced by species richness and species evenness, an accurate description of diversity includes H' and its component parts, species richness, d (Margalef, 1951), and evenness, J (Pielou, 1966).

$$d = \frac{s-1}{\log N}$$

$$J = \frac{H'}{H_{max}}$$

Where: s = number of species

H_{max} = the maximum possible diversity with individuals evenly divided among species

Species richness can be dependent upon sample size because the number of species caught is related to the number of individuals caught. Species diversity, H', is not dependent upon sample size given that the collection method is adequately sampling the community.

There is considerable debate as to the accurate mathematical description of diversity as well as its practical application. However, there is general accep-

tance of the observation that environments under stress are less diverse than "healthy" environments. In terms of diversity indices, an environmental stress tends to eliminate certain species either by avoidance or death. These communities of reduced species tend to have one or two numerically dominant species. Thus, diversity, H', species richness, d, and evenness, J, are all reduced.

Because of the relation between environmental stress and diversity, changes in diversity indices have been used as indicators of pollution (Wilhm and Dorris, 1966; Wilhm, 1968; Johnson, 1970; Chu-fa Tsai, 1973). Using diversity indices to identify pollution is preferable to using the concentration of indicator species or change in the life history parameters because values for indices can be analyzed statistically when sufficient data are available. For example, non-parametric ANOVA can be used to statistically evaluate changes in diversity with time or within a sampling area. If a statistical change in diversity values is confirmed, the source of environmental stress which is related to the variation in diversity can be identified using a multiple regression analysis among water quality data.

LEAST SIGNIFICANT DIFFERENCE

The Least Significant Difference (LSD) is a single value which, once computed, permits the investigator to look at a pair of means and tell whether they are significantly different.

The LSD is basically a Student's t-test using a pooled error variance. Since the LSD need be calculated only once and takes advantage of the pooled error variance, its use is seen to be a time saver as compared with making individual t-tests.

$$LSD\ (\alpha) = t_{\alpha}\ s_{\bar{d}}$$

where t_{α} = the tabular value of t for error degrees of freedom

$$s_{\bar{d}} = \sqrt{2s^2/r}$$

s^2 = error variance

r = number of observations per mean.

For the difference between two means to be significant the observed difference must exceed the LSD at the chosen α level.

SPECIES DIVERSITY

When biological sampling is directed toward assessing environmental change, it is necessary to analyze fish collections as representing a community of interacting species having measurable community parameters such as species diversity, species associations, and faunal homogeneity. Measurements of community parameters are especially important when the environmental impact is directed toward species which are not abundant enough to receive analysis of life history parameters.

Species diversity is a community parameter which is sensitive to changes within the less abundant species. Moreover, species diversity is easily calculated since the total data required are the numbers of individuals caught for each species. By reducing the mass of data obtained from any fish collection to a single value representing the diversity of the collection, it is possible to apply statistical analyses to spatial or temporal series of collections.

The diversity of a community is dependent upon the number of species present (species richness) and the distribution of individuals among the species (species evenness or equatability). Several equations from information theory can be used to relate the number of individuals and the number of species to community structure. The most frequently used index is Shannon's formula which expresses diversity, H', as information content in bits per individual. As diversity increases the information content per species decreases.

STUDENT-NEWMAN-KEULS PROCEDURES

After performing an analysis of variance, if it's found that a source of variation between means is significant, an a - posteriori test can be utilized to determine which of those means differ from one another. The Student-Newman-Keuls procedure (SNK) permits these tests to be performed while maintaining a specified overall "protection level" (i.e., the probability of concluding that two means differ when, in reality, they do not, is a Type I error. Maintaining a protection level of α% assures us of a risk of no greater than (100 - α)% of making any Type I errors).

The result of this test will be sets of means which do not differ significantly among themselves.

The procedure is based on order statistics of the Studentized range.

STUDENT'S T-TEST

To test the significance of the difference between two group means, a statistic known as the Student's "t" is employed. In a test of this sort the null hypothesis is that the two samples come from the same population; that is they must have the same parametric mean. Thus, the difference $(\mu_1-\mu_2)$ is expected to be zero. The deviation of the difference $(\bar{x}_1-\bar{x}_2)$ from zero is tested.

$$t = \frac{(\bar{x}_1-\bar{x}_2) - (\mu_1-\mu_2)}{\sqrt{\left[\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}\right]\left(\frac{n_1 + n_2}{n_1 n_2}\right)}}$$

The numerator represents a deviation between a single difference between two sample means $\bar{x}_1$ and $\bar{x}_2$ and the true difference between the means of the population represented by these means.

The denominator is a standard error of the difference between two means $s_{\bar{x}_1-\bar{x}_2}$

The left portion in square brackets is a weighted average of the variances of the two samples s_1^2 and s_2^2. The portion in parenthesis is the factor by which the average variance within groups must be multiplied in order to convert it into a variance of the difference of means.

The calculated "t" statistic is compared to the tabulated t value at the set level of significance with $(n_1 + n_2 - 2)$ degrees of freedom.

The null hypothesis is rejected when t calculated $\begin{cases} \leq t_{\alpha/2}\ (n_1 + n_2 - 2) \\ \geq t_{1-\alpha/2}\ (n_1 + n_2 - 2) \end{cases}$

The null hypothesis is not rejected otherwise.

TWO-WAY ANOVA

When dealing with a population in which each object may be classified according to two factors, but is otherwise homogeneous, the analysis of variance may be used to determine whether varying either of the factors will affect the response.

Suppose there is a factor A, having a levels, and a factor B, having b levels. The analysis of variance is used to compare the means of the different levels of A by adjusting for the fact that the population is not homogeneous in factor B. Similarly, the means of the different levels of B are compared, adjusting for non-homogeneity in A.

Let:

Y_{ij} = a response from level i of factor A and level j of factor B

μ = the mean of the overall population

$\bar{A}_i$ = the mean the population being at level i of factor A

$\bar{B}_j$ = themean the population being at level j of factor B

$\bar{C}_{ij}$ = the mean the population being at both level i of A and level j of B

ε = a random variable having mean 0

The model used is: $Y_{ij}=\bar{C}_{ij} + \varepsilon$

which can be written as:

$$Y_{ij} = \mu + (\bar{A}_i - \mu) + (\bar{B}_j - \mu) + (\bar{C}_{ij} - \bar{A}_i - \bar{B}_{ij} + \mu) + \varepsilon$$

Let:

$\alpha i = \bar{A}_i - \mu$

$\bar{\beta}_j = \bar{B}_j - \mu$

$Y_{ij}= \bar{C}_{ij} - \bar{A}_i - \bar{B}_j + \mu$

Then: $Y_{ij} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon$

If it is the case that $\bar{A}_1 = \bar{A}_2 = \ldots = \bar{A}_a$, then it is also the case that $\alpha_1 = \alpha_2 = \ldots = \alpha_a = 0$. Thus, the null hypothesis tested is Ho: $\alpha_1 = \alpha_2 = \ldots = \alpha_a = 0$. Acceptance of this implies that $\bar{A}_1 = \bar{A}_2 = \ldots = \bar{A}_a$. If $\bar{B}_1 = \bar{B}_2 = \ldots = \bar{B}_b = 0$, then $\beta_1 = \beta_2 = \ldots = \beta_b = 0$ and by testing Ho: $\beta_1 = \ldots = \beta_b$, inferences can be drawn about $\bar{B}_1 \ldots, \bar{B}_b$.

The term γ_{ij} is referred to as the interaction of level i of A and level j of B.

Ho: $\gamma_{11} = \gamma_{12} = \ldots = \gamma_{1b} = \gamma_{21} = \ldots = \gamma_{2b} = \ldots = \gamma_{a1} = \ldots \gamma_{ab}$

If it is accepted, then it is said that there is no interaction and tests on A and B are valid.

If it is rejected, then it is said that there is interaction between A and B, and tests on A and B are not performed. However, if the gross effects of these variables are to be assessed, they could be tested over the error mean square.

WILCOXON MATCHED - PAIRS SIGNED RANK TEST

The Wilcoxon Matched-Pairs signed rank test is a non-parametric test which corresponds to the parametric paired t-test.

The steps in this procedure are:

i) find the difference of each pair

ii) rank these differences from smallest to largest without regard to sign

iii) assign to the ranks the signs of the original differences

iv) compute the sum of the positive or negative ranks, whichever sum is smaller. Let this sum = T.

v) compare T disregarding the sign with the critical value in the table to judge significance.

If an observed T is less then or equal to the critical value from the table under a particular significance level for the observed value of N, the null hypothesis may be rejected at that level of significance. On occasion the difference of some pairs may be zero. Such pairs are dropped from the analysis. Thus the value of N is equal to the number of matched pairs minus the number of pairs whose difference is equal to zero.

Beyond the range of the table the approximate normal deviate may be calculated:

$$Z = (|\mu - T| - 1/2)/\sigma$$

where T is the smaller rank sum, and

$$\mu = n\ (n + 1)/4; \quad \sigma = \sqrt{2n + 1)\ \mu/6}$$

The number -1/2 is a correction for continuity. As usual, $Z > 1.96$ signifies rejection at the 5% level.

WILCOXON RANK SUM TEST

The Wilcoxon two-sample test for unpaired observations is as follows where $n_1 \leq n_2$.

i) rank the observations for both samples together from smallest to largest (Tied observations, when they occur, are given the mean rank)

ii) add the ranks for the smaller sample. Call this sum T.

iii) compute $T' = n_1 (n_1 + n_2 - 1) - T$, the value you would get for the smaller sample if the observations had been ranked largest to smallest (It is not the sum of the ranks of the other sample)

iv) compare the smaller rank sum (i.e., min (T, T') with the tabulated values.

Small values of this test criterion lead to rejection of the null hypothesis.

For values of n_1 and n_2 outside the limits of the table calculate

$$Z = (|\mu - T| - 1/2)/\sigma$$

where $\mu = n_1 (n_1 + n_2 + 1)/2$

and $\sigma = \sqrt{n_2 \mu / 6}$

The approximate normal deviate Z, is referred to the table of the normal distribution to give the significance probability (p).

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APPENDIX III-A

APPENDIX III-A

ROSETON/DANSKAMMER POINT
PHYTOPLANKTON CELLS/LITER NET, FILTRATE AND WHOLE WATER

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 5/31/73
SAMPLE TYPE: Net cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	o./liter o sample	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.	2264	18185	22678	3635		21233	9239
Asterionella formosa							
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.							
Coscinodiscus sp.	7923	2139	4389	1454		5717	5774
Cyclotella sp.	4527	4279	8778	5815		3267	5774
Cymbella sp.		2139	732				2310
Diatoma sp.			1463				
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.		33161	8778	5815		15516	
Fragilaria crotonensis							
Gomphonema sp.		1070					2310
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	30559	10697	25604	14539		128215	65825
M. granulata							
Meridion circulare	2264	4279	732				
Navicula sp.	10186	7488	4389	5089		3267	1155
Navicula sp A.							
Nitzschia sp.		1070	732	5089			1155
N. sigma							
Pinnularia sp.						817	
Rhoicosphenia curvata							
Stephanodiscus sp.	12450	13906	6584			5717	1155
Surirella sp.	6791	4279	7315	3635		8167	8084
S. patella		3209					
Synedra sp.	4527		1463				
S. ulna							
Tabellaria sp.	9055						2310
T. flocculosa							
T. fenestrata							

DATE: 5/31/73
SAMPLE TYPE: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric		1070		727		18783	
UID pennate	3396	8558				5717	10393
UID spined-centric							
TOTAL DIATOMS	93942	115529	93637	45798		216416	115484
% OF TOTAL PHYTOPLANKTON	46.6	65.5	62.7	32.5		73.6	73.0
B. EUGLENOIDS							
Euglena sp.							
Phacus sp.	1132		732				
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS	1132		732				
% OF TOTAL PHYTOPLANKTON	0.6		0.5				

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 5/31/73
SAMPLE TYPE: Net; cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii							
Ankistrodesmus	1132						
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.				10177		817	
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.							
Golenkinia radiata				1454			
Kirchneriella sp.							
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex							
P. glanduliferum							
P. simplex				4362		26133	
P. tetras							

DATE: 5/31/73
SAMPLE TYPE: Net; cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda							
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.						817	
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.	80359	58834	50476	42162		21233	
UID colonial				29077		11433	
UID desmid							1155
UID flagellate							
UID filamentous	18109						41574
UID four-spined							
UID Gonium-like							
UID unicellular	3395		2195	2181			
Volvox sp.							
TOTAL GREENS	102995	58834	52671	89413		60433	42729
% OF TOTAL PHYTOPLANKTON	51.1	33.3	35.3	63.4		20.6	27.0

Roseton - Danskammer Phytoplankton

Date: 5/31/73
Sample type: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.	2264	2139		4362		17150	
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate	1132			1454			
TOTAL YELLOW-BROWNS	3396	2139		5816		17150	
% OF TOTAL PHYTOPLANKTON	1.7	1.2		4.1		5.8	
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.			2195				
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

Roseton - Danskammer Phytoplankton

Date: 5/31/73
Sample type: Net, cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
E. BLUE-GREENS CON'T							
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular							
TOTAL BLUE-GREENS			2195				
% OF TOTAL PHYTOPLANKTON			1.5				
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	201465	176502	149235	141027		293999	158213

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter sample	no./liter no sample	no./liter no sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	8650	1311	22448	13158			
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.							
Cosinodiscus sp.	7081		1320	2024			
Cyclotella sp.	1081	874	3961	1012			
Cymbella sp.							
Diatoma sp.							
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	3244	437	13205	4049			
M. granulata							
Meridion circulare							
Navicula sp.		437	660				
Navicula sp A.							
Nitzschia sp.							
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.				2024			
Surirella sp.							
S. patella							
Synedra sp.		437					
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 6/26/73
SAMPLE TYPE: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric				1012			
UID pennate							
UID spined-centric							
TOTAL DIATOMS	14056	3496	41594	23279			
% OF TOTAL PHYTOPLANKTON	100%	100%	17.4%	100%			
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
Actinastrum sp.			11224				
A. gracillimum.							
A. hantzschii.							
Ankistrodesmus.							
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.							
Closterium sp.			27069				
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans.							
Franceia sp.							
Golenkinia radiata.							
Kirchneriella sp.							
Micractinium pusillum.							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.							
P. glanduliferum.							
P. simplex.							
P. tetras.							

DATE: 6/26/73
SAMPLE TYPE: Net; cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE ›./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp							
Protococcus sp							
Scenedesmus sp							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda							
Schroedria sp							
Schroederia setigera							
Selenastrum sp							
Sphaerocystis sp							
Spirogyra sp							
Staurastrum sp							
Staurastrum aspinosa							
Stigeoclonium sp							
Tetradesmus sp							
Tetraedron sp							
Tetraedron trigonum							
Tetrastrum sp							
Ulothrix sp							
UID colonial							
UID desmid							
UID flagellate							
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular			1320				
Volvox sp							
TOTAL GREENS			39613				
% OF TOTAL PHYTOPLANKTON			16.5				

Roseton - Danskammer Phytoplankton

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
D. YELLOW-BROWNS (DINOFLAGELLATES)							
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.							
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.			158454				
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

Date: 6/26/73
Sample type: Net, cells

Roseton - Danskammer Phytoplankton

Date: 6/26/73
Sample type: Net Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular							
TOTAL BLUE-GREENS			158454				
% OF TOTAL PHYTOPLANKTON			66.1				
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	14056	3496	239661	23279			

Roseton - Danskammer Phytoplankton

Date: 7/24/73
Sample type: Net; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
E. BLUE-GREENS CON'T							
Phormidium sp.						42006	
Spirulina sp.							
Synechococcus sp.			2565	9110	3704		
UID Aphanothece-like	5300						
UID branched filamentous							
UID colonial							
UID filamentous			4104	19876			
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular			1026	12422			
TOTAL BLUE-GREENS	11263	4194	30780	110145	538518	42006	
% OF TOTAL PHYTOPLANKTON	10.8	11	25.6	33.2	90.0	27	
F. OTHERS							
UID flagellate							
TOTAL OTHERS					741	955	
% OF TOTAL PHYTOPLANKTON					.12	.6	
G. TOTAL PHYTOPLANKTON	104680	38283	120555	333172	598516	154659	

Roseton - Danskammer Phytoplankton

Date: 7/24/73
Sample type: Net;cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.			7565	9938			
Synura sp.							
UID dinoflagellate					741		
TOTAL YELLOW-BROWNS			2565	9938	741		
% OF TOTAL PHYTOPLANKTON			2.1	3.0	.12		
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.			14877				
Aphanothece sp.							
Chroococcus sp.	5963	2097					
Cylindrospermum sp.				4969			
Dactylococcopsis sp.							
Gleocapsa sp.		2097					
Gleothece sp.					481		
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.			8208				
M. glauca							
M. major							
Microcystis sp.				63768	533333		
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

DATE: 7/24/73
SAMPLE TYPE: Net; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus	2650		3078				
S. arcuatus							
S. bijuga	5300						
S. dimorphus							
S. denticulatus		4195					
S. obliquus				3313			
S. quadricauda		6294	3591	8282		5728	
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.					5185		
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.	3975	3671	29754	6625	5185	8592	
UID colonial				7453			
UID desmid							
UID flagellate							
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular	4638	4720			37036	9547	
Volvox sp.							
TOTAL GREENS	47039	18880	52839	143181	48887	94604	
% OF TOTAL PHYTOPLANKTON	44.9	49	43.8	43.1	8.2	60.0	

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
Actinastrum sp.				59627	1481	66828	
A. gracillimum.							
A. hantzschii.							
Ankistrodesmus.							
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.				9938			
Chlorococcum sp.				1656			
Chodatella sp.				828			
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans.							
Franceia sp.							
Golenkinia radiata.							
Kirchneriella sp.							
Micractinium pusillum.							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.				19048			
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.	19876		16416	19876			
P. glanduliferum.	10600						
P. simplex.				6625			
P. tetras.						1909	

DATE: 7/24/73
SAMPLE TYPE: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric	663			15078			
UID pennate							
UID spined-centric							
TOTAL DIATOMS	45715	15209	3437	68908	7467	19094	
% OF TOTAL PHYTOPLANKTON	43.7	40	28.5	20.7	1.2	12	
B. EUGLENOIDS							
Euglena sp.							
Phacus sp.							
Trachelomonas sp.	663				2222		
UID euglenoids							
TOTAL EUGLENOIDS	663				2222		
% OF TOTAL PHYTOPLANKTON	0.6				3.7		

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE: Net, cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
							no sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa			513				
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.				828	741		
Coscinodiscus sp.	2650			828		1909	
Cyclotella sp.	15238	5245	10773	28986	4444	8592	
Cymbella sp.							
Diatoma sp.	1325			828	741	955	
Diploneis sp.		524					
Eunotia sp.	1988						
Fragilaria sp.							
Fragilaria crotonensis		1573					
Gomphonema sp.							
Gyrosigma sp.			513				
Hantzschia sp.							
Melosira sp.	21863	5245	17955	15735	1481	5728	
M. granulata							
Meridion circulare				828			
Navicula sp.	1988	2622	3078	4141			
Navicula sp A.							
Nitzschia sp.				828		955	
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.							
Surirella sp.							
S. patella							
Synedra sp.			1539	828		955	
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
					o Sample		No sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa				1088			
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.			1224	1088			
Coscinodiscus sp.	16655	10159	20805	17410		17308	
Cyclotella sp.	19986	19048	22029	11969		40386	
Cymbella sp.							
Diatoma sp.							
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis	11659						
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	38307	54603		27203		5769	
M. granulata							
Meridion circulare				1088			
Navicula sp.	1666		2448	1088		11539	
Navicula sp A.							
Nitzschia sp.						1442	
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.			3671				
Surirella sp.	3331	1270	1224			2885	
S. patella							
Synedra sp.						1442	
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 8/21/73
SAMPLE TYPE: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate		1270					
UID spined-centric							
TOTAL DIATOMS	91604	86350	51401	60934		80771	
% OF TOTAL PHYTOPLANKTON	16.8	11.6	4.1	8.7		3.5	
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Net; cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.		15238	19581		) Sample	11539	
A. gracillimum.							
A. hantzschii.			1224	16322		33175	
Ankistrodesmus.							
Asterococcus sp.							
Chlamydomonas sp.				6529		8654	
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.		1270					
Closterium sp.			39163	56581		7212	
Coelastrum sp.	3331	16508				23078	
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.				23938			
Eudorina sp.							
E. elegans.						1442	
Franceia sp.							
Golenkinia radiata.							
Kirchneriella sp.							
Micractinium pusillum.							
Micrasterias sp.							
Mougeotia sp.	18321	35556	3671	26115		2885	
Oocystis sp.				8705		2885	
Pandorina sp.		31746	55072	73991		17308	
P. charkowiensis.							
Pediastrum biradiatum.				8705			
P. duplex.	18321	60952	78325	87049		138468	
P. glanduliferum.							
P. simplex.		20317				92312	
P. tetras.							

DATE: 8/21/73
SAMPLE TYPE: Net; cells

C. GREENS cont'd.

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata			39163			23078	
Polyedriopsis sp.							
Protococcus sp.	6662	5079					
Scenedesmus sp.							
S. abundans			4895				
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus			11014	4352			
S. denticulatus							
S. obliquus			24477	14145		28847	
S. quadricauda							
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.							
UID colonial							
UID desmid							
UID flagellate							
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS							
% OF TOTAL PHYTOPLANKTON							

Roseton - Danskammer Phytoplankton

Date: 8/21/73
Sample type: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter No sample	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.			3671	5441		10097	
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS			3671	5441		10097	
% OF TOTAL PHYTOPLANKTON			0.3	0.8		0.4	
E. BLUE-GREENS							
Anabaena sp.			9791				
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.				18498		343285	
Aphanothece sp.							
Chroococcus sp.		134603	31820	6529		178854	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.	183207					12981	
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.			774686	70727		115390	
M. glauca							
M. major							
Microcystis sp.	49965	261587				646184	
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	149896	63492	81997	70727		364921	

Roseton - Danskammer Phytoplankton

Date: 8/21/73
Sample type: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial				92489		161546	
UID filamentous							
UID Gloeocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular			6119	3264			
TOTAL BLUE-GREENS	383068	459682	904413	262234		1823161	
% OF TOTAL PHYTOPLANKTON	70.3	61.9	73.0	37.3		78.9	
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	544624	742856	1238518	702917	No sample	2310682	

Roseton - Danskammer Phytoplankton

Date: 9/18/73
Sample type: Net; cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous	68921	157640	23326	64527			
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular							
TOTAL BLUE-GREENS	1488696	1677019	1104116	619462	054958	1313906	
% OF TOTAL PHYTOPLANKTON	84.7	86.6	73.6	61.9	78.3	85.2	
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1757486	1937514	1500665	1000761	47229	1542065	

Roseton - Danskammer Phytoplankton

Date: 9/18/73
Sample type: Net, cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
D. YELLOW-BROWNS (DINOFLAGELLATES)							
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Anabaena sp.	72367	259379				33356	
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.						93398	
Aphanothece sp.							
Chroococcus sp.	58583		138403	97378	5567	20014	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.	561707	395776	359227	202968	226858	293536	
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	727118	864224	583160	254589	822533	873602	

DATE: 9/18/73
SAMPLE TYPE: Net; cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.				1173			
Protococcus sp.							
Scenedesmus sp.	27568	13416	6220	9387	23660		
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus						5337	
S. denticulatus							
S. obliquus							
S. quadricauda						10674	
Schroedria sp.					1392		
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.				25811			
Spirogyra sp.							
Staurastrum sp.	3446	3354	1555				
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.	1723	1118					
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.							
UID colonial					36186	5337	
UID desmid							
UID flagellate		2236					
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular	1723	1118		1173			
Volvox sp.							
TOTAL GREENS	215377	183353	323460	247551	275570	172119	
% OF TOTAL PHYTOPLANKTON	12.3	9.5	21.6	24.7	20.5	11.2	

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Net, cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.		16770	10886				
A. gracillimum			7775				
A. hantzschii						9340	
Ankistrodesmus	1723	2236			1392		
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. minorum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.	3446		3110	1173			
Coelastrum sp.							
Cosmarium sp.	3447	6708		4693	1392		
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.	17230	38012		30504			
E. elegans							
Franceia sp.							
Golenkinia radiata	1723						
Kirchneriella sp.							
Micractinium pusillum	58583		108857		90465		
Micrasterias sp.							
Mougeotia sp.	60306	26832	74645	126708	61238	34691	
Oocystis sp.					4175		
Pandorina sp.	20676		35767				
P. charkowiensis							
Pediastrum biradiatum							
P. duplex	13784		24882	9386	33402	106740	
P. glanduliferum							
P. simplex		71553	79763	37543	22268		
P. tetras							

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate			1555	2346			
UID spined-centric							
TOTAL DIATOMS	53413	77142	73089	133748	16701	56040	
% OF TOTAL PHYTOPLANKTON	3.04	4.0	4.87	13.4	1.2	3.6	
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

DATE: 9/18/73
SAMPLE TYPE: Net; cells

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Net; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter No sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa							
Atthoya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.							
Coscinodiscus sp.	8615	7826	12441	11732	9742	18680	
Cyclotella sp.	17230	13416	12441	18772	4175	10674	
Cymbella sp.		1118					
Diatoma sp.					2784		
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.		39130					
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	17230	7826	34212	93858		24017	
M. granulata							
Meridion circulare							
Navicula sp.	6892	3354	6220	3520			
Navicula sp A.							
Nitzschia sp.							
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.			4665				
Surirella sp.	3446	4472	1555	3520		2669	
S. patella							
Synedra sp.							
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 10/16/73
SAMPLE TYPE: NET; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa							
Atthaya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.		1196	524				
Cosinodiscus sp.	2956	1196	9965	5901	5201	8385	2312
Cyclotella sp.	7095	14953	17308	2622	6687	8385	17725
Cymbella sp.							
Diatoma sp.							
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis				1967			
Gomphonema sp.							
Gyrosigma sp.		598					
Hantzschia sp.							
Melosira sp.	11736	29308	11539	45894	28979	37267	61652
M. granulata			524				
Meridion circulare	591	1196	3671	656	743	3727	3083
Navicula sp.							
Navicula sp A.	591	1196	524		1486		
Nitzschia sp.							
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.	591	2991	524			1863	
Surirella sp.	591		1573	1967			1541
S. patella							
Synedra sp.							
S. ulna							
Tabellaria sp.							
T. flocculosa		598					
T. ferestrata							

DATE: 10/16/73
SAMPLE TYPE: NET: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate	591	11364	1573				1541
UID spined-centric							
TOTAL DIATOMS	24742	64596	47725	59007	43096	59627	87854
% OF TOTAL PHYTOPLANKTON	1.56	2.58	2.06	3.21	2.35	2.17	3.47
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 10/16/73
SAMPLE TYPE: NET : Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii	75675	67587	43533	46549	53499	67081	27743
Ankistrodesmus	591	4187				2795	771
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Choda'ella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.					[illegible]		[illegible]
Closterium sp.					1486		1541
Coelastrum sp.		9570		7867			
Cosmarium sp.		598	524	656	1486	1863	
Crucigenia sp.							
Dictyosphaerium sp.		10766					
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans		8972			12632		
Franceia sp.							
Golenkinia radiata		598					
Kirchneriella sp.							
Micractinium pusillum		16149			15604	3727	12330
Micrasterias sp.				7867			
Mougeotia sp.	40202	40672	59793	38682	47555	27019	52404
Oocystis sp.				1311			3083
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex	18919	41868	9965	49827	23777	21429	21578
P. glanduliferum							
P. simplex			8392	20980	2377	29814	3083
P. tetras		21532					

DATE: 10/16/73
SAMPLE TYPE: NET : Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.	11824						
Protococcus sp.							
Scenedesmus sp.			4196				23119
S. abundans							
S. acuminatus				2622			
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliqu[illegible]	10642	26317	27274	26225	26006	11180	18496
S. quadricauda							
Schroedria sp.		5383					
Schroederia setigera							
Selenastrum sp.							8477
Sphaerocystis sp.							
Spirogyra sp.					743		
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.	1182	598					
Tetradesmus sp.							
Tetraedron sp.	2365	13757					
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.	41385		14161	5245		4658	11560
UID colonial							
UID desmid							
UID flagellate		598					
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular				1311			
Volvox sp.							
TOTAL GREENS	202785	269152	167838	209142	185165	169566	184185
% OF TOTAL PHYTOPLANKTON	12.80	10.75	7.26	11.38	10.1	6.17	7.27

Roseton - Danskammer Phytoplankton

Date: 10/16/73
Sample type: NET: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
D. YELLOW-BROWNS (DINOFLAGELLATES)							
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.		598					
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS		598					
% OF TOTAL PHYTOPLANKTON		0.024					
E. BLUE-GREENS							
Anabaena sp.	369508		848640	9179	344771	998758	1104336
A. flos-aquae							
A. spiroides		38877					
Aphanizomenon sp.							
Aphanocapsa sp.		283506	18357	34092			
Aphanothece sp.							
Chroococcus sp.	28969	55625	97032	22947	20805	120186	97101
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.						75466	
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.		168070			112942		
Merismopedia sp.							
M. glauca		76559					
M. major							
Microcystis sp.	185641		457364	559903	460686	516149	383011
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	624911	1542535	645659	943444	665022	798447	673545

Roseton - Danskammer Phytoplankton

Date: 10/16/73
Sample type: NET: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
E. BLUE-GREENS CON'T							
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial	7686		30421			9317	3083
UID filamentous	135979						
UID Gloecapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular	3547	3589					
TOTAL BLUE-GREENS	1356241	2168761	2097473	1569565	1604226	2518323	2261076
% OF TOTAL PHYTOPLANKTON	85.63	86.64	90.68	85.41	87.54	91.66	89.26
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1583768	2503107	2313036	1837714	1832487	2747516	2533115

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: NET: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa							
Atthoya zachariasi					874	552	
Ceratoneis sp.				1442			1346
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.					1311	1656	
Cosmindiscus sp.	3092	2636	4233	3846	2185	8834	3140
Cyclotella sp.	20869	4833	10582	5769	13987	40304	9869
Cymbella sp.	386			481			
Diatoma sp.						1104	
Diploneis sp.	773						
Eunotia sp.							
Fragilaria sp.	6570			2885			
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.	386				473	1656	
Hantzschia sp.							
Melosira sp.	240000	110285	213227	157699	338739	336232	209489
M. granulata							
Meridion circulare						552	
Navicula sp.	773	879		2885	1311	4969	1794
Navicula sp A.							
Nitzschia sp.					874	2760	
N. sigma							
Pinnularia sp.						552	
Rhoicosphenia curvata							
Stephanodiscus sp.	386			481	473	552	1346
Surirella sp.	386	439		481	1748	3313	448
S. patella							
Synedra sp.						552	
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 11/12/73
SAMPLE TYPE: NET: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	1546				473		
Chaetoceros-like	9662				4808		
TOTAL DIATOMS	284829	119072	228042	175969	367256	403588	227432
% OF TOTAL PHYTOPLANKTON	19.19	15.8	24.36	14.86	19.7	17.20	19.72
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: NET: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.							
A. gracillimum.							
A. hantzschii.	26280	14500	4232	4808	41085	23188	3140
Ankistrodesmus.		879	529		437	1104	
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	773				1311		
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.	8502						
C. subsalsa.							
C. quadrata.	35169				10490	8834	
Closteriopsis sp.							
Closterium sp.		439					
Coelastrum sp.				11539	5682		
Cosmarium sp.	386				437		
Crucigenia sp.							
Dictyosphaerium sp.	37488					99931	
Echinosphaerella sp.						552	
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.					6993		
E. elegans.							
Franceia sp.							
Golenkinia radiata.			529	481		552	448
Kirchneriella sp.							
Micractinium pusillum.	13526	1757	14815	12020			
Micrasterias sp.							
Mougeotia sp.	10821	10984	30159	24520	39337	8281	5383
Oocystis sp.	8116		2116		10490		
Pandorina sp.				4327		5521	
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.	27826		8995	962	14424	7729	13906
P. glanduliferum.						8281	
P. simplex.		7030					14355
P. tetras.	3092					4417	

DATE: 11/12/73
SAMPLE TYPE: NET : Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp							
Protococcus sp		1757					
Scenedesmus sp				1923			
S. abundans							
S. acuminatus	4638		5291		1748	6625	
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	2705				3497	2208	
S. obliquus							
S. quadricauda	10821	3515	13757	3846	10490	27053	8972
Schroedria sp							
Schroederia setigera							
Selenastrum sp							
Sphaerocystis sp	4638					24845	
Spirogyra sp							
Staurastrum sp					874	552	
Staurastrum aspinosa							
Stigeoclonium sp							
Tetradesmus sp			4232				
Tetraedron sp	386		529				
Tetraedron trigonum							
Tetrastrum sp	1546				1748	4417	
Ulothrix sp						2208	
UID colonial	61449	36469	122222	13943			37681
UID desmid							
UID flagellate						552	
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular		2636	1587	5289			2691
Volvox sp							
TOTAL GREENS	258162	79966	208993	83658	149043	236850	86576
% OF TOTAL PHYTOPLANKTON	17.4	10.6	22.33	7.07	7.99	10.09	7.51

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: NET; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Anabaena sp.	67633	228479	340741	368286	76052		342270
A. flos-aquae					5682		
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.		25045	4762		56821	71221	
Aphanothece sp.							
Chroococcus sp.	57971	20651	47090	52406	21417	31470	104071
Cylindrospermum sp.							
Dactylococcopsis sp.		439					
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	52174				268806	184955	
Merismopedia sp.				30771			62802
M. glauca						8834	
M. major							
Microcystis sp.	217584	90513	21164	216837	142052	266114	206798
M. aeruginosa						32022	
Nostoc sp.							
Oscillatoria sp.	545700	173556	85185	191355	708074	1111387	123361

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: NET : Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like					58569		
UID branched filamentous					10053		
UID colonial		13621		25963			
UID filamentous				38463			
UID Gloeocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular							
TOTAL BLUE-GREENS	941062	552304	498942	924081	1347526	1706003	839302
% OF TOTAL PHYTOPLANKTON	63.4	73.5	53.31	78.07	72.30	72.71	72.77
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1484053	751342	935977	1183708	1863825	2346441	1153310

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: NET; Cells

GROUP A. DIATOMS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.	798	840				1716	817
Asterionella formosa (A. sp.)	33527	47021	43156	69841	43892 (sp)	44619	35116
Attheya zachariasi							
Ceratoneis sp.		840				858	
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	798	1679			828	3432	1633
Coscinodiscus sp.	1596	2519		2381	2484	6006	1633
Cyclotella sp.	65457	83966	46855	58730	88613	89238	101265
Cymbella sp.							3267
Diatoma sp.		1679			1656	2574	
Diploneis sp.							
Eunotia sp.	798				17391		
Fragilaria sp.							
Fragilaria crotonensis (f. sp.)		1679 (sp.)	2466	44444	4969	66929	34299
Comphonema sp.							
Gyrosigma sp.		840	616			858	1633
Hantzschia sp.							
Melosira sp.	30334	78088	54253	63492	101035	93529	64516
M. granulata							
Meridion circulare	1596		616		2484	2574	1633
Navicula sp.	798	2519	1233	11637	4141	9439	5717
Navicula sp A.							
Nitzschia sp.	798	2519	616	40729	6625	1716	2450
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.		840				858	
Surirella sp.	1596	1679			4141	1716	1633
S. patella							
Synedra sp.	2395	1679	1849	3175		2574	2450
S. ulra							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 12/12/73
SAMPLE TYPE: NET: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	7184	21831	4316	3968	11594	6864	8166
Chaetoceros-like	3193		7398		4969		19600
TOTAL DIATOMS	150868	250218	163374	298397	294822	335500	285828
% OF TOTAL PHYTOPLANKTON	63.42	72.15	25.88	81.03	72.21	32.21	75.59
B. EUGLENOIDS							
Euglena sp.				794			
Phacus sp.							
Trachelomonas sp.	798						
UID euglenoids							
TOTAL EUGLENOIDS	798			794			
% OF TOTAL PHYTOPLANKTON	0.34			0.22			

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: NET: Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.	3193				2484		
A. gracillimum.							
A. hantzschii.			4932	4762			
Ankistrodesmus.	1596		616	2381	1656	5148	
Asterococcus sp.							
Chlamydomonas sp.	798		616		4141		817
Chlorella sp.	798	4198	616	3968	4969	3432	2450
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.						858	
C. quadrata.						35181	
Closteriopsis sp.	798			794			
Closterium sp.							
Coelastrum sp.			7398				
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.			88162		11594	30890	
Echinosphaerella sp.							817
Elaktothrix sp.				3175			
Euastrum sp.							
Eudorina sp.							
E. elegans.							
Franceia sp.							
Golenkinia radiata.		3359	616		4141	2574	
Kirchneriella sp.							
Micractinium pusillum.	1596				3313	4290	3267
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.			4316		3313		
Pandorina sp. (P. morum)						13729 (P. morum)	
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.				22222			
P. glanduliferum.							
P. simplex.							
P. tetras.							

DATE: 12/12/73
SAMPLE TYPE: NET : Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.				794		858	1633
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus	4789	13434	16646	9524	16563	13729	3267
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus					1656		
S. obliquus							
S. quadricauda	22351		2466		16563	12013	11433
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.				13492	3313	2574	4083
Sphaerocystis sp.			6782				
Spirogyra sp.							
Staurastrum sp.							1633
Staurastrum aspinosa		840					
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							817
Tetraedron trigonum							
Tetrastrum sp.		3359	4316	6349	9938		
Ulothrix sp.							
UID colonial		10076					
UID desmid		840					
UID flagellate				794			
UID filamentous							
UID four-spined	798	2519					2450
UID Gonium-like					19876		
UID unicellular							
Volvox sp.							
Carteria sp.				794			
TOTAL GREENS	36717	38625	137482	69049	103520	125276	32667
% OF TOTAL PHYTOPLANKTON	15.44	11.14	21.78	18.75	25.36	12.03	8.64

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type:NET ; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
				no sample			
Dinobryon sp.	4789		616		828		
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS	4789		616		828		
% OF TOTAL PHYTOPLANKTON	2.01		0.10		0.20		
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.			9864		6625		
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.		48700	308875			24026	20416
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.	39114					419593	38383
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	5588	8397	6165			99535	

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type: NET ; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous						37755	
UID Gleocapsa-like			4932		2484		
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular		840					817
TOTAL BLUE-GREENS	44702	57937	329836	no sample	9109	580909	59616
% OF TOTAL PHYTOPLANKTON	18.79	16.71	52.25		2.23	55.77	15.77
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	237874	346780	631308	368240	408279	1041685	378111

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 5/31/73
SAMPLE TYPE: FILTRATE: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa							
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.							
Coscinodiscus sp.							
Cyclotella sp.		130435	43478				
Cymbella sp.		43478					43478
Diatoma sp.						43478	
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.			173913				
M. granulata							
Meridion circulare		43478					
Navicula sp.	43478	391304	43478				130435
Navicula sp A.							
Nitzschia sp.		173913					43478
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.							
Surirella sp.			43478				86957
S. patella							
Synedra sp.		43478					
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 5/31/73
SAMPLE TYPE: FILTRATE: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	o./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric			43478				
UID pennate	86957					43478	
UID spined-centric							
TOTAL DIATOMS	130435	826085	347825			86956	304348
% OF TOTAL PHYTOPLANKTON	100	32.8	100			100	70
B. EUGLENOIDS							
Euglena sp							
Phacus sp							43478
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							43478
% OF TOTAL PHYTOPLANKTON							9.99

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 5/31/73
SAMPLE TYPE: FILTRATE: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii							
Ankistrodesmus							
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.							
Golenkinia radiata							
Kirchneriella sp.							
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex							
P. glanduliferum							
P. simplex							
P. tetras							

DATE: 5/31/73
SAMPLE TYPE: FILTRATE: Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda							
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.		1086957					
UID colonial							
UID desmid							
UID flagellate							
UID filamentous		434783					
UID four-spined							
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS		1521740					
% OF TOTAL PHYTOPLANKTON		60.2					

Roseton - Danskammer Phytoplankton

Date: 5/31/73
Sample type: FILTRATE: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate		130435					86957
TOTAL YELLOW-BROWNS		130435					86957
% OF TOTAL PHYTOPLANKTON		5.2					20
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.							
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

Roseton - Danskammer Phytoplankton

Date: 5/31/73
Sample type: FILTRATE: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.....							
Spirulina sp.....							
Synechococcus sp.....							
UID Aphanothece-like.....							
UID branched filamentous.....							
UID colonial.....							
UID filamentous.....							
UID Gleocapsa-like.....							
UID long cell.....							
UID sheathed cell.....							
UID two-celled colonial.....							
UID unicellular.....							
TOTAL BLUE-GREENS.....							
% OF TOTAL PHYTOPLANKTON.....							
F. OTHERS							
UID flagellate.....							
TOTAL OTHERS.....		43478					
% OF TOTAL PHYTOPLANKTON.....		1.7					
G. TOTAL PHYTOPLANKTON	130435	2521738	347825			86961	434783

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: FILTRATE: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
					no sample	no sample	no sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa			86957				
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.			86957				
Coscinodiscus sp.		43478					
Cyclotella sp.		130435	260870	86957			
Cymbella sp.				43478			
Diatoma sp.							
Diploneis sp.							
Eunotia sp.		43478					
Fragilaria sp.							
Fragilaria crotonensis			43478				
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	130435	434783	391304	86957			
M. granulata							
Meridion circulare							
Navicula sp.	43478	86957	43478				
Navicula sp A.							
Nitzschia sp.							
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.							
Surirella sp.			43478				
S. patella							
Synedra sp.		43478					
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 6/26/73
SAMPLE TYPE: FILTRATE; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric							
TOTAL DIATOMS	173913	782609	956522	217392			
% OF TOTAL PHYTOPLANKTON	40	78.3	79	83			
B. EUGLENOIDS							
Euglena sp.							
Phacus sp.							
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: FILTRATE : Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE ./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii							
Ankistrodesmus							
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.							
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.							
Golenkinia radiata							
Kirchneriella sp.							
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex							
P. glanduliferum							
P. simplex							
P. tetras							

DATE: 6/26/73
SAMPLE TYPE: FILTRATE: Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE ./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda		173913					
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.			260870				
UID colonial							
UID desmid							
UID flagellate							
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS		173913	260870				
% OF TOTAL PHYTOPLANKTON		17.4	21				

Roseton - Danskammer Phytoplankton

Date: 6/26/73
Sample type: FILTRATE: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
D. YELLOW-BROWNS (DINOFLAGELLATES)							
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate		43478		43478			
TOTAL YELLOW-BROWNS		43478		43478			
% OF TOTAL PHYTOPLANKTON		4.3		17			
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.	260870						
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

Roseton - Danskammer Phytoplankton

Date: 6/26/73
Sample type: FILTRATE : Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular							
TOTAL BLUE-GREENS	260870						
% OF TOTAL PHYTOPLANKTON	60						
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	434783	1000000	1217392	260870			

Roseton - Danskammer Phytoplankton

Date: 7/24/73
Sample type: Filtrate; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.	347826		86957		869565		
UID Aphanothece-like.							
UID branched filamentous.							
UID colonial.							
UID filamentous.							
UID Gleocapsa-like.							
UID long cell.							
UID sheathed cell.							
UID two-celled colonial.							
UID unicellular.	86957		43478				
TOTAL BLUE-GREENS.	347826	86957	1000000		869565		
% OF TOTAL PHYTOPLANKTON.	47.1	5.6	60.5		44.4		
F. OTHERS							
UID flagellate.							
TOTAL OTHERS.							
% OF TOTAL PHYTOPLANKTON.							
G. TOTAL PHYTOPLANKTON	739131	782609	1652174	391304	1956521	260869	

Roseton - Danskammer Phytoplankton

Date:7/24/73
Sample type: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.			347826				
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.			521739				
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

DATE: 7/24/73
SAMPLE TYPE: Filtrate: Cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliqu[illegible]							
S. quadricauda							
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.							
UID colonial	86957		43478		173913		
UID desmid							
UID flagellate							
UID filamentous				43478			
UID four-spined			130435				
UID Gonium-like							
UID unicellular		173913		217391	521739	130435	
Volvox sp.							
TOTAL GREENS	217392	391305	217391	260869	826087	130435	
% OF TOTAL PHYTOPLANKTON	29.4	50	13.2	66.7	42.2	50	

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE: Filtrate Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.		86957					
A. gracillimum.							
A. hantzschii.							
Ankistrodesmus.							
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	130435		43478		30435		
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.							
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans.							
Franceia sp.							
Golenkinia radiata.							
Kirchneriella sp.							
Micractinium pusillum.		130435					
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.							
P. glanduliferum.							
P. simplex.							
P. tetras.							

DATE: 7/24/73
SAMPLE TYPE: Filtrate Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric	43478						
UID pennate							
UID spined-centric							
TOTAL DIATOMS	173913	260869	434783	130435	50869	130434	
% OF TOTAL PHYTOPLANKTON	23.5	33.3	26.3	33.3	13.3	50	
B. EUGLENOIDS							
Euglena sp.							
Phacus sp.							
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
							no sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa							
Atthoya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.							
Coscinodiscus sp.							
Cyclotella sp.		130435	43478	130435	43478	43478	
Cymbella sp.							
Diatoma sp.							
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	130435	43478	260870		130435	43478	
M. granulata							
Meridion circulare							
Navicula sp.			86957				
Navicula sp A.							
Nitzschia sp.		43478			43478		
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.			43478			43478	
Surirella sp.							
S. patella							
Synedra sp.		43478			43478		
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Filtrate Cells

GROUP A. DIATOMS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter o sample	RI no./liter	DI no./liter no sample
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	493	1697		618			
Atthaya zachariasi		1697					
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	4926	10180	9856	6798		3687	
Coscinodiscus sp.			2190	618			
Cyclotella sp.	89651	398727	156601	117419		217553	
Cymbella sp.	1478	11877	2190	2472		922	
Diatoma sp.	493		1095			922	
Diploneis sp.							
Eunotia sp.	493						
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.		1697		618			
Gyrosigma sp.							
Hantzschia sp.		1697					
Melosira sp.	26600	76352	30663	11742		41483	
M. granulata							
Meridion circulare	493	13574	1095	618			
Navicula sp.	18226	30541	37234	27810		47935	
Navicula sp A.							
Nitzschia sp.	493	42418	1095	618		2766	
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata	493	1697					
Stephanodiscus sp.							
Surirella sp.	1478			618		1844	
S. patella							
Synedra sp.		3393		618			
S. ulna							
Tabellaria sp.							
T. flocculosa	493						
T. fenestrata							

DATE: 8/21/73
SAMPLE TYPE: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate			1095			1844	
UID spined-centric							
TOTAL DIATOMS	145810	595547	243114	170567		318956	
% OF TOTAL PHYTOPLANKTON	27.7	17.7	33.4	21.6		30.5	
B. EUGLENOIDS							
Euglena sp.		8484					
Phacus sp.							
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS		8484					
% OF TOTAL PHYTOPLANKTON		0.25					

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Filtrate, Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.	6404					7375	
A. gracillimum							
A. hantzschii							
Ankistrodesmus sp	3941	30541	9856	13596		12906	
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	6896	57688	9856	20394		19359	
Chlorococcum sp.							
Chodatella sp.							
C. longiseta	493						
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.	9852		8761	21012		23968	
Cosmarium sp.		13574					
Crucigenia sp.	7881	67869	4380	32136		16593	
Dictyosphaerium sp.	11822	50901					
Echinosphaerella sp.		1697					
Elaktothrix sp.							
Euastrum sp.		8484					
Eudorina sp.							
E. elegans							
Franceia sp.				1236			
Golenkinia radiata						922	
Kirchneriella sp.							
Micractinium pusillum	1970	8484				15671	
Micrasterias sp.							
Mougeotia sp.		3393	4380	1236		1844	
Oocystis sp.	1970	32238	12046	1236		10140	
Pandorina sp.		13574	13141			14749	
P. charkowiensis							
Pediastrum biradiatum	14778						
P. duplex		16967	9856	5562		14749	
P. glanduliferum							
P. simplex							
P. tetras		50901	15332	12978		7375	

DATE: 8/21/73
SAMPLE TYPE: Filtrate Cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata			17522				
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans				1236		1844	
S. acuminatus				2472		6453	
S. arcuatus							
S. bijuga	3941	11877					
S. dimorphus							
S. denticulatus	6896	27147	8761	2472		16593	
S. obliquus							
S. quadricauda	27092	186638	53660	32136		36873	
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.		20361					
Sphaerocystis sp.						41483	
Spirogyra sp.							
Staurastrum sp.	493			618			
Staurastrum aspinosa							
Stigeoclonium sp.				35844			
Tetradesmus sp.							
Tetraedron sp.	493	6787	2190	2472		2766	
Tetraedron trigonum							
Tetrastrum sp.	1970	37328	4380	16686		7375	
Ulothrix sp.	10837	39024		15450		10140	
UID colonial	985						
UID desmid	2463		8761	4944		14749	
UID flagellate							
UID filamentous			4380				
UID four-spined				618			
UID Gonium-like							
UID unicellular			1095	1854		922	
Volvox sp.							
TOTAL GREENS	121177	685473	188357	226188		284849	
% OF TOTAL PHYTOPLANKTON	23.0	20.4	25.9	28.7		27.2	

Roseton - Danskammer Phytoplankton

Date: 8/21/73
Sample type: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.		1697	2190				
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS		1697	2190				
% OF TOTAL PHYTOPLANKTON		0.05	0.3				
E. BLUE-GREENS							
Anabaena sp.	14778	6787					
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.		22057	131413	31518		78356	
Aphanothece sp.							
Chroococcus sp.	27092	74655	15332	15450		21202	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.	5911						
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.	63051	1303075	17522	187870		276550	
M. glauca							
M. major							
Microcystis sp.		190032		9888			
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	122654	332556	99655	110003		28577	

Roseton - Danskammer Phytoplankton

Date: 8/21/73
Sample type: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.		10180		4326			
Synechococcus sp.							
UID Aphanothece-like		16967					
UID branched filamentous		8484				11984	
UID colonial	1970	45811					
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular	19703	55992	30663	32136		25811	
TOTAL BLUE-GREENS	255159	2066596	294585	391191		442480	
% OF TOTAL PHYTOPLANKTON	48.5	61.5	40.5	49.6		42.3	
F. OTHERS							
UID flagellate	3448						
TOTAL OTHERS	3448						
% OF TOTAL PHYTOPLANKTON	0.65						
G. TOTAL PHYTOPLANKTON	525594	3357797	728246	787946		1046285	

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Filtrate: Cells

GROUP A. DIATOMS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Achnanthes sp.							no sample
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	4348	2457		4013		6616	
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.	130435						
Chaetoceros sp A.							
Cocconeis sp.	4348	4915	24201	24080	37027	13233	
Coscinodiscus sp.							
Cyclotella sp.	300000	233459	321529	345150	23983	244802	
Cymbella sp.	4348	4915		8027		6616	
Diatoma sp.							
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis	39130						
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	147826	63894	165951	212709	175877	119093	
M. granulata	34783						
Meridion circulare	4348	2457	3457	12040			
Navicula sp.	121739	73724	58774	76254	83310	86011	
Navicula sp A.							
Nitzschia sp.	39130	14745	24201	56187	27770	19849	
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata	4348						
Stephanodiscus sp.	4348						
Surirella sp.		2457		4013		13233	
S. patella							
Synedra sp.						6616	
S. ulna							
Tabellaria sp.							
T. flocculosa		2457					
T. fenestrata							

DATE: 9/18/73
SAMPLE TYPE: Filtrate Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric							
TOTAL DIATOMS	839131	405480	598113	742473	647967	516069	
% OF TOTAL PHYTOPLANKTON	4.3	4.3	6.3	4.4	5.5	6.9	
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Filtrate : Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							no sample
A. gracillimum.							
A. hantzschii.	186957	56522	13829	56187	46283	119093	
Ankistrodesmus sp.	34783	49149	20744	24080	55540	79395	
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	65217	44234	58774	64214	37027	39698	
Chlorococcum sp.							
Chodatella sp.						6616	
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.						6616	
Closterium sp.	13043			4013			
Coelastrum sp.	95652		41488	56187			
Cosmarium sp.	43478	14745	34573		55540	72779	
Crucigenia sp.	17391			28094			
Dictyosphaerium sp.		46692			29593		
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.			3457		9257		
Eudorina sp.			69146				
E. elegans.							
Franceia sp.							
Golenkinia radiata.		4915		44147		33081	
Kirchneriella sp.	13043		10372	12040	9257		
Micractinium pusillum.							
Micrasterias sp.							
Mougeotia sp.	286957	83554	127920	131868	38850	19849	
Oocystis sp.			6915	40134	37027	19849	
Pandorina sp.							
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.	39130	7372	82975	20067			
P. glanduliferum.							
P. simplex.							
P. tetras.	104348	86011	100262	92308	74053	52930	

DATE: 9/18/73
SAMPLE TYPE: Filtrate: Cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							no sample
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.		24575		16054			
S. abundans							
S. acuminatus	17391			16054		66163	
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	52174	88469	44945	56187	129593		
S. obliquus							
S. quadricauda	230435	267864	276584	224749	166620	291115	
Schroedria sp.	4348	2457	10372				
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.	17391	14745	10372	24080	9257	33081	
Tetraedron trigonum							
Tetrastrum sp.	108696	98299	27658	124415	111080	79359	
Ulothrix sp.				32107			
UID colonial							
UID desmid							
UID flagellate							
UID filamentous							
UID four-spined	4348					6616	
UID Gonium-like							
UID unicellular			17286		9257		
Volvox sp.							
TOTAL GREENS	1334782	889603	957672	1066985	018234	926276	
% OF TOTAL PHYTOPLANKTON	6.9	9.5	10.1	6.3	8.6	12.4	

Roseton - Danskammer Phytoplankton

Date: 9/18/73
Sample type: Filtrate : Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.	no sample		no sample		o ample	no sample	no sample
Glenodinium sp.							
Peridinium sp.		7372		8027			
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS		7372		8027			
% OF TOTAL PHYTOPLANKTON		0.08		0.05			
E. BLUE-GREENS							
Anabaena sp.		19660					no sample
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.	434783	331758					
Aphanothece sp.							
Chroococcus sp.	10000	127788	162493	152508	2567	105860	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	1447826	110095	1216972	461538		694707	
Merismopedia sp.		98299	193609	139895	4053	211720	
M. glauca		157278			96213		
M. major							
Microcystis sp.	104348	88469					
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	15217391	7035728	6357988	14327759	552875	4896030	

Roseton - Danskammer Phytoplankton

Date: 9/18/73
Sample type: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
							no sample
Phormidium sp.	17391	17202	20744	32107			
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell		14745		32107		13233	
UID two-celled colonial	52174	56522	17286	40134	92567	86011	
UID unicellular							
TOTAL BLUE-GREENS	17283913	8057544	7969092	15186048	)108275	6007561	
% OF TOTAL PHYTOPLANKTON	88.8	86.1	83.7	89.3	85.8	80.6	
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	19457826	9359999	9524877	17003533	11774476	7449906	

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 10/16/79
SAMPLE TYPE: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa				6358	4937		
Attheya zachariasi							
Ceratoneis sp.				76297			73968
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.		5270	7635		9874		6164
Coscinodiscus sp.							
Cyclotella sp.	225617	258250	305408	527723	97488	248276	277380
Cymbella sp.			7635				
Diatoma sp.	7050						
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.					4937	5397	
Hantzschia sp.							
Melosira sp.	28202	110679	129798	260683	96986	118741	18492
M. granulata	21151						
Meridion circulare			7635				
Navicula sp.	56404	31622	61082	31791	88870	86357	61640
Navicula sp A.							
Nitzschia sp.	28202	31622	38176	25432	9874	43178	6164
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							6164
Stephanodiscus sp.	7050					5397	12328
Surirella sp.	7050	5270		6358		5397	
S. patella							
Synedra sp.		5270		6358			6164
S. ulna							
Tabellaria sp.							
T. flocculosa							6164
T. fenestrata							

DATE: 10/16/73
SAMPLE TYPE: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric							
TOTAL DIATOMS	380726	447983	557369	941000	52966	512743	474628
% OF TOTAL PHYTOPLANKTON	2.4	2.8	2.84	3.56	2.89	3.63	3.3
B. EUGLENOIDS							
Euglena sp			7635	6358	4937		
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS			7635	6358	4937		
% OF TOTAL PHYTOPLANKTON			0.039	0.024	0.026		

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 10/16/73
SAMPLE TYPE:Filtrate: Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.	77556						
A. gracillimum.							
A. hantzschii.		126490	61082	152595		64768	
Ankistrodesmus.	112808	89597	106893	69939	34560	59370	43148
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	49354	31622	68717	95372	19749	26987	36984
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.			7635				
C. quadrata.							
Closteriopsis sp.							
Closterium sp.	7050		7635	12716	4937	5397	
Coelastrum sp.		31622				43178	
Cosmarium sp.	28202	10541		44507	14812	5397	12328
Crucigenia sp.							
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.			15270				
Eudorina sp.							
E. elegans.							
Franceia sp.							
Golenkinia radiata.		15811		6358	9874	21589	
Kirchneriella sp.							24656
Micractinium pusillum.							
Micrasterias sp.							
Mougeotia sp.	77556	26352	61082	139878	19749	5397	
Oocystis sp.				12716		16192	
Pandorina sp.							
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.							49312
P. glanduliferum.							
P. simplex.							
P. tetras.	56404	79056	198515	50865	33304	86357	55476

DATE: 10/16/73
SAMPLE TYPE: Filtrate: Cells

C.. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus	28202	15811	15270				24656
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							24656
S. obliquus							
S. quadricauda	169213	115949	221421	165311	08618	183508	110952
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.	7050		7635		4937		6164
Tetraedron trigonum							
Tetrastrum sp.	296122	284602	152704	349696	22174	145727	339020
Ulothrix sp.							
UID colonial				6358			
UID desmid							
UID flagellate							
UID filamentous			7635	12716			
UID four-spined							
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS	909517	827453	931494	1119027	72714	663867	727352
% OF TOTAL PHYTOPLANKTON	5.6	5.2	4.75	4.24	2.99	4.7	5.1

Roseton - Danskammer Phytoplankton

Date: 10/16/73
Sample type: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.	7050					5397	
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS	7050					5397	
% OF TOTAL PHYTOPLANKTON	0.04					0.04	
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides	253819			336980			
Aphanizomenon sp.							
Aphanocapsa sp.						32384	332856
Aphanothece sp.							
Chroococcus sp.	91657	52704	389395	89014	39498	151124	61640
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	2897767	342577	2191304	2168116	22000		2619703
Merismopedia sp.	84606			50865	78995	86357	49312
M. glauca	211516	927593		203460	73971	10795	197248
M. major							
Microcystis sp.						464168	
M. aeruginosa							30820
Nostoc sp.		100138		63581			
Oscillatoria sp.	11273795	13291982	15476563	21344178	6366811	12143927	9634342

Roseton - Danskammer Phytoplankton

Date: 10/16/73
Sample type: Filtrate; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							12328
UID unicellular	77556	47434	38176	82655	19749	53973	28178
TOTAL BLUE-GREENS	14890716	14762428	18095438	24338849	001024	12942728	12966427
% OF TOTAL PHYTOPLANKTON	91.99	92.0	92.36	92.17	94.1	92.6	91.5
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	16188009	16037864	19591936	26405234	131641	14124735	14168407

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: Filtrate : Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa				12204			10010
Attheya zachariasi			5884				
Ceratoneis sp.	4983						
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	4983			18307	9739	5561	5005
Coscinodiscus sp.			17652			5561	
Cyclotella sp.	403661	350725	470712	427155	365217	372598	355359
Cymbella sp.					9739		10010
Diatoma sp.						5561	
Diploneis sp.			5884			5561	
Eunotia sp.							
Fragilaria sp.	34884						
Fragilaria crotonensis							
Gomphonema sp.							5005
Gyrosigma sp.			11768	12204		5561	10010
Hantzschia sp.							
Melosira sp.	433562	278161	276542	189168	180174	628412	125126
M. granulata							
Meridion circulare	9967		5884		9739		10010
Navicula sp.	44851	60470	35303	97635	19478	77856	65066
Navicula sp A.							
Nitzschia sp.	14950	12094	58839	61022	14609	22245	40040
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata				6102			5005
Stephanodiscus sp.							
Surirella sp.	4983			6102	4870	22245	
S. patella							
Synedra sp.				6102			
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							5005

DATE: 11/12/73
SAMPLE TYPE: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric	14950						
UID pennate							
UID spined-centric	4983		5884	6102	4870		
TOTAL DIATOMS	976757	701450	894352	842103	618435	1151161	645651
% OF TOTAL PHYTOPLANKTON	8.94	5.64	7.37	5.23	5.8	9.00	5.7
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: Filtrate : Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii	29901						10010
Ankistrodesmus	4983	36282	23535	73226	9739	5561	
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	44851	18141	58839	36613	19478	5561	25025
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata	139537				19478		
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.	4983	6047		12204	9739	5561	10010
Crucigenia sp.		314443		195271		66734	60061
Dictyosphaerium sp.	259141			54920			205207
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans		84658					
Franceia sp.					9739		
Golenkinia radiata							5005
Kirchneriella sp.							
Micractinium pusillum	19934						
Micrasterias sp.							
Mougeotia sp.	119603		235355		38956	22245	55056
Oocystis sp.				12204		16683	
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex						44489	
P. glanduliferum							
P. simplex							
P. tetras	19934	18141		42715		33367	

DATE: 11/12/73
SAMPLE TYPE: Filtrate: Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda	29901	78611	70607	85431	68174	77856	55056
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.					38956		
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.			5884				
Tetraedron trigonum							
Tetrastrum sp.	74752	169315	41187	115942		88979	80080
Ulothrix sp.							
UID colonial							
UID desmid							
UID flagellate	29901	6047					
UID filamentous							
UID four-spined	19934	24188					
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS	797355	755873	435407	628526	214259	367036	505510
% OF TOTAL PHYTOPLANKTON	7.29	6.08	3.59	3.9	2.0	2.87	4.47

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: Filtrate, Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Aphanothece-like			47071			122346	40040
Anabaena sp.	84719		241239	183066		150152	80081
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.				67124	87652	278059	
Aphanothece sp.	34884						
Chroococcus sp.	99669	193503	182400	12204	38956	116785	145147
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.					14609		
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	573099	2104348	400104	317315	754783	1657229	755763
Merismopedia sp.			1035563				
M. glauca	159471						
M. major							
Microcystis sp.							135136
M. aeruginosa					199652		
Nostoc sp.							
Oscillatoria sp.	8177879	8610894	8878781	13986268	8701913	8875631	9009100

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.						55612	
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial	9967	24188					
UID unicellular	14950	36282	5884	61022	9739	11122	
TOTAL BLUE-GREENS	9154638	10969215	10791042	14626999	9807304	11266936	10165267
% OF TOTAL PHYTOPLANKTON	83.77	88.3	89.03	90.86	92.17	88.12	89.83
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	10928750	12426538	12120801	16097628	10639998	12785133	11316428

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.	4695						
Amphiprora sp.							
Amphora sp.			5332				
Asterionella formosa	93913	110049	26658	40729	102568	130435	105485
Atthaya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.			15995	145460	212461		
Chaetoceros sp A.							
Cocconeis sp.	23478		10663			10435	5552
Coscinodiscus sp.						10435	5552
Cyclotella sp.	493043	492600	613139	535294	527491	542609	749498
Cymbella sp.	9391	15721	5332	5818	14653	20869	5552
Diatoma sp.	4695						5552
Diploneis sp.							
Eunotia sp.						5217	
Fragilaria sp.					7326		
Fragilaria crotonensis		15721	15995	5818	7326	5217	
Gomphonema sp.					7326		
Gyrosigma sp.							
Hantzschia sp.	258261	282983	287909	407289	117220	401739	532976
Melosira sp.							
M. granulata		5240				5217 (sp)	
Meridion circulare	79826	89087	58648	5818	58610	57391	88829
Navicula sp.			5332				
Navicula sp A.	42261	89087	58648		29305	78261	66622
Nitzschia sp.							
N. sigma						5217	
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.		5240					11104
Surirella sp.			10663				
S. patella		20962	10663	5818	7326	10435	16655
Synedra sp.							
S. ulna							
Tabellaria sp.							
T. flocculosa						10435	
T. fenestrata							

DATE: 12/12/73
SAMPLE TYPE: Filtrate Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	65739	78606	31990	34910	58610	26087	66622
TOTAL DIATOMS	1075302	1205296	1156967	1186954	1150222	1319999	1659999
% OF TOTAL PHYTOPLANKTON	80.35	54.25	79.49	66.02	64.88	77.85	72.75
B. EUGLENOIDS							
Euglena sp.	4695						
Phacus sp.							
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS	4695						
% OF TOTAL PHYTOPLANKTON	0.35						

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: Filtrate; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum.							
A. hantzschii.							
Ankistrodesmus.	32869	5240	10663	34910	36631	20869	33311
Asterococcus sp.	4695						
Chlamydomonas sp.							
Chlorella sp.	18783	26202		11637	14653	5217	33311
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.		83847		69821			
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.			10663				
Crucigenia sp.							
Dictyosphaerium sp.		78606	79975	5818	43958		199866
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans.						83478	
Franceia sp.							
Golenkinia radiata.	4695		5332	23274	7326		5552
Kirchneriella sp.							
Micractinium pusillum.	32869						
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis.							
Pediastrum biradiatum.							
P. duplex.	23478	5240					
P. glanduliferum.							
P. simplex.							
P. tetras.							

DATE: 12/12/73
SAMPLE TYPE: Filtrate : Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus				23274	58610	41739	22207
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda		41923		11637	29305	41739	11104
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.		36683	42653	11637	51284	67826	33311
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.					14653		
Staurastrum aspinosa							
Stigeoclonium sp.						15652	
Tetradesmus sp.							
Tetraedron sp.		5240					
Tetraedron trigonum							
Tetrastrum sp.	37565	20962	42653	116368	80589	41739	
Ulothrix sp.							
UID colonial							
UID desmid							
UID flagellate	4695	26202			51284	15652	22207
UID filamentous							
UID four-spined		26202	21327	23274	7326	10435	5552
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS	164344	361587	213266	372379	302945	344346	366421
% OF TOTAL PHYTOPLANKTON	12.28	16.27	14.65	20.71	22.73	20.31	16.06

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type: Filtrate: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.			5332		14653		5552
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS			5332		14653		5552
% OF TOTAL PHYTOPLANKTON			0.37		0.83		0.24
E. BLUE-GREENS							
Anabaena sp.	70435			226918			
A. flos-aquae		628851					
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.			21327				55518
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							172107
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.			42653		13851		
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.		26202				20869	

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type: Filtrate: Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
E. BLUE-GREENS CON'T							
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular	23478		15995	11637	51284	10435	22207
TOTAL BLUE-GREENS	93913	655053	79975	238555	205135	31304	249832
% OF TOTAL PHYTOPLANKTON	7.0	29.48	5.49	13.27	11.57	1.85	10.95
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1338254	2221936	1455540	1797888	1772955	1695649	2281804

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
					no sample	no sample	no sample
Achnanthes sp.	5,097	4,444	2,053				
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	229,348	164,444	100,603				
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	30,580	4,444	18,478				
Coscinodiscus sp.	5,097	17,778	10,266				
Cyclotella sp.	290,507	284,444	160,145				
Cymbella sp.	5,097	4,444	6,159				
Diatoma sp.	20,386	8,889					
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.			6,159				
Fragilaria crotonensis		4,444					
Gomphonema sp.			4,106				
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	631,981	364,444	388,043				
M. granulata							
Meridion circulare	10,193	17,778	8,213				
Navicula sp.	107,029	88,889	49,275				
Navicula sp A.							
Nitzschia sp.	50,966	40,000	45,169				
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.	10,193	8,889	6,159				
Surirella sp.	15,290	17,778	8,123				
S. patella							
Synedra sp.	10,193	4,444					
S. ulna							
Tabellaria sp.			12,319				
T. flocculosa							
T. fenestrata							

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate		4,449					
UID spined-centric							
TOTAL DIATOMS	1421,957	1,053,331	825,360				
% OF TOTAL PHYTOPLANKTON	72.66	73.6	72.0				
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

DATE: 6/26/73
SAMPLE TYPE: Whole Water; Cells

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 6/26/73
SAMPLE TYPE: Whole Water; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.	40,773						
A. gracillimum							
A. hantzschii							
Ankistrodesmus			2,053				
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	25,483	8,889	6,159				
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.							
Coelastrum sp.							
Cosmarium sp.			2,053				
Crucigenia sp.		71,111					
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.							
Golenkinia radiata	5,097						
Kirchneriella sp.							
Micractinium pusillum		31,111					
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.	50,966		12,319				
P. charkowiensis							
Pediastrum biradiatum							
P. duplex							
P. glanduliferum							
P. simplex							
P. tetras		35,556					

DATE: 6/26/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans	40,773						
S. acuminatus							
S. arcuatus							
S. bijuga	117,222						
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda	71,353	88,889	54,435				
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum							
Tetrastrum sp.							
Ulothrix sp.							
UID colonial			2,035				
UID desmid							
UID flagellate							
UID filamentous	5,097						
UID four-spined	122,319	97,778	55,435				
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS	479,093	333,334	135,507				
% OF TOTAL PHYTOPLANKTON	24.48	23.3	11.8				

Roseton - Danskammer Phytoplankton

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.	10,193						
Peridinium sp.	5,097	4,444	4,106				
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS	15,290	4,444	4,106				
% OF TOTAL PHYTOPLANKTON	.78	0.3	.4				
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.	20,386	22,222	90,338				
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.							
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.							

Date: 6/26/73
Sample type: Whole Water; Cells

Roseton - Danskammer Phytoplankton

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.	15,290	17,778					
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular	5,097		90,338				
TOTAL BLUE-GREENS	40,773	40,000	180,676				
% OF TOTAL PHYTOPLANKTON	2.08	2.0	15.8				
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1,957,113	1,431,109	1,145,649	0			

Date: 6/26/73
Sample type: Whole Water; Cells

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							no sample
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	5,217		7,536	2,560			
Attheya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	15,652		7,536	5,121	7,222		
Coscinodiscus sp.	5,217			1,024	1,667		
Cyclotella sp.	777,319	277,712	101,739	204,831	322,222	177,958	
Cymbella sp.	10,435	33,867	7,536	1,536	2,778	2,781	
Diatoma sp.		6,773	3,768	1,024	5,556	5,561	
Diploneis sp.							
Eunotia sp.			11,304	2,048			
Fragilaria sp.							
Fragilaria crotonensis			3,768				
Gomphonema sp.		6,773					
Gyrosigma sp.							
Hantzschia sp.							
Melosira sp.	349,565	243,844	150,725	123,923	843,889	130,688	
M. granulata		40,641	3,768	1,536	8,333		
Meridion circulare	219,130	47,414	45,217	53,256	15,111	5,005	
Navicula sp.							
Navicula sp A.	15,652	6,773	26,377	512	2,778	2,781	
Nitzschia sp.							
N. sigma							
Pinnularia sp.		13,547		1,024			
Rhoicosphenia curvata							
Stephanodiscus sp.	5,217	6,773	3,768	1,024	1,667		
Surirella sp.			3,768	3,072	3,333		
S. patella							
Synedra sp.	10,435	6,773	7,536	2,560	1,667	2,781	
S. ulna							
Tabellaria sp.				1,536			
T. flocculosa							
T. fenestrata							

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	26,087			512	13,333	2,781	
TOTAL DIATOMS	1,439,998	690,890	384,346	407,099	365,556	330,336	
% OF TOTAL PHYTOPLANKTON	66.0	40.8	40.0	51.6	52.5	60.6	
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

DATE: 7/24/73
SAMPLE TYPE: Whole Water; Cells

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 7/24/73
SAMPLE TYPE: Whole Water; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.	41,739			2,048		22,245	
A. gracillimum							
A. hantzschii							
Ankistrodesmus	5,217	13,547	3,786	3,072	10,556	11,122	
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	15,652	33,867	30,145	33,797	215,000	11,122	
Chlorococcum sp.							
Chodatella sp.		6,773			1,667		
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.				2,560		2,781	
Coelastrum sp.					45,000		
Cosmarium sp.			15,072				
Crucigenia sp.	20,870	216,751	71,594	57,353	48,889	77,856	
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.							
Golenkinia radiata					4,444		
Kirchneriella sp.							
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.			30,145	12,290			
P. charkowiensis							
Pediastrum biradiatum							
P. duplex	83,478		60,290		44,444		
P. glanduliferum							
P. simplex	318,261	108,375		16,386			
P. tetras		54,188	30,145		31,111		

DATE: 7/24/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus					13,333		
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	20,870						
S. obliquus							
S. quadricauda	73,040	142,243	15,072	21,507	43,333	16,684	
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.				512		2,781	
Tetraedron trigonum	20,870	54,188					
Tetrastrum sp.							
Ulothrix sp.	99,130	47,414	37,681	14,338	169,444		
UID colonial	20,870						
UID desmid	5,217			1,024	2,778		
UID flagellate							
UID filamentous			120,580				
UID four-spined							
UID Gonium-like							
UID unicellular		27,094					
Volvox sp.					333,333		
TOTAL GREENS	725,217	704,440	414,492	164,887	963,332	14,591	
% OF TOTAL PHYTOPLANKTON	33.3	41.6	43.1	20.9	37.1	26.6	

Roseton - Danskammer Phytoplankton

Date: 7/24/73
Sample type: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.		40,641	11,304	4,097	20,556		
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS		40,641	11,304	4,097	20,556		
% OF TOTAL PHYTOPLANKTON		2.4	1.2	.5	0.79		
E. BLUE-GREENS							
Anabaena sp.							
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.		115,149	56,522	28,164	117,222	25,025	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.				6,145			
M. glauca							
M. major							
Microcystis sp.				134,164			
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.				32,773			

Roseton - Danskammer Phytoplankton

Date: 7/24/73
Sample type: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.		81,281			22,222	22,245	
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial			37,681				
UID filamentous							
UID Gleocapsa-like							
UID long cell					8,333		
UID sheathed cell				512			
UID two-celled colonial							
UID unicellular	10,435	60,961	56,522	11,265	99,444	22,245	
TOTAL BLUE-GREENS	10,435	257,391	150,725	213,023	247,221	69,515	
% OF TOTAL PHYTOPLANKTON	.48	15.2	15.7	28	9.52	12.8	
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	2,175,650	1,693,392	960,867	789,106	,596,665	544,442	

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.					no sample		no sample
Amphiprora sp.							
Amphora sp.							
Asterionella formosa	2,401	7,482	1,820	748		4,247	
Attheya zachariasi				1,496			
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.							
Cocconeis sp.	14,408	41,153	9,100	3,741		4,247	
Coscinodiscus sp.	7,240	18,706					
Cyclotella sp.	218,529	759,454	262,083	201,274		212,336	
Cymbella sp.	4,803	22,447		4,489		4,247	
Diatoma sp.	2.401	14,965	1,820	2,993			
Diploneis sp.							
Eunotia sp.	9,606	41,153		1,496		12,740	
Fragilaria sp.							
Fragilaria crotonensis	7,240						
Gomphonema sp.							
Gyrosigma sp.							
Hantzschia sp.		3,741					
Melosira sp.	48,028	325,480	54,601	66,593		101,921	
M. granulata							
Meridion circulare	4,803	3,741	3,640				
Navicula sp.	21,613	149,646	29,120	27,685		33,974	
Navicula sp A.							
Nitzschia sp.	16,810	63,600	7,280	14,216		8,493	
N. sigma	2,401	3,741					
Pinnularia sp.							
Rhoicosphenia curvata	2,401						
Stephanodiscus sp.	16,810	11,223	5,460	6,734			
Surirella sp.		18,706		2,245			
S. patella						8,493	
Synedra sp.		11,223					
S. ulna				748			
Tabellaria sp.	2,401	3,741		748			
T. flocculosa							
T. fenestrata							

DATE: 8/21/73
SAMPLE TYPE: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	2,401		1,820				
TOTAL DIATOMS	384,224	1,500,202	376,744	335,206		390,698	
% OF TOTAL PHYTOPLANKTON	21.6	17.8	23.1	19.5		11.5	
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 8/21/73
SAMPLE TYPE: Whole Water; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.	19,211	29,929					
A. gracillimum							
A. hantzschii			29,120	14,216			
Ankistrodesmus sp.	12,007	44,894	14,560	9,727		16,987	
Asterococcus sp.		11,223					
Chlamydomonas sp.							
Chlorella sp.	28,817	56,117	16,380			46,714	
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							
Closterium sp.			1,820				
Coelastrum sp.	50,430	48,635	25,480	49,383		93,428	
Cosmarium sp.	2,401		10,920	8,979		8,493	
Crucigenia sp.		89,788	20,020	11,972			
Dictyosphaerium sp.							
Echinosphaerella sp.				748			
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.				50,880		76,441	
E. elegans							
Franceia sp.			3,640				
Golenkinia radiata							
Kirchneriella sp.						16,987	
Micractinium pusillum		18,706	109,201			42,467	
Micrasterias sp.							
Mougeotia sp.	43,225			2,993		38,220	
Oocystis sp.	4,803	44,894	25,480	14,965		16,987	
Pandorina sp.		59,858	69,161	71,830		174,115	
P. charkowiensis							
Pediastrum biradiatum							
P. duplex	96,057	377,856	18,200	169,848		29,727	
P. glanduliferum							
P. simplex			58,241	71,830			
P. tetras	2,401	243,175	25,480	8,979			

DATE: 8/21/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus		14,965	7,280	2,993			
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	9,606	14,965		8,979			
S. obliquus							
S. quadricauda	50,430	145,905	32,760	55,369		89,181	
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.	7,204			2,993			
Sphaerocystis sp.						59,454	
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.		7,482	1,820	2,993		4,247	
Tetraedron trigonum							
Tetrastrum sp.		29,929		8,231			
Ulothrix sp.	43,225	26,188		2,993			
UID colonial		14,695					
UID desmid		7,482					
UID flagellate							
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular		14,965				8,493	
Volvox sp.							
TOTAL GREENS	369,817	1,301,921	469,563	570,901		721,941	
% OF TOTAL PHYTOPLANKTON	20.8	15.5	28.8	33.2		21.2	

Roseton - Danskammer Phytoplankton

Date: 8/21/73
Sample type: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.							
Glenodinium sp.	4,803	7,482				4,247	
Peridinium sp.							
Synura sp.			7,280	6,734			
UID dinoflagellate							
TOTAL YELLOW-BROWNS	4,803	7,482	7,280	6,734		4,247	
% OF TOTAL PHYTOPLANKTON	0.1	0.1	0.4	0.4		0.1	
E. BLUE-GREENS							
Anabaena sp.		86,047					
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.	264,156	347,927		231,951			
Aphanocapsa sp.							
Aphanothece sp.							
Chroococcus sp.	38,423	288,069	25,480	49,383		80,688	
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.							
Merismopedia sp.	230,536	1,870,576	65,521	41,153			
M. glauca							
M. major		59,858					
Microcystis sp.		475,126	227,503	26,188		845,096	
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	451,466	2,267,139	405,864	413,023		1,240,040	

Roseton - Danskammer Phytoplankton

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial						67,947	
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial	9,606	44,894					
UID unicellular	24,014	172,093	50,961	44,146		50,961	
TOTAL BLUE-GREENS	1,018,201	5,611,729	775,329	805,844		2,284,732	
% OF TOTAL PHYTOPLANKTON	57.3	66.6	47.6	46.9		67.2	
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	1,777,045	8,421,334	1,628,916	1,718,685	o sample	3,401,618	no sample

Date: 8/21/73
Sample type: Whole Water; Cells

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.			4,076			11,544	
Asterionella formosa							
Atthaya zachariasi						51,949	
Ceratoneis sp.							
Chaetoceros sp.							
Chaetoceros sp A.	15,942	10,145	4,076		10,870	5,772	12,319
Cocconeis sp.					5,435	5,772	
Coscinodiscus sp.	191,304	213,043	338,315	120,924	358,696	346,327	184,783
Cyclotella sp.	7,971			8,062			
Cymbella sp.							
Diatoma sp.							
Diploneis sp.			8,152		10,870	11,544	
Eunotia sp.							
Fragilaria sp.							
Fragilaria crotonensis							
Gomphonema sp.			4,076			5,772	
Gyrosigma sp.							
Hantzschia sp.	55,797	192,754	73,369	185,417	103,261	51,949	61,594
Melosira sp.							
M. granulata	7,971		4,076				6,159
Meridion circulare	15,942	50,725	73,369	24,185	43,478	46,177	86,232
Navicula sp.							
Navicula sp A.	7,971	10,145	24,456		27,174	63,493	43,116
Nitzschia sp.							
N. sigma					5,435		
Pinnularia sp.					5,435		
Rhoicosphenia curvata			24,456	16,123			6,159
Stephanodiscus sp.	7,971	5,072	12,228	8,062	16,304		
Surirella sp.							
S. patella				8,062			
Synedra sp.							
S. ulna							
Tabellaria sp.							
T. flocculosa							
T. fenestrata							

DATE: 9/18/73
SAMPLE TYPE: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric							
TOTAL DIATOMS	310,869	481,884	570,649	370,835	586,958	600,299	400,362
% OF TOTAL PHYTOPLANKTON	5.7	2.5	4.3	3.0	5.01	5.7	1.7
B. EUGLENOIDS							
Euglena sp			4,076	8,062			
Phacus sp							6,159
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS			4,076	8,062			6,159
% OF TOTAL PHYTOPLANKTON			0.03	0.07			0.03

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 9/18/73
SAMPLE TYPE: Whole Water; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii	486,232	344,927	32,609	48,370	364,130	46,177	117,029
Ankistrodesmus sp.	39,885	86,232	40,761	8,062	70,652	103,898	43,116
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	47,826	25,362	28,533	16,123	65,217	34,633	30,797
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.				8,062	10,870		
Closterium sp.		5,072	8,152	16,123	5,435	5,772	12,319
Coelastrum sp.	63,768	152,174	130,435	145,109	173,913	92,354	104,710
Cosmarium sp.	55,797	5,072	24,456	16,123	38,043	17,316	18,478
Crucigenia sp.		20,290	97,826				
Dictyosphaerium sp.				88,678			
Echinosphaerella sp.	7,971			8,062	10,870	5,772	6,159
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.						126,986	
E. elegans							
Franceia sp.							
Golenkinia radiata		10,145	4,076				12,319
Kirchneriella sp.				32,246	27,174		24,638
Micractinium pusillum			40,761		125,000		135,507
Micrasterias sp.							
Mougeotia sp.	231,159	289,130	216,003	32,246	402,174	202,023	80,072
Oocystis sp.		30,435			21,739	17,316	43,116
Pandorina sp.					97,826		49,275
P. charkowiensis			65,217				
Pediastrum biradiatum P sp.						75,037 sp	
P. duplex	143,478	167,391	122,283		298,913		43,116
P. glanduliferum							
P. simplex							
P. tetras		40,580	65,217	24,185	135,870	23,088	73,913

DATE: 9/18/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata				225,725			
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.						23,088	
S. abundans							
S. acuminatus		60,869	73,369		21,739		49,725
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	63,768	81,159	48,913		146,739	57,712	24,638
S. obliquus							
S. quadricauda	207,246	314,493	179,348	241,848	565,217	103,898	221,739
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.			4,076				
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							12,319
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							
Tetraedron trigonum		5,072	16,304	8,062	16,304	23,088	
Tetrastrum sp.	63,768	96,377		48,370	141,304	80,809	67,754
Ulothrix sp.							
UID colonial			73,369				
UID desmid			65,217				
UID flagellate			4,076				
UID filamentous							
UID four-spined							
UID Gonium-like							
UID unicellular							
Volvox sp.					16,304		
TOTAL GREENS	1,410,868	1,734,780	1,341,031	967,394	,755,433	1,038,976	1,176,448
% OF TOTAL PHYTOPLANKTON	26.0	9.0	10.1	7.8	23.5	9.8	5.1

Roseton - Danskammer Phytoplankton

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.	no sample		no sample		no sample	no sample	no sample
Glenodinium sp.				8,062			
Peridinium sp.							
Synura sp.		5,072					
UID dinoflagellate							
TOTAL YELLOW-BROWNS		5,072		8,062			
% OF TOTAL PHYTOPLANKTON		0.3		0.7			
E. BLUE-GREENS							
Anabaena sp.		263,768	330,163		81,522		
A. flos-aquae							
A. spiroides					54,348		
Aphanizomenon sp.							
Aphanocapsa sp.				104,800			
Aphanothece sp.							
Chroococcus sp.	31,884	248,551	81,522	306,341	445,652	178,936	178,623
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	1,355,072				163,043		1,355,072
Merismopedia sp.	47,826	324,638		32,346		92,354	344,928
M. glauca					586,957		
M. major							
Microcystis sp.		552,898	391,304				
M. aeruginosa							
Nostoc sp.							
Oscillatoria sp.	2,211,159	15,146,376	10,442,934	10,528,441	994,565	8,611,993	10,716,303

Date: 9/18/73
Sample type: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric							
TOTAL DIATOMS	954,234	714,202	796,457	786,876	620,838	703,324	997,822
% OF TOTAL PHYTOPLANKTON	3.4	2,5	2.3	4.55	2.81	2.5	4.33
B. EUGLENOIDS							
Euglena sp.							
Phacus sp.						7,992	
Trachelomonas sp.							
UID euglenoids							
TOTAL EUGLENOIDS						7,992	
% OF TOTAL PHYTOPLANKTON						0.029	

DATE: 10/16/73
SAMPLE TYPE: Whole Water; Cells

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 10/16/73
SAMPLE TYPE: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.							
A. gracillimum							
A. hantzschii	34,325	261,874	29,498	124,506	384,025	71,931	844,720
Ankistrodesmus	41,190	59,517	47,197	59,763	64,004	79,923	52,795
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	34,325	41,662	100,294	49,802	38,402	23,977	26,397
Chlorococcum sp.							
Chodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.	6,865		5,900		6,400		
Closterium sp.		5,952	5,900		6,400	7,992	5,279
Coelastrum sp.		124,985		69,723		63,939	
Cosmarium sp.	6,865	5,952	41,298	14,941	12,800		15,838
Crucigenia sp.							
Dictyosphaerium sp.					89,606	119,885	
Echinosphaerella sp.					6,400		5,279
Elakatothrix sp.							
Euastrum sp.					12,801		5,279
Eudorina sp.							
E. elegans							
Franceia sp.						7,992	10,559
Golenkinia radiata	34,325	29,758	29,498	39,842	32,002	23,977	10,559
Kirchneriella sp.							
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.	123,570	113,082	141,592	9,960	198,413	95,908	110,869
Oocystis sp.	27,460						
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex	109,840	95,227	247,786	209,170	268,818	255,754	
P. glanduliferum							
P. simplex							
P. tetras	54,920	47,613	135,692	149,407	19,201	143,862	

DATE: 10/16/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans	54,920	23,807	35,398	39,842		63,939	42,236
S. acuminatus							
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus			17,699			15,985	
S. obliquus							
S. quadricauda	384,439	130,937	300,883	144,427	115,208	175,831	237,578
Schroedria sp.			5,900				
Schroederia setigera							
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.							
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.	6,865	11,903	11,799	4,980	6,400		26,397
Tetraedron trigonum							
Tetrastrum sp.	164,760	190,454	389,378	169,328	243,216	143,862	184,783
Ulothrix sp.							
UID colonial							
UID desmid							
UID flagellate	13,730						26,397
UID filamentous						31,969	
UID four-spined							
UID Gonium-like							
UID unicellular	13,730			19,921			5,279
Volvox sp.							
TOTAL GREENS	1,112,129	1,142,723	1,545,712	1,105,612	504,096	1,326,726	1,610,244
% OF TOTAL PHYTOPLANKTON	4.0	4.0	4.48	6.39	6.82	4.77	6.98

Roseton - Danskammer Phytoplankton

Date: 10/16/73
Sample type: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.			23,599				
Glenodinium sp.				9,960		7,992	
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS			23,599	9,960		7,992	
% OF TOTAL PHYTOPLANKTON			0.07	0.058		0.029	
E. BLUE-GREENS							
Anabaena sp.		261,874		99,605			
A. flos-aquae							
A. spiroides					633,642		
Aphanizomenon sp.							
Aphanocapsa sp.	144,165	511,845	342,180	547,826	115,208		295,652
Aphanothece sp.							
Chroococcus sp.	487,414	119,034	159,291	204,190	249,616	55,946	332,609
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.							
Lyngbya sp.	2,512,586	2,493,758	6,589,926	727,115	76,805	967,071	1,008,385
Merismopedia sp.		1,047,497	117,993	413,360	204,813	159,846	570,186
M. glauca			94,395	159,368	460,830	383,632	316,770
M. major							
Microcystis sp.		95,227	861,351				
M. aeruginosa	199,085					3,996,163	
Nostoc sp.	171,625						
Oscillatoria sp.	22,064,071	22,068,869	23,905,444	13,172,726	3,145,189	20,148,656	17,871,117

Roseton - Danskammer Phytoplankton

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like							
UID branched filamentous							
UID colonial							
UID filamentous							
UID Oscillatoria-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial	27,460				12,801		
UID unicellular	61,785	47,613	64,896	64,743	32,002	31,969	58,074
TOTAL BLUE-GREENS	25,668,191	26,645,717	32,135,476	15,388,933	,930,906	25,743,283	20,452,793
% OF TOTAL PHYTOPLANKTON	92.55	93.5	93.1	88.997	90.37	92.64	88.6
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	27,734,554	28,502,642	34,501,244	17,291,381	055,840	27,789,318	23,060,859

Date: 10/16/73
Sample type: Whole Water; Cells

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: Whole Water:Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.							
Amphiprora sp.							
Amphora sp.							
Asterionella formosa		7567				5353(sp)	
Attheya zachariasi			6000	7690		5353	
Ceratoneis sp.		3783					
Chaetoceros sp.							
Chaetoceros sp A.		64317	150013				
Cocconeis sp.	24035	18917	12001	15380	12744	48178	21366
Coscinodiscus sp.	8012	7567	24002			26765	7122
Cyclotella sp.	516756	469138	612052	799763	471514	984971	562650
Cymbella sp.	8012	11350	6000	15380		10706	
Diatoma sp.		3783		7690			
Diploneis sp.							
Eunotia sp.							
Fragilaria sp.						10706	
Fragilaria crotonensis							
Gomphonema sp.							
Gyrosigma sp.		3783	6000	46140		21412	7122
Hantzschia sp.							
Melosira sp.	544797	707490	870074	330671	106197	192712	1702194
M. granulata							
Meridion circulare		3783	12001		12744	16059	7122
Navicula sp.	120176	56750	72006	169181	46727	203418	99710
Navicula sp A.							
Nitzschia sp.	56082	30267	48004	53830	16991	42825	14244
N. sigma							
Pinnularia sp.							
Rhoicosphenia curvata							
Stephanodiscus sp.	4006				4248		7122
Surirella sp.	4006	3783	12001			5353	7122
S. patella							
Synedra sp.		3783	18001	7690		10706	
S. ulna							
Tabellaria sp.			6000				
T. flocculosa					4248		
T. fenestrata							

DATE: 11/12/73
SAMPLE TYPE: Whole Water : Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric	32047						
UID pennate							
UID spined-centric	8012	22700	6000	7690		5353	
TOTAL DIATOMS	1329947	1418761	1860155	1461105	675413	1589870	2435774
% OF TOTAL PHYTOPLANKTON	7.02	9.06	8.85	7.02	5.02	12.23	19.67
B. EUGLENOIDS							
Euglena sp							
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS							
% OF TOTAL PHYTOPLANKTON							

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 11/12/73
SAMPLE TYPE: Whole Water: Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. GREENS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Actinastrum sp.							
A. gracillimum.							
A. hantzschii.	68100	166468	48004	61520			
Ankistrodesmus.	4006	7567	12001	7690	12744	26765	28489
Asterococcus sp.							
Chlamydomonas sp.							
Chlorella sp.	56082	34050	24002	46140	38231	42825	56977
Chlorococcum sp.							
Chodatella sp.							
C. longiseta.							
C. microporum.							
C. subsalsa.							
C. quadrata.							
Closteriopsis sp.		3783					
Closterium sp.							
Coelastrum sp.			24002			107062	
Cosmarium sp.	12017	3783	12001	15380	8496		7122
Crucigenia sp.	128187	90801		123040	33983	64237	
Dictyosphaerium sp.	292428	268619	558047	1099674		347952	277764
Echinosphaerella sp.				7690			
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans.							28489
Franceia sp.							
Golenkinia radiata.				15380	4248		
Kirchneriella sp.							
Micractinium pusillum.				107660			42733
Micrasterias sp.							
Mougeotia sp.	100146	189168	48004	30760	140180	310480	56977
Oocystis sp.	8012			23070			
Pandorina sp.							
P. charkowiensis.	172252						
Pediastrum biradiatum.							
P. duplex.		52967			12744	107062	
P. glanduliferum.							
P. simplex.			48004				
P. tetras.	56082	71884	192016		[illegible]983	74943	

DATE: 11/12/73
SAMPLE TYPE: Whole Water: Cells

C. GREENS cont'd.	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Platydorina caudata							
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus	40059			76006			
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus	32047	15133	30002		16991	21412	
S. obliquus							
S. quadricauda	80117	68101	138012	115350	212394	149887	284886
Schroedria sp.							
Schroederia setigera		3783					
Selenastrum sp.							
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.			6000				
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.		3783	6000	7690	4248		
Tetraedron trigonum		3783					
Tetrastrum sp.	120176	151335	120010	276841	135932	203418	128199
Ulothrix sp.				107660	25487		
UID colonial						53531	
UID desmid							
UID flagellate			6000		4248	10706	7122
UID filamentous							
UID four-spined	4006	3783				5353	7122
UID Gonium-like							
UID unicellular							
Volvox sp.							
TOTAL GREENS	1173717	1176624	1272105	2122445	683909	1525633	925880
% OF TOTAL PHYTOPLANKTON	6.20	7.52	6.05	10.2	5.08	11.73	7.47

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
D. YELLOW-BROWNS (DINOFLAGELLATES)							
Dinobryon sp.							
Glenodinium sp.							
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS							
% OF TOTAL PHYTOPLANKTON							
E. BLUE-GREENS							
Aphanothece-like		60534	408034		480010	283714	876025
Anabaena sp.	36053			292221	144428		
A. flos-aquae							
A. spiroides						117768	
Aphanizomenon sp.							
Aphanocapsa sp.	192281	2001519		161491		128474	
Aphanothece sp.	20029						
Chroococcus sp.	156229	223219	72006	53830	267616	251596	156687
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gleocapsa sp.							
Gleothece sp.							
Gomphosphaeria sp.					407796		
Lyngbya sp.	1482169	563722	720061	845903	836831	695903	
Merismopedia sp.			384032		203898		
M. glauca		121068					
M. major							
Microcystis sp.	1986908					1611284	1873126
M. aeruginosa							
Nostoc sp.						139181	
Oscillatoria sp.	12542354	10067551	16261376	15726114	9630909	6659261	6089441

Roseton - Danskammer Phytoplankton

Date: 11/12/73
Sample type: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DF
E. BLUE-GREENS CON'T	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.							
UID Aphanothece-like.							
UID branched filamentous.							
UID colonial.							
UID filamentous.							
UID Gleocapsa-like.							
UID long cell.							
UID sheathed cell.							
UID two-celled colonial.			12001		8496		
UID unicellular.	20029	18917	18001	138420	59470		28489
TOTAL BLUE-GREENS.	16436052	13056530	17875511	17217979	12089454	9887181	9023768
% OF TOTAL PHYTOPLANKTON.	86.78	83.42	85.09	82.77	89.89	76.04	72.86
F. OTHERS							
UID flagellate.							
TOTAL OTHERS.							
% OF TOTAL PHYTOPLANKTON.							
G. TOTAL PHYTOPLANKTON	18939716	15651915	21007771	20801529	13448776	13002684	12385422

ROSETON-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: Whole Water; cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
A. DIATOMS	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Achnanthes sp.	139261	244604	168230	235870	89524	220311	197558
Amphiprora sp.					6886		
Amphora sp.	139261	244604	168230	235870	89524	220311	197558
Asterionella formosa							
Atthoya zachariasi							
Ceratoneis sp.							
Chaetoceros sp.	64989	7445		26630	68865	33894	
Chaetoceros sp A.	9284	15952	16022	22826	20659	16947	31864
Cocconeis sp.	9284	15952	8011	11413		5649	6373
Coscinodiscus sp.	914482	967782	969325	970109	778173	824754	860333
Cyclotella sp.	18568	21270	8011	22826		5649	12746
Cymbella sp.	4642			7609		5649	19118
Diploma sp.							6373
Diploneis sp.				7609		225960	12746
Eunotia sp.							
Fragilaria sp.	143903			22826		169470	
Fragilaria crotonensis							
Gomphonema sp.						11298	
Gyrosigma sp.							
Hantzschia sp.	436352	350954	456624	353804	426962	1050714	331388
Melosira sp.							
M. granulata	4642	5317		15217	6886		12746
Meridion circulare	60347	95715	96131	83696	55092	84735	127457
Navicula sp.	9284			3804			
Navicula sp A.	83557	37222	40055	34239	82638	90384	82847
Nitzschia sp.							
N. sigma							6373
Pinnularia sp.		15952					6373
Rhoicosphenia curvata	13926	5317				5649	
Stephanodiscus sp.	4642	5317	8011		13773		
Surirella sp.				7609		33894	
S. patella	18568	5317	8011	7609	6886	22596	6373
Synedra sp.							
S. ulna							
Tabellaria sp.						5649	
T. flocculosa			8011			45192	6373
T. fenestrata							

DATE: 12/12/73
SAMPLE TYPE: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
A. DIATOMS cont'd							
UID centric							
UID pennate							
UID spined-centric	116051	180794	56077	91304	34432	73437	127457
TOTAL DIATOMS	2051782	2041910	1842519	1925000	1590776	2931831	1854498
% OF TOTAL PHYTOPLANKTON	75.9	77.58	70.99	70.97	71.36	85.93	74.23
B. EUGLENOIDS							
Euglena sp		5317					
Phacus sp							
Trachelomonas sp							
UID euglenoids							
TOTAL EUGLENOIDS		5317					
% OF TOTAL PHYTOPLANKTON		0.20					

ROSETONE-DANSKAMMER PHYTOPLANKTON

DATE: 12/12/73
SAMPLE TYPE: Whole Water; Cells

GROUP C. GREENS	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Actinastrum sp.							25491
A. gracillimum.							
A. hantzschii	27852	5317	40055	60870	34432	16947	25491
Ankistrodesmus							
Asterococcus sp.	13926	5317		15217	13773	28245	
Chlamydomonas sp.	9284	42540	80109	15217	41319	11298	38237
Chlorella sp.							
Chlorococcum sp.							
Crodatella sp.							
C. longiseta							
C. microporum							
C. subsalsa							
C. quadrata							
Closteriopsis sp.							6373
Closterium sp.							
Coelastrum sp.			8011				
Cosmarium sp.	37136			30435		90384	
Crucigenia sp.	167113		32044	15217			
Dictyosphaerium sp.							
Echinosphaerella sp.							
Elaktothrix sp.							
Euastrum sp.							
Eudorina sp.							
E. elegans							
Franceia sp.	4642	10635		30435		22596	
Golenkinia radiata							
Kirchneriella sp.	27852	37222					
Micractinium pusillum							
Micrasterias sp.							
Mougeotia sp.							
Oocystis sp.							
Pandorina sp.							
P. charkowiensis							
Pediastrum biradiatum							
P. duplex							
P. glanduliferum							
P. simplex							
P. tetras							

DATE: 12/12/73
SAMPLE TYPE: Whole Water; Cells

C. GREENS cont'd.	RNCE no./liter	RNCW no./liter	RSCE no./liter	RSCW no./liter	RDE no./liter	RI no./liter	DI no./liter
Platydorina caudata		5317					
Polyedriopsis sp.							
Protococcus sp.							
Scenedesmus sp.							
S. abundans							
S. acuminatus	69623			15217	55092	39543	
S. arcuatus							
S. bijuga							
S. dimorphus							
S. denticulatus							
S. obliquus							
S. quadricauda	97483	63810	72098	72283	55092	90384	127457
Schroedria sp.							
Schroederia setigera							
Selenastrum sp.	88199	79762		144565		96033	76474
Sphaerocystis sp.							
Spirogyra sp.							
Staurastrum sp.		5317					
Staurastrum aspinosa							
Stigeoclonium sp.							
Tetradesmus sp.							
Tetraedron sp.							6373
Tetraedron trigonum							
Tetrastrum sp.	18568		96131	91304	192822	67788	19118
Ulothrix sp.							
UID colonial				7609			
UID desmid							
UID flagellate	32494						
UID filamentous							
UID four-spined	18568	10635	8011	34239	6886		12746
UID Gonium-like							
UID unicellular			8011				
Volvox sp.							
TOTAL GREENS	612740	265872	344470	532608	399416	463218	337760
% OF TOTAL PHYTOPLANKTON	22.68	10.10	13.27	19.64	17.90	13.58	13.52

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type: Whole Water; Cells

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
D. YELLOW-BROWNS (DINOFLAGELLATES)	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
Dinobryon sp.	37136		8011	22826	6886		
Glenodinium sp.					6886		
Peridinium sp.							
Synura sp.							
UID dinoflagellate							
TOTAL YELLOW-BROWNS	37136		8011	22826	13772		
% OF TOTAL PHYTOPLANKTON	1.37		0.31	0.84	0.62		
E. BLUE-GREENS							
Anabaena sp.	No sample			171196			
A. flos-aquae							
A. spiroides							
Aphanizomenon sp.							
Aphanocapsa sp.			144197				
Aphanothece sp.		175472					267659
Chroococcus sp.			16022	60870	68865		
Cylindrospermum sp.							
Dactylococcopsis sp.							
Gloeocapsa sp.							
Gloethece sp.							
Gomphosphaeria sp.							
Lyngbya sp.			184252		117070		
Merismopedia sp.		85080					
M. glauca							
M. major							
Microcystis sp.							
M. aeruginosa					27546		
Nostoc sp.		15952	48066				31864
Oscillatoria sp.							

Roseton - Danskammer Phytoplankton

Date: 12/12/73
Sample type: Whole Water; Cells

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter	no./liter
E. BLUE-GREENS CON'T							
Phormidium sp.							
Spirulina sp.							
Synechococcus sp.		10635					
UID Aphanothece-like							
UID Branched filamentous							
UID colonial							
UID filamentous							
UID Gleocapsa-like							
UID long cell							
UID sheathed cell							
UID two-celled colonial							
UID unicellular		31905	8011		13773	16947	6373
TOTAL BLUE-GREENS	No sample	319044	400548	232066	227254	16947	305896
% OF TOTAL PHYTOPLANKTON		12.12	15.43	8.56	10.19	0.50	12.24
F. OTHERS							
UID flagellate							
TOTAL OTHERS							
% OF TOTAL PHYTOPLANKTON							
G. TOTAL PHYTOPLANKTON	2701658	2632143	2595548	2712500	2231218	3411996	2498154

APPENDIX III-B

APPENDIX III-B

ROSETON/DANSKAMMER POINT
1973
MICROZOOPLANKTON

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 5/31/73
DEPTH: 0-10'

GROUP	RNCE no./m³	RNCW no./m³	RSCE no./m³	RSCW no./m³	RDE no./m³	RI no./m³	DI no./m³
A. COPEPODS							
Nauplii	2903	3657	24296	1455	mple	5269	697
Copepodites							
Calanoids	1016	549	784			1118	
Cyclopoids	1016		2612	624		1118	
Harpacticoids	435	549		624			697
UID Copepods							
TOTAL COPEPODS	5370	4755	27692	2703		7505	1394
% OF TOTAL MICROZOOPLANKTON	23.5	31.7	45.1	36.1		35.1	4.8
B. CLADOCERANS							
Bosmina sp.	2903	2926	14630			2714	697
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	2903	2926	14630			2714	697
% OF TOTAL MICROZOOPLANKTON	12.7	19.5	23.8			12.7	2.4
C. ROTIFERS							
Brachionus sp.		549					1626
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.	1016	3109					
Kellekotia sp.	435	1280		1455		1118	3948
Keratella sp.	5370		5225	624		3672	8592
Lecane sp.						479	
Mothuica sp.			7054			1118	1626
Ploesoma sp.		549		624			
Polyarthra sp.			784				697
Proalides sp.							
Trichocerca sp.							
Trichotria sp.							

DATE: 5/31/73
DEPTH: 0-10'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Pdelloides	7692	1829	6009	2078		4790	9985
UID in capsule							
TOTAL ROTIFERS	14513	7316	19072	4781		11177	26474
% OF TOTAL MICROZOOPLANKTON	63.7	48.8	31.1	63.9		52.2	92.7
D. TOTAL MICROZOOPLANKTON	22786	14997	61394	7484		21396	28565

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 5/31/73
DEPTH: 0-20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS					ɔ		
Nauplii	7153	3352	20636	3744	ample	4934	4134
Copepodites	945						
Calanoids			4586			863	1453
Cyclopoids	945	305		261		370	1117
Harpacticoids				1132			
UID Copepods							
TOTAL COPEPODS	2603	3657	25222	5137		6167	6704
% OF TOTAL MICROZOOPLANKTON	32.1	40.5	54.1	56.2		28.3	28.4
B. CLADOCERANS							
Bosmina sp.	3104	711	5274	1132		2096	1453
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	3104	711	5274	1132		2096	1453
% OF TOTAL MICROZOOPLANKTON	11	7.86	11.3	12.4		9.6	6.1
C. ROTIFERS							
Brachionus sp.		305		261		370	
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							335
Keliskotia sp.	1754	305	1605	609		370	1117
Keratella sp.	3104	1016	7567	870		3330	3687
Lecane sp.	945					370	335
Nothulca sp.	3104		1605			2097	1900
Ploesoma sp.		711					
Polyarthra sp.	405						
Proalides sp.							
Trichocerca sp.							
Trichotria sp.							

DATE: 5/31/73
DEPTH: 0-20'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	6748	2336	5274	1132		7031	8157
UID in capsule							
TOTAL ROTIFERS	16060	4673	16051	2872		13568	15531
% OF TOTAL MICROZOOPLANKTON	56.9	51.69	34.5	31.4		62.2	65.6
D. TOTAL MICROZOOPLANKTON	28207	9041	46547	9141		21831	23688

ROSETON-DAMSKAMMER MICROZOOPLANKTON

DATE: 5/31/73
DEPTH: 0-30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS			no		)		
Nauplii	3657	3329	sample	412	mple	6139	8193
Copepodites							
Calanoids	755			412			
Cyclopoids	406	1800				1698	2581
Harpacticoids	174					392	786
UID Copepods							
TOTAL COPEPODS	4992	5129		824		8229	11560
% OF TOTAL MICROZOOPLANKTON	38.0	36.3		13.4		0.8	50.5
B. CLADOCERANS							
Bosmina sp.	1567	900		412		2612	3030
Daphnia sp.				412			786
Kellicottia sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	1567	900		824		2612	3816
% OF TOTAL MICROZOOPLANKTON	.2	6.4		13.3		9.4	16.7
C. ROTIFERS							
Brachionus sp.		270		412		392	337
Cephalodella sp.							
Diglois sp.	174						
Floscularia sp.							
Filinia sp.	174						
Kellekotia sp.	755	630		412		2612	786
Keratella sp.	1741	2429		962		3527	3030
Lecane sp.		1530					337
Notholca sp.	1335	1170		962		3004	786
Ploesoma sp.	406						
Polyarthra sp.	174					392	786
Proalides sp.							337
Trichocerca sp.							
Trichotria sp.							

DATE: 5/31/73
DEPTH: 0-30'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	1741	2069		1786		6922	11223
UID in capsule							
TOTAL ROTIFERS	6500	8089		4534		16849	7522
% OF TOTAL MICROZOOPLANKTON	50	57.3		73.3		60.9	32.8
D. TOTAL MICROZOOPLANKTON	13059	14127		6182		27690	22898

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 6/26/73
DEPTH: 0-10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	327736	54862	81184	128038	mple	no sample	no sample
Copepodites	1321		761				
Calanoids	2453		761	7660			
Cyclopoids	3208	3962	3298	7660			
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	334718	58824	86004	143358			
% OF TOTAL MICROZOOPLANKTON	88.0	74.2	87.2	66.5			
B. CLADOCERANS							
Bosmina sp.	25094	9144	2537	40491			
Daphnia sp.				3283			
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	25094	9144	2537	43774			
% OF TOTAL MICROZOOPLANKTON	6.6	11.6	2.6	20.3			
C. ROTIFERS							
Brachionus sp.							
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	566	3048	1776				
Lecane sp.							
Nothalca sp.							
Ploesoma sp.	3208	914		10943			
Polyarthra sp.	6226	2134	5835	3283			
Proalides sp.							
Trichocerca sp.	8113		761	10943			
Trichotria sp.							

DATE: 6/26/73
DEPTH: 0-10'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	2453	5181	1776	3283			
UID in capsule							
TOTAL ROTIFERS	20566	11277	10148	28452			
% OF TOTAL MICROZOOPLANKTON	5.4	14.2	10.3	13.2			
D. TOTAL MICROZOOPLANKTON	380378	79245	98689	215548			

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 6/26/73
DEPTH: 0-20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS					o	no	no
Nauplii	220463	24670	76731	51968	ample	sample	sample
Copepodites			544				
Calanoids	2235	1016	3628	1757			
Cyclopoids	4134	3338	3084	7532			
Harpacticoids			544				
UID Copepods		1016					
TOTAL COPEPODS	226832	30040	84531	61257			
% OF TOTAL MICROZOOPLANKTON	86.3	87.3	78.9	73.1			
B. CLADOCERANS							
Bosmina sp.	20113	2467	5442	15063			
Daphnia sp.	1117	435	544				
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	21230	2902	5986	15063			
% OF TOTAL MICROZOOPLANKTON	8.1	8.44	5.6	17.96			
C. ROTIFERS							
Brachionus sp.							
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	4134	435	7256	1757			
Lecane sp.							
Nothulca sp.	782		544				
Ploesoma sp.	782		2358	1757			
Polyarthra sp.	3687	1016	2358				
Proalides sp.							
Trichocerca sp.	3017		2358	753			
Trichotria sp.							

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Edelloides	2235		1814	3264			
UID in capsule							
TOTAL ROTIFERS	14637	1451	16688	7531			
% OF TOTAL MICROZOOPLANKTON	5.6	4.22	15.5	8.98			
D. TOTAL MICROZOOPLANKTON	262699	34393	107205	83851			

DATE: 6/26/73
DEPTH: 0-20'

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 6/26/73
DEPTH: 0-30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS					o	no	no
Nauplii	103575	47001	40162	108325	ample	sample	sample
Copepodites	818						
Calanoids	2327	948	2253	3081			
Cyclopoids	2075	2303	2651	4741			
Harpacticoids	189	1354	398				
UID Copepods		406	398				
TOTAL COPEPODS	108984	52012	45862	116147			
% OF TOTAL MICROZOOPLANKTON	90.3	89.1	78.1	82.0			
B. CLADOCERANS							
Bosmina sp.	4213		6230	10193			
Daphnia sp.		1354	928	1659			
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans	440						
TOTAL CLADOCERANS	4653	1354	7158	11852			
% OF TOTAL MICROZOOPLANKTON	3.8	2.1	12.2	8.4			
C. ROTIFERS							
Brachionus sp.							
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	1447	948	1325	711			
Lecane sp.							
Nothulca sp.							
Ploesoma sp.	189		1325	2730			
Polyarthra sp.	1258	3657	398	4030			
Proalides sp.	2515						
Trichocerca sp.		1354	2651	3081			
Trichotria sp.							

DATE: 6/26/73
DEPTH: 0-30'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	1698	6366		3081			
UID in capsule							
TOTAL ROTIFERS	7107	12325	5699	13633			
% OF TOTAL MICROZOOPLANKTON	5.9	18.8	9.7	9.6			
D. TOTAL MICROZOOPLANKTON	120742	65691	24216	141632			

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 7/24/73
DEPTH: 0-10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no
Nauplii	7358	36284	13234	25370	29173	18427	sample
Copepodites							
Calanoids	3962	1089					
Cyclopoids	1698	2540				5608	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	13018	39113	13234	25370	29173	24035	
% OF TOTAL MICROZOOPLANKTON	53.5	70.5	54.6	69.7	55.8	50.0	
B. CLADOCERANS							
Bosmina sp.	1698		4787		5660	2403	
Daphnia sp.			845		4354		
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	1698		5632		10014	2403	
% OF TOTAL MICROZOOPLANKTON	7.0		23.3		19.2	6.0	
C. ROTIFERS							
Brachionus sp.					3048		
Cephalodella sp.	1698	1089		3309	1306	5608	
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.		1089	3660		4354		
Lecane sp.							
Nothulca sp.							
Ploesoma sp.	3962	13425	845	7721	4354	2403	
Polyarthra sp.						5608	
Proalides sp.							
Trichocerca sp.		1089					
Trichotria sp.							

DATE: 7/24/73
DEPTH: 0-10'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Edelloides	3962						
UID in capsule							
TOTAL ROTIFERS	9622	16692	5350	11030	13062	13619	
% OF TOTAL MICROZOOPLANKTON	39.5	29.5	22.1	30.3	25.0	34.0	
D. TOTAL MICROZOOPLANKTON	24338	56605	24216	36400	52249	40057	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 7/24/73
DEPTH: 0-20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no
Nauplii	5950	14902	9926	10920	19155	16050	sample
Copepodites							
Calanoids	892				3193	2293	
Cyclopoids	2975	1656	1219				
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	9817	16558	11145	10920	22348	18343	
% OF TOTAL MICROZOOPLANKTON	54.3	72.9	48.2	58.1	66.0	80.0	
B. CLADOCERANS							
Bosmina sp.	3867	710	3882		4151	688	
Daphnia sp.	2975		2960	762			
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans		710					
TOTAL CLADOCERANS	6842	1420	6442	762	4151	688	
% OF TOTAL MICROZOOPLANKTON	37.1	6.26	27.8	4.1	12.3	3.0	
C. ROTIFERS							
Brachionus sp.					958		
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.		710	2264	1778	2235	1605	
Lecane sp.							
Nothulca sp.							
Ploesoma sp.	892	2365	1741	1778	3193	1605	
Polyarthra sp.		1656	522				
Proalides sp.							
Trichocerca sp.			522				
Trichotria sp.						688	

DATE: 7/24/73
DEPTH: 0-20'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	892		522	1778	958		
UID in capsule							
TOTAL ROTIFERS	1784	4731	5571	7112	7344	3898	
% OF TOTAL MICROZOOPLANKTON	9.7	20.83	24.0	37.8	21.7	17.0	
D. TOTAL MICROZOOPLANKTON	18443	22709	23158	18794	33843	22929	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 7/24/73
DEPTH: 0-30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no sample
Nauplii	3870	9375	11146	11563	15238	18535	
Copepodites				938			
Calanoids	3580	1151	6192	938	2201	3388	
Cyclopoids	1258	493	2105			1395	
Harpacticoids							
UID Copepods		2138	867			1395	
TOTAL COPEPODS	4838	13157	20310	13439	17439	24713	
% OF TOTAL MICROZOOPLANKTON	68.2	60.2	79.3	87.8	50.5	78.9	
B. CLADOCERANS							
Bosmina sp	2515	1645	3344		4571	1993	
Daphnia sp	677	493				1993	
Leptodora sp							
Pleuroxus sp							
UID Cladocerans							
TOTAL CLADOCERANS	3192	2138	3344		4571	3986	
% OF TOTAL MICROZOOPLANKTON	25.0	9.7	13.04		26.5	12.7	
C. ROTIFERS							
Brachionus sp							
Cephalodella sp					508		
Diplois sp							
Elosa sp							
Filinia sp							
Kellekotia sp							
Keratella sp	290	1645	372		2878	598	
Lecane sp	290						
Nothulca sp							
Ploesoma sp	290	4934	1610	938	1185	1998	
Polyarthra sp					1693		
Proalides sp							
Trichocerca sp							
Trichotria sp							

DATE: 7/24/73
DEPTH: 0-30'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides				938	1693		
UID in capsule							
TOTAL ROTIFERS	870	6579	1928	1876	7957	2591	
% OF TOTAL MICROZOOPLANKTON	6.8	30.1	7.7	12.25	23.0	8.3	
D. TOTAL MICROZOOPLANKTON	12770	21874	2563	15315	34538	31290	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 8/21/73
DEPTH: 0-10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS					no sample		no sample
Nauplii	14462	27228	16877	8273		25707	
Copepodites							
Calanoids	2154	3890	2961			627	
Cyclopoids	7077	6614	2961	1655		8360	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	23693	37732	22799	9928		34694	
% OF TOTAL MICROZOOPLANKTON	40.0	54.8	47.8	50.0		65.3	
B. CLADOCERANS							
Bosmina sp.	20308	8946	7994	3309		5643	
Daphnia sp.							
Leptodora sp.	4308		2961				
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	24616	8946	10955	3309		5643	
% OF TOTAL MICROZOOPLANKTON	41.5	13.0	23.0	16.7		10.6	
C. ROTIFERS							
Brachionus sp.	923						
Cephalodella sp.							
Euplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	3077	2723	2073	1158		1463	
Lecane sp.							
Nothulca sp.		2723	888			2090	
Ploesoma sp.		2723		498		627	
Polyarthra sp.		3890				1463	
Proalides sp.							
Trichocerca sp.	923	8946	8882	4964		5643	
Trichotria sp.							

DATE: 8/21/73
DEPTH: 0-10'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	6154	1167	2073			1463	
UID in capsule							
TOTAL ROTIFERS	11077	22172	13916	6618		12749	
% OF TOTAL MICROZOOPLANKTON	18.7	32.2	29.2	33.3		24.0	
D. TOTAL MICROZOOPLANKTON	59386	68850	47670	19855		53086	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 8/21/73
DEPTH: 0-20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no
Nauplii	7183	20752	7314	9868	mple	23618	sample
Copepodites							
Calanoids	5316		1056	863		1850	
Cyclopoids	7614	8301	813	863		6857	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	20113	29053	9183	11594		34694	
% OF TOTAL MICROZOOPLANKTON	38.9	77.8	65.3	62.3		65.3	
B. CLADOCERANS							
Bosmina sp.	18677	1453	2438	3330		5643	
Daphnia sp.		623					
Leptodora sp.	3879		244				
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	22556	2076	2682	3330		4354	
% OF TOTAL MICROZOOPLANKTON	43.6	5.6	19.1	17.9		9.2	
C. ROTIFERS							
Brachionus sp.		623					
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	1868					1088	
Lecane sp.							
Nothulca sp.	2442	1453				1088	
Ploesoma sp.		623	244			327	
Polyarthra sp.			569				
Proalides sp.							
Trichocerca sp.	3304	3528	1382	3700		6530	
Trichotria sp.							

DATE: 8/21/73
DEPTH: 0-20'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	1437					1850	
UID in capsule							
TOTAL ROTIFERS	9051	6227	2195	3700		10883	
% OF TOTAL MICROZOOPLANKTON	17.5	16.7	15.6	19.9		22.9	
D. TOTAL MICROZOOPLANKTON	51720	37356	14060	18624		47562	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 8/21/73
DEPTH: 0 - 30'

GROUP	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3 no sample	RI no./m^3	DI no./m^3 no sample
A. COPEPODS							
Nauplii	8458	10359	19834	21324		23365	
Copepodites							
Calanoids	8185	2871	3411	561		2559	
Cyclopoids	10004	2871	6585	4096		5897	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	26647	16101	29830	25981		31821	
% OF TOTAL MICROZOOPLANKTON	59.2	60.0	62.4	76.3		66.7	
B. CLADOCERANS							
Bosmina sp.	13005	32.45	7140	2974		3338	
Daphnia sp.				393			
Leptodora sp.	909		1825			334	
Pleuroxus sp.							
UID Cladocerans	273						
TOTAL CLADOCERANS	14187	3245	8965	3367		3672	
% OF TOTAL MICROZOOPLANKTON	31.5	8.32	18.8	9.89		7.7	
C. ROTIFERS							
Brachionus sp.		374		168		334	
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	1182	2122	793	393		1113	
Lecane sp.							
Nothulca sp.			1031				
Ploesoma sp.						779	
Polyarthra sp.	273	874	238	393		1891	
Proalides sp.							
Trichocerca sp.	2092	2871	5315	3760		5563	
Trichotria sp.							

DATE: 8/21/73
DEPTH: 0 - 30'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides.....	637	1248	1587			2559	
UID in capsule.....							
TOTAL ROTIFERS.....	4184	7489	8964	4714		12239	
% OF TOTAL MICROZOOPLANKTON.....	9.3	27.9	18.8	13.8		25.6	
D. TOTAL MICROZOOPLANKTON.....	45018	26835	47759	34062		47732	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 9/18/73
DEPTH: 0 - 10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no sample
Nauplii	67054	65878	42659	58165	44122	32395	
Copepodites					662		
Calanoids					662		
Cyclopoids		1727	4343	3245	2868	4679	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	67054	67605	47002	61410	48314	37074	
% OF TOTAL MICROZOOPLANKTON	70.0	84.5	52.4	65.5	45.4	64.8	
B. CLADOCERANS							
Bosmina sp.	20029	6662	39083	26711	47872	9718	
Daphnia sp.							
Leptodora sp.					662		
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	20029	6662	39083	26711	48534	9718	
% OF TOTAL MICROZOOPLANKTON	20.9	8.32	43.6	28.5	45.6	16.98	
C. ROTIFERS							
Brachionus sp.			1788	4244	662		
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.		1727		749	1544		
Lecane sp.							
Nothulca sp.						1080	
Ploesoma sp.							
Polyarthra sp.		740			662		
Proalides sp.							
Trichocerca sp.	8708	3208	1788	749	2206	4679	
Trichotria sp.							

DATE: 9/18/73
DEPTH: 0 - 10'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Edelloides					4412	4679	
UID in capsule							
TOTAL ROTIFERS	8708	5775	3576	5742	9486	10438	
% OF TOTAL MICROZOOPLANKTON	9.1	7.21	3.99	6.1	8.9	18.2	
D. TOTAL MICROZOOPLANKTON	95791	80042	89661	93863	106334	57230	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 9/18/73
DEPTH: 0 - 20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							no sample
Nauplii	35568	54352	51432	52939	43579	20733	
Copepodites							
Calanoids	4368	531	2586		2075	924	
Cyclopoids	8112	1770	8620	2481	3671	6603	
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	48048	56653	62638	55420	49325	28260	
% OF TOTAL MICROZOOPLANKTON	74.7	71.1	39.5	57.5	46.6	54.8	
B. CLADOCERANS							
Bosmina sp.	12480	14163	94149	35816	44217	13602	
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.			287				
UID Cladocerans							
TOTAL CLADOCERANS	12480	14163	94436	35816	44217	13602	
% OF TOTAL MICROZOOPLANKTON	19.4	17.8	59.5	37.1	41.8	26.3	
C. ROTIFERS							
Brachionus sp.	1872	1239	958	1654		396	
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	1872			579	1117	924	
Lecane sp.							
Nothulca sp.		531				924	
Ploesoma sp.					479	924	
Polyarthra sp.		1239	287	248			
Proalides sp.							
Trichocerca sp.		2302	287	2730	2714	1321	
Trichotria sp.							

DATE: 9/18/73
DEPTH: 0 - 20'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides		3541			7981	5282	
UID in capsule							
TOTAL ROTIFERS	3744	8852	1532	5211	12291	9771	
% OF TOTAL MICROZOOPLANKTON	5.8	11.1	.97	5.4	11.6	18.9	
D. TOTAL MICROZOOPLANKTON	64272	79667	158606	96447	105833	51633	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 9/18/73
DEPTH: 0 - 30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3 no sample
A. COPEPODS							
Nauplii	69301	111272	35014	32462	24982	22978	
Copepodites		340	7924	258	386		
Calanoids	4779	340	7653	3444	2592	4475	
Cyclopoids							
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	74080	111952	50591	36164	27960	27453	
% OF TOTAL MICROZOOPLANKTON	75.0	91.4	38.3	47.6	32.7	70.7	
B. CLADOCERANS							
Bosmina sp	19835	8716	75378	27296	48529	6893	
Daphnia sp						1572	
Leptodora sp			1151	258			
Pleuroxus sp	1673	340					
UID Cladocerans					386		
TOTAL CLADOCERANS	21508	9056	76529	27554	48915	8465	
% OF TOTAL MICROZOOPLANKTON	21.8	7.4	57.8	36.2	57.2	21.8	
C. ROTIFERS							
Brachionus sp	717	792	203	861	937	847	
Cephalodella sp							
Diplois sp							
Elosa sp							
Filinia sp				258			
Kellicotia sp			677	1119	717	847	
Keratella sp							
Lecane sp	717		677		165		
Nothulca sp				258	165		
Ploesoma sp				603	386		
Polyarthra sp							
Proalides sp							
Trichocerca sp	1673	792	474	1464	1489	1209	
Trichotria sp							

DATE: 9/18/73
DEPTH: 0 - 30'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides			3183	7750	4798		
UID in capsule							
TOTAL ROTIFERS	3107	1584	5214	12313	8657	2903	
% OF TOTAL MICROZOOPLANKTON	3.2	1.29	3.9	16.2	10.1	7.48	
D. TOTAL MICROZOOPLANKTON	98695	122592	132334	76031	85532	38821	

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 10/16/73
DEPTH: 0 - 10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	19698	11280	29887	29887	19733	16459	7257
Copepodites	505					6035	1887
Calanoids					575		435
Cyclopoids	505		6897	3321	4406	2377	5370
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	20708	11280	31584	33208	24714	24871	14949
% OF TOTAL MICROZOOPLANKTON	69.9	55.8	87.8	76.9	72.5	42.8	61.0
B. CLADOCERANS							
Bosmina sp.		1179			575	3657	435
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS		1179			575	3657	435
% OF TOTAL MICROZOOPLANKTON		5.8			1.7	6.3	1.8
C. ROTIFERS							
Brachionus sp.		505	766	3321	575	549	
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.	6229	3367	2554	2554	4406	14630	5370
Keratella sp.							
Lecane sp.							
Nothulca sp.				766	575	2377	
Ploesoma sp.				766	575	549	
Polyarthra sp.	505			1788	1341	549	435
Proalides sp.				766			
Trichocerca sp.		2189	1788		1341	1280	435
Trichotria sp.							

DATE: 10/16/73
DEPTH: 0 - 10'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	2189	1684				9692	2903
UID in capsule							
TOTAL ROTIFERS	8923	7745	5108	9961	8813	29626	9143
% OF TOTAL MICROZOOPLANKTON	30.1	38.3	12.2	23.1	25.8	50.9	37.3
D. TOTAL MICROZOOPLANKTON	29631	20204	41892	43169	34102	58154	24527

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 10/16/73
DEPTH: 0 - 20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	20897	6022	11464	14441	13917	5932	5211
Copepodites	313				711		
Calanoids		843	1146		305	244	579
Cyclopoids	1776	3613	10662	2699	3759	4632	579
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	22986	10478	23272	17140	18692	10808	6369
% OF TOTAL MICROZOOPLANKTON	64.6	48.4	81.6	69.1	44.9	73.1	51.3
B. CLADOCERANS							
Bosmina sp.	731	361	1490	945	2032	813	1654
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.			344				
UID Cladocerans							
TOTAL CLADOCERANS	731	361	1834	945	2032	813	1654
% OF TOTAL MICROZOOPLANKTON	2.1	1.7	6.4	3.8	4.9	5.5	13.3
C. ROTIFERS							
Brachionus sp.	731	2048	802		711	244	
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	6269	7588	2293	4993	11885	2438	2481
Lecane sp.							
Nothulca sp.	313	361	344			244	
Ploesoma sp.					2336		
Polyarthra sp.	1776			1350	2336		248
Proalides sp.							
Trichocerca sp.	731	843		405	305	244	
Trichotria sp.							

DATE: 10/16/73
DEPTH: 0 - 20'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	2090				3352		1654
UID in capsule							
TOTAL ROTIFERS	11910	10840	3439	6748	20925	3170	4383
% OF TOTAL MICROZOOPLANKTON	33.4	50.0	12.1	27.2	50.2	21.4	35.3
D. TOTAL MICROZOOPLANKTON	35627	21679	28545	24833	41649	14791	12406

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 10/16/73
DEPTH: 0 - 30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	12158	3287	15480	14182	11795	5443	6163
Copepodites		535	1935		494		2377
Calanoids			967			561	
Cyclopoids	1534	2522	6096	7971		7856	3522
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	13692	6344	24478	22153	12289	14421	12062
% OF TOTAL MICROZOOPLANKTON	70.3	35.7	79.4	79.8	75.3	80.0	43.4
B. CLADOCERANS							
Bosmina sp.		2293	454	725		729	1409
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS		2293	454	725		729	1409
% OF TOTAL MICROZOOPLANKTON		12.9	14.65	2.6		4.1	5.1
C. ROTIFERS							
Brachionus sp.			290	1035			880
Cephalodella sp.							
Diplois sp.							
Elosa sp.							880
Filinia sp.							
Kellekotia sp.							
Keratella sp.	3187	4051	967	3830	2825	1291	6779
Lecane sp.							
Nothulca sp.	354					393	264
Ploesoma sp.		994	290			393	616
Polyarthra sp.	354				494		880
Proalides sp.							
Trichocerca sp.	354	1299	290		706	393	264
Trichotria sp.							

DATE: 10/16/73
DEPTH: 0 - 30'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	1534	2828				393	3786
UID in capsule							
TOTAL ROTIFERS	5783	9172	1837	4865	4025	2863	14349
% OF TOTAL MICROZOOPLANKTON	29.7	51.5	5.95	17.5	24.7	15.9	51.6
D. TOTAL MICROZOOPLANKTON	19475	17809	30861	27743	16314	18013	27820

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 11/12/73
DEPTH: 0 - 10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	3541	409	3135	691	2415	322	769
Copepodites	1239						769
Calanoids	1771		784	987		1074	1308
Cyclopoids		409	549	1944		2900	1769
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	6551	818	4468	3652	2415	4296	4615
% OF TOTAL MICROZOOPLANKTON	27.2	6.4	40.5	30.8	16.3	43.0	41.1
B. CLADOCERANS							
Bosmina sp.	531	955	1567	296		752	231
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.				296			
UID Cladocerans							
TOTAL CLADOCERANS	531	955	1567	592		752	231
% OF TOTAL MICROZOOPLANKTON	2.2	7.38	14.2	5.0		7.5	2.05
C. ROTIFERS							
Brachionus sp.							
Cephalodella sp.							
Diplois sp.	1239						
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	11155	7231	2900	3938	5016	3222	3846
Lecane sp.							
Nothulca sp.			235				
Ploesoma sp.	531						
Polyarthra sp.	1239	1774	549	1648	1300		538
Proalides sp.							
Trichocerca sp.		409					
Trichotria sp.							

DATE: 11/12/73
DEPTH: 0 - 10'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	531	1364	549	296	5573	1396	1769
UID in capsule	2302	409	784	1678	557	322	231
TOTAL ROTIFERS	16997	11187	5017	7600	12446	4940	6384
% OF TOTAL MICROZOOPLANKTON	70.6	86.3	45.4	64.2	83.8	49.5	56.8
D. TOTAL MICROZOOPLANKTON	24079	12960	11052	11844	14861	9988	11230

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 11/12/73
DEPTH: 0 - 20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	1453	1382	2032	1960	1959	834	789
Copepodites			152	457	509	254	139
Calanoids		244	1676	653		254	139
Cyclopoids		569	660	2612	118	363	789
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	1453	2195	4520	5682	2586	1705	1856
% OF TOTAL MICROZOOPLANKTON	15.1	19.4	46.3	60.4	40.5	56.0	37.7
B. CLADOCERANS							
Bosmina sp.		244	1016	653	392	254	464
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.				196	118		
UID Cladocerans							
TOTAL CLADOCERANS		244	1016	849	510	254	464
% OF TOTAL MICROZOOPLANKTON		2.1	10.4	9.0	7.98	8.3	9.4
C. ROTIFERS							
Brachionus sp.							139
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	6369	6745	1524	1502	1450	726	1718
Lecane sp.							
Nothulca sp.	335						139
Ploesoma sp.					274		139
Polyarthra sp.	335	569	152	457	666		325
Proalides sp.							
Trichocerca sp.		244	152			109	
Trichotria sp.							

DATE: 11/12/73
DEPTH: 0 - 20'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
C. ROTIFERS cont'd.							
UID Bdelloides		569	863	457	392	254	139
UID in capsule	1117	813	1524	457	509		
TOTAL ROTIFERS	8156	8940	4215	2873	3291	1089	2599
% OF TOTAL MICROZOOPLANKTON	84.9	78.6	43.2	30.6	51.5	35.7	52.8
D. TOTAL MICROZOOPLANKTON	9606	11379	9751	9404	6387	3048	4919

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 11/12/73
DEPTH: 0-30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	1567	413	1463	604	1402	1089	736
Copepodites	580			325	289		258
Calanoids	3077	486	3793	2183	67	888	625
Cyclopoids	755	316	2546	3390		1086	1103
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	5979	1215	7802	6502	1758	3063	2722
% OF TOTAL MICROZOOPLANKTON	41.9	34.1	49.6	59.1	36.1	68.4	44.3
B. CLADOCERANS							
Bosmina sp.	1161	316	2005	789	289	329	368
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS	1161	316	2005	789	289	329	368
% OF TOTAL MICROZOOPLANKTON	8.1	8.8	12.8	7.2	5.9	7.4	6.0
C. ROTIFERS							
Brachionus sp.	174			1858		99	110
Cephalodella sp.							
Diplois sp.							
Flosa sp.							
Filinia sp.							
Kellekotia sp.							
Keratella sp.	4644	1870	3793		1936	888	2096
Lecane sp.							
Nothulca sp.	406			139			110
Ploesoma sp.	174		163		67	99	
Polyarthra sp.	755			139	156		
Proalides sp.							
Trichocerca sp.			163		67		
Trichotria sp.							

DATE: 11/12/73
DEPTH: 0-30'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
C. ROTIFERS cont'd.							
UID Bdelloides	580		1084	789	378		257
UID in capsule	406	170	704	789	223		478
TOTAL ROTIFERS	7139	2040	5907	3714	2827	1086	3051
% OF TOTAL MICROZOOPLANKTON	50.0	57.1	37.6	33.8	58.0	24.3	49.7
D. TOTAL MICROZOOPLANKTON	14279	3571	15714	11005	4874	4475	6141

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 12/12/73
DEPTH: 0-10'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	2075	1524	1829		1585	2554	1167
Copepodites	1118				1585		
Calanoids	479			601			6612
Cyclopoids							
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	3672	1524	1829	601	3170	2554	7779
% OF TOTAL MICROZOOPLANKTON	23.2	13.2	7.0	15.8	13.6	10.6	24.4
B. CLADOCERANS							
Bosmina sp.	111 8		1829		679		1167
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans		653					
TOTAL CLADOCERANS	1118	653	1829				1167
% OF TOTAL MICROZOOPLANKTON	7.1	5.66	7.0				3.7
C. ROTIFERS							
Brachionus sp.	1597	1524	784			1788	3890
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.							
Kellekotia sp.					679		1167
Keratella sp.	6865	4354	19071	2604	1321	10218	5057
Lecane sp.	479	2177	784		679	6897	10502
Notholca sp.			1829				
Ploesoma sp.	479	653			2943	766	1167
Polyarthra sp.							
Proalides sp.							
Trichocerca sp.							
Trichotria sp.							

DATE: 12/12/73
DEPTH: 0-10'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
C. ROTIFERS cont'd.	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
UID Bdelloides	1597	653		601	3849	1788	1167
UID in capsule							
TOTAL ROTIFERS	11017	9361	22468	3205	0150	21457	22950
% OF TOTAL MICROZOOPLANKTON	69.7	81.1	86.0	84.2	86.4	89.4	71.95
D. TOTAL MICROZOOPLANKTON	15807	11538	26126	3806	3320	24011	31896

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 12/12/73
DEPTH: 0 - 20'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	1625	935	3004	2804	3037	1059	6130
Copepodites		401					
Calanoids	1138		3918	366	1321		
Cyclopoids	1138	401	914	366	396	742	1300
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	3901	1737	7836	3536	4754	1801	7430
% OF TOTAL MICROZOOPLANKTON	32.4	8.7	25.7	18.7	17.5	11.1	26.3
B. CLADOCERANS							
Bosmina sp.			1306		1320	318	2415
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS			1306		1320	318	2415
% OF TOTAL MICROZOOPLANKTON			4.3		4.85	1.95	8.6
C. ROTIFERS							
Brachionus sp.	1138	1335	3004	366	2245	1801	1857
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.				366	924		
Kellekotia sp.	488	401	392	366			557
Keratella sp.	3738	10681	13975	11824	13602	6674	7987
Lecane sp.							
Nothulca sp.	1138	2270	1306	853	1717	3920	4272
Ploesoma sp.							
Polyarthra sp.	488	1335	914	1219	1717	742	1300
Proalides sp.							
Trichocerca sp.							
Trichotria sp.							

DATE: 12/12/73
DEPTH: 0 - 20'

C. ROTIFERS cont'd.	RNCE no./m^3	RNCW no./m^3	RSCE no./m^3	RSCW no./m^3	RDE no./m^3	RI no./m^3	DI no./m^3
UID Bdelloides	1138	2270	1698	366	924	1059	2415
UID in capsule							
TOTAL ROTIFERS	8128	18292	21289	15360	21129	14196	18388
% OF TOTAL MICROZOOPLANKTON	67.6	91.3	69.96	81.3	77.7	87.0	65.1
D. TOTAL MICROZOOPLANKTON	12029	20029	30431	18896	27203	16315	28233

ROSETON-DANSKAMMER MICROZOOPLANKTON

DATE: 12/12/73
DEPTH: 0 - 30'

GROUP	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
A. COPEPODS							
Nauplii	4257	342	1678	1587	2341	2612	1161
Copepodites						290	
Calanoids	745		1678		351		
Cyclopoids		799	296	1349	351	2225	813
Harpacticoids							
UID Copepods							
TOTAL COPEPODS	5002	1141	3652	2936	3043	5127	1974
% OF TOTAL MICROZOOPLANKTON	20.4	9.0	12.6	15.5	19.8	26.9	13.3
B. CLADOCERANS							
Bosmina sp.			987		819	290	1161
Daphnia sp.							
Leptodora sp.							
Pleuroxus sp.							
UID Cladocerans							
TOTAL CLADOCERANS			987		819	290	1161
% OF TOTAL MICROZOOPLANKTON			3.4		5.3	1.5	7.9
C. ROTIFERS							
Brachionus sp.	3938	1941	3947	1349	1522	677	1509
Cephalodella sp.							
Diplois sp.							
Elosa sp.							
Filinia sp.					351		
Keilekotia sp.	1064	342	987	555	351		
Keratella sp.	12026	4224	11842	11662	7375	6482	4644
Lecane sp.							
Nothulca sp.	1809	2283	2961	555	819	5515	3831
Ploesoma sp.							
Polyarthra sp.	319	799	3651	555	819		
Proalides sp.							
Trichocerca sp.							
Trichotria sp.							

DATE: 12/12/73
DEPTH: 0 - 30'

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3	no./m^3
C. ROTIFERS cont'd.							
UID Bdelloides	319	1941	987	1349	351	967	1509
UID in capsule							
TOTAL ROTIFERS	19475	11530	24375	16025	11588	13641	11493
% OF TOTAL MICROZOOPLANKTON	79.6	91	83.9	84.5	75.0	71.6	78.6
D. TOTAL MICROZOOPLANKTON	24477	12671	29041	18961	15450	19058	14628

APPENDIX III-C

APPENDIX III-C

ROSETON/DANSKAMMER POINT
1973
MACROZOOPLANKTON

MACROZOOPLANKTON

APRIL 11, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0900S1	288.6	0.0	0.0	0.0	0.0
1100S1	248.6	502.9	0.0	0.0	502.9

MACROZOOPLANKTON

MAY 10, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0933S1	263.9	515.4	7.6	3.8	526.7
1150S1	200.3	0.0	0.0	10.0	10.0
1209M1	210.9	9.5	9.5	0.0	19.0
1340M1	186.1	37.6	37.6	0.0	75.2
1808S1	160.2	6.2	0.0	0.0	6.2
2028S1	160.2	1897.4	62.4	6.2	1966.0
2044M1	177.9	1506.5	129.3	0.0	1635.8
2257M1	276.9	5100.2	281.7	108.4	5490.3

MACROZOOPLANKTON

MAY 22, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1010S1	164.9	0.0	0.0	0.0	0.0
1010S1	69.5	14.4	14.4	0.0	28.8
1620S1	60.1	0.0	0.0	0.0	0.0
1620S1	176.7	316.9	50.9	96.2	464.0
2025S1	31.8	157.2	660.2	503.0	1320.4
2025S1	47.1	4520.0	3756.0	106.1	8382.1
2325S1	169.6	6254.2	265.3	58.9	6578.4
2325M1	169.6	3253.8	76.6	17.7	3348.1

MACROZOOPLANKTON

MAY 23, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0148S2	67.1	3112.6	804.2	1057.4	4974.2
0148S1	268.6	2103.4	800.4	714.8	3618.7
0230S1	196.7	5809.6	350.7	340.5	6500.9
0556M1	189.7	26.4	52.7	26.4	105.4
0556M1	189.7	152.9	195.1	31.6	379.6
0619B1	156.7	146.8	0.0	0.0	146.8
0619B1	156.7	1040.3	153.2	0.0	1193.5
0809S1	214.4	0.0	0.0	4.7	4.7

MACROZOOPLANKTON

JUNE 7, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1820S1	147.3	0.0	0.0	0.0	0.0
1820M1	162.6	756.6	387.5	49.2	1193.3
1820M1	179.1	759.5	22.3	22.3	804.1
2124S1	230.9	6500.4	298.8	86.6	6885.9
2124M1	169.6	10728.2	70.7	58.9	10857.9
2210S1	190.9	3961.2	282.9	152.0	4396.1
2210S1	174.4	12164.6	229.4	154.9	12548.8
2210M1	129.6	3117.5	216.1	15.4	3349.0
2347S1	181.4	3009.5	66.1	33.1	3108.7
2347M1	149.6	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

JUNE 8, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0212S1	219.1	10852.2	1912.1	383.3	13147.7
0212S1	168.5	7971.8	682.6	160.3	8814.7
0345M1	302.8	33028.2	42.9	0.0	33071.1
0345M1	176.7	12494.7	345.2	215.0	13054.9
0628S1	205.0	1292.7	4.9	14.6	1312.3
0946S1	238.0	21.0	12.6	0.0	33.6
0946S1	252.1	0.0	0.0	0.0	0.0
1020M1	283.9	521.3	14.1	14.1	549.4

MACROZOOPLANKTON

JUNE 19, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0925M1	110.7	2203.3	180.6	451.5	2835.4
1205S1	181.4	0.0	0.0	3770.1	3770.1
1453S1	49.5	40.4	0.0	4991.9	5032.3
1453M1	131.9	6123.7	181.9	303.2	6608.7
0925S1	201.5	5.0	5.0	491.4	501.4

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION:RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0018S1	160.2	5330.1	131.1	7102.7	12563.8
0018M1	144.9	12145.8	752.2	200.1	13098.1
0037S1	155.5	8372.5	315.1	70.7	8758.3
0611M1	190.9	4904.3	403.5	4139.3	9447.1

MACROZOOPLANKTON

JULY 2, 1973

LOCATION:RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1214S1	230.9	121.3	17.3	140021.4	140160.0
1214S2	69.5	158.3	86.3	193418.9	193663.5
1313S1	206.2	485.0	19.4	18528.6	19033.1
1313M1	208.5	105.5	201.4	1371.5	1678.5

MACROZOOPLANKTON

JULY 3, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0215S1	126.1	31303.4	698.1	25369.5	57371.0
0215S2	55.7	37441.3	503.0	12899.6	50844.0
0400M1	283.9	201858.2	472.0	18568.5	220898.6
0400S1	247.4	17348.4	359.7	1992.7	19700.8

MACROZOOPLANKTON

JULY 17, 1973

LOCATION:RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1145S1	200.3	1318.2	354.5	1997.2	3669.9
1145S2	50.7	19.7	0.0	79.0	98.7
1338M1	208.5	800.9	575.5	11274.5	12650.8
1338S1	149.6	0.0	13.4	6770.5	6783.9
2152S1	183.8	3972.1	5832.9	190.4	9995.5
2152M1	183.8	13080.6	2872.9	5653.4	21606.9

MACROZOOPLANKTON

JULY 18, 1973

LOCATION:RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0215S1	192.0	8665.3	2822.5	5665.8	17153.5
0215S2	55.1	9133.6	2796.4	33955.9	45885.8

MACROZOOPLANKTON

JULY 31,1973

LOCATION:RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1131S2	54.5	532.3	91.8	4625.3	5249.4
1240S1	180.2	959.8	33.3	382.8	1375.9
1240N1	187.3	32.0	64.1	1847.1	1943.2
1633S1	225.0	480.0	71.1	4.4	555.5
1633N1	179.1	0.0	251.3	100.5	351.8
2223S1	97.8	4080.5	4029.4	40.9	8150.8

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0223S2	79.2	10906.3	2739.2	189.3	13834.8
0223S1	253.3	9459.5	837.0	236.9	10533.3
0253S1	219.1	17350.7	4449.5	41.1	21841.3

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1525S1	197.9	50.5	25.3	651.8	727.6
1525M1	128.4	194.7	85.7	3668.2	3948.5
1738S2	70.7	28.3	28.3	254.7	311.3
1738S1	17.7	0.0	0.0	962.0	962.0
2133S1	144.9	4354.5	3526.4	55.2	7936.2
2133S2	31.5	13550.6	8282.7	1205.9	23039.2

MACROZOOPLANKTON

AUGUST 15, 1973

LOCATION: RDW

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0115S1	248.6	2228.7	1878.7	2176.4	6283.7
0133S1	258.0	1562.0	205.4	302.3	2069.7
0505M1	240.3	4593.6	844.7	45.8	5484.1

MACROZOOPLANKTON

APRIL 11, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0915S1	281.6	436.8	60.4	0.0	497.2
1115S1	254.5	263.3	7.9	3.9	275.1

MACROZOOPLANKTON

MAY 10,1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0949S1	245.0	73.5	20.4	0.0	93.9
1135S1	181.4	0.0	5.5	38.6	44.1
1230M1	202.6	9.9	0.0	0.0	9.9
1246M1	177.9	0.0	39.3	0.0	39.3
1324M1	188.5	5.3	15.9	5.3	26.5
1400B1	217.9	165.2	27.5	50.5	243.2
1430B1	189.7	970.1	664.3	5.3	1639.7
1605B1	208.5	652.2	944.7	48.0	1644.9
1905S1	179.1	0.0	27.9	0.0	27.9
2011S1	205.0	156.1	404.9	4.9	565.9
2108M1	195.6	1600.5	2832.8	61.4	4494.7
2230M1	222.7	6449.3	1006.0	13.5	7468.8
2314B1	332.2	1077.6	400.3	12.0	1490.0

MACROZOOPLANKTON

MAY 11, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0018B1	223.8	1233.0	540.6	17.9	1791.5

MACROZOOPLANKTON

MAY 22, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1045S1	196.7	0.0	5.1	5.1	10.2
1045S1	207.3	0.0	0.0	0.0	0.0
1305M1	201.5	0.0	0.0	0.0	0.0
1305M1	227.4	0.0	8.8	0.0	8.8
1335B2	22.4	44.7	44.7	0.0	89.4
1445M1	161.4	6.2	0.0	12.4	18.6
1445M2	55.7	0.0	18.0	107.8	125.8
1640S1	161.4	0.0	0.0	6.2	6.2
1640S1	176.7	28.3	11.3	34.0	73.6
2050S1	180.2	5.5	38.8	0.0	44.4
2050S1	163.8	1123.6	989.3	36.6	2149.5
2115M1	177.9	3423.4	286.7	39.3	3749.4
2245M1	168.5	3442.8	142.5	59.4	3644.6
2245B1	168.5	5277.0	35.6	65.3	5377.9
2340M1	180.2	5575.6	55.5	27.7	5658.8

MACROZOOPLANKTON

MAY 23, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0248S1	175.5	1031.1	0.0	125.3	1156.5

MACROZOOPLANKTON

JUNE 7, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1858S1	256.8	15.6	3.9	0.0	19.5
1858S1	134.3	104.2	22.3	0.0	126.6
1858M1	177.9	1073.7	168.6	16.9	1259.2
2055S1	176.7	107.5	169.8	11.3	288.6
2055B1	156.7	20997.2	293.6	51.1	21341.9
2055B1	188.5	23958.1	100.8	0.0	24058.9
2240S1	194.4	684.2	30.9	591.6	1306.7
2240S1	172.0	8842.9	209.3	866.3	9918.5
2240M1	185.0	6779.8	465.0	102.7	7347.5

MACROZOOPLANKTON

JUNE 8, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0035B1	197.9	11181.2	742.7	480.0	12404.0
0035B1	192.0	10842.0	453.1	109.4	11404.5
0236S1	217.9	761.6	41.3	59.6	862.6
0236S1	197.9	1419.8	101.1	30.3	1551.1
0405M1	172.0	19383.4	482.6	168.6	20034.6
0520B1	241.5	4008.1	91.1	49.7	4148.9
0520B1	253.3	10343.8	118.4	55.3	10517.5
0643S1	210.9	75.9	0.0	4.7	80.6
0643S1	0.6	5092.9	0.0	0.0	5092.9
0930S1	164.9	12.1	12.1	12.1	36.4
0930S1	267.4	0.0	0.0	18.7	18.7
1039N1	276.9	1448.4	3.6	0.0	1452.0

MACROZOOPLANKTON

JUNE 19, 1973.

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1145M1	190.9	83.8	21.0	6780.1	6884.9
1655S1	136.7	0.0	0.0	241.5	241.5
1655B1	153.2	4453.1	117.5	58.8	4629.4
0951S1	162.6	0.0	0.0	6.2	6.2
1145S1	188.5	42.4	0.0	6313.1	6355.6
2049M1	143.7	438.3	981.0	2108.1	3527.5
2139M1	182.6	5158.7	284.8	27.4	5470.8

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0000S1	220.3	1688.6	494.8	6681.7	8865.0
0000B1	179.1	13938.6	519.3	145.2	14603.1
0057M1	152.0	36966.6	579.0	3322.9	40868.6
0633S1	185.0	140.6	5.4	957.0	1102.9
0633B1	170.8	4343.6	29.3	17.6	4390.5

MACROZOOPLANKTON

JULY 2, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1332S1	207.3	173.6	14.5	10620.0	10808.0
1332B1	222.7	1320.4	637.7	5245.6	7203.8
1638M2	79.5	62.9	0.0	34446.3	34509.2
1638M1	297.0	0.0	26.9	5283.7	5310.6
2132S1	254.5	522.7	2027.7	27740.1	30290.5
2132B1	346.4	7587.5	1175.1	5396.1	14158.6

MACROZOOPLANKTON

JULY 3, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0241M2	45.4	45201.0	352.8	10583.6	56137.4
0241M1	278.0	20947.3	151.1	1575.4	22673.7

MACROZOOPLANKTON

JULY 17, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1300M1	206.2	591.8	683.9	4738.9	6014.5
1300M2	58.0	34.5	68.9	12720.5	12823.9
1356S1	176.7	90.5	50.9	322.6	464.0
1356B1	179.1	15077.8	7918.6	2021.5	25018.0
2214B1	21.2	242763.8	126333.4	47.2	369144.3
2214S1	155.5	4121.9	4237.7	167.2	8526.8

MACROZOOPLANKTON

JULY 18, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0235M2	96.0	15571.8	1593.6	14405.2	31570.6
0235M1	230.9	7466.2	2070.1	7933.9	17470.2

MACROZOOPLANKTON

JULY 31, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0857B1	120.4	66.4	307.3	41.5	415.3
1300S1	114.3	192.5	35.0	2564.0	2791.5
1300M1	399.4	277.9	896.4	2328.6	3503.0
1300B1	147.3	1826.7	1935.3	1276.6	5038.6
1937S1	168.5	0.0	17.8	17.8	35.6
2142M1	196.7	1301.2	1087.7	162.6	2551.6
2330S1	179.1	4428.4	2194.7	3490.2	10113.3
2330M1	170.8	7867.7	766.9	1627.4	10262.0
2330B1	239.2	21375.3	1229.3	878.1	23482.7

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0149S1	71.9	11994.9	4619.8	27.8	16642.5
0149M1	210.9	14112.3	2821.5	28.5	16962.3

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RDWCH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1252M1	150.8	0.0	0.0	10862.3	10862.3
1252M2	49.2	40.7	284.7	8682.1	9007.5
1542S1	192.0	10.4	36.5	343.7	390.6
1542B1	162.6	203.0	621.2	4662.4	5486.6
2106M1	179.1	14508.2	2183.5	837.7	17529.3
2158M1	173.2	4631.0	2962.2	277.2	7870.4

MACROZOOPLANKTON

APRIL 11, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0932S1	239.2	4.2	4.2	0.0	8.4
1135S1	288.6	10.4	24.3	0.0	34.6

MACROZOOPLANKTON

MAY 10, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1013S1	240.3	8.3	4.2	4.2	16.6
1124M1	219.1	9.1	0.0	9.1	18.3
1306M1	185.0	5.4	0.0	48.7	54.1
1417B1	190.9	41.9	52.4	0.0	94.3
1957S1	192.0	5.2	494.7	5.2	505.1
2130M1	241.5	1958.5	2053.7	16.6	4028.8
2156M1	181.4	915.0	766.1	71.7	1752.8
2338B1	116.6	13692.7	1329.0	34.3	15055.9

MACROZOOPLANKTON

MAY 22, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1125S1	199.1	0.0	0.0	5.0	5.0
1125S1	180.2	0.0	0.0	0.0	0.0
1210M1	190.9	0.0	10.5	0.0	10.5
1210M1	162.6	0.0	0.0	6.2	6.2
1350B1	208.5	9.6	9.6	14.4	33.6
1350B2	55.7	431.2	305.4	556.9	1293.6
1520S2	52.4	19.1	19.1	57.2	95.4
1520S1	236.8	0.0	0.0	0.0	0.0
1805S1	157.9	0.0	12.7	0.0	12.7
1805S1	133.1	15.0	15.0	187.8	217.8
2200M1	146.1	13855.0	260.1	178.0	14293.1
2200M1	146.1	321.7	20.5	0.0	342.3
2220M1	169.6	15502.8	359.6	70.7	15933.1
2220B1	169.6	2446.3	11.8	11.8	2469.8

MACROZOOPLANKTON

MAY 23, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0005S1	136.7	175.6	22.0	0.0	197.6
0005M1	136.7	4170.9	109.8	0.0	4280.7
0045S2	65.4	168.2	91.8	30.6	290.6
0045S1	261.5	669.1	221.8	118.5	1009.4
0316S1	166.1	439.5	30.1	234.8	704.3
0316S1	166.1	3088.3	403.3	186.6	3678.2
0456M1	193.2	1092.1	113.9	139.7	1345.7
0456M1	193.2	3043.3	98.3	269.1	3410.8
0702B1	236.8	101.4	21.1	46.5	168.9
0702B1	236.8	109.8	118.2	84.5	312.5
0737S1	282.7	0.0	3.5	7.1	10.6

MACROZOOPLANKTON

JUNE 7, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1921S1	190.9	0.0	0.0	15.7	15.7
1921M1	137.8	21.8	72.5	14.5	108.8
2036S1	162.6	12.3	153.8	1310.1	1476.2
2036B1	168.5	27500.7	2208.1	59.4	29768.2
2036B1	156.7	27832.5	568.0	6.4	28406.9
2328S1	185.0	3303.4	108.1	124.4	3535.9
2328S1	161.4	10427.5	179.7	12.4	10619.6
2328M1	147.3	10321.7	156.2	74.7	10552.6

MACROZOOPLANKTON

JUNE 8, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0015B1	189.7	9511.1	279.4	100.2	9890.6
0015B1	182.6	17748.6	416.2	98.6	18263.4
0258S1	217.9	646.9	27.5	215.6	890.1
0258S1	239.2	2847.5	79.4	146.3	3073.3
0424M1	202.6	21951.0	39.5	14.8	22005.3
0424M1	193.2	8824.7	150.1	5.2	8979.9
0552B1	185.0	21242.2	378.5	81.1	21701.8
0552B1	160.2	34202.6	112.3	6.2	34321.2
0702S1	201.5	0.0	0.0	0.0	0.0
0702S1	189.7	10.5	10.5	1012.3	1033.4
0910S1	185.0	86.5	5.4	10.8	102.7

MACROZOOPLANKTON

JUNE 19, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1015S1	215.6	13.9	0.0	913.8	927.7
1015B1	193.2	5351.7	320.9	16153.5	21826.2
1120M1	94.2	551.7	0.0	29708.9	30260.6
2202B1	212.1	363.1	33.0	9.4	405.5
2232M1	43.6	46249.5	0.0	160.6	46410.0

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0140M1	208.5	25023.5	450.8	12363.1	37837.4
0654S1	188.5	37.1	58.4	206.9	302.4
1320M1	116.6	231.5	25.7	38960.2	39217.4
0528M1	232.1	594.6	8.6	3761.5	4364.8

MACROZOOPLANKTON

JULY 2, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1232M1	258.0	54.3	11.6	227484.9	227550.8
1232M2	71.9	222.7	41.7	231011.2	231275.6
1352S1	221.5	9.0	0.0	16001.2	16010.3
1352B1	187.3	4345.6	416.4	79330.4	84092.3
2207S1	240.3	1934.8	936.2	154282.2	157153.2
2207B1	276.9	27408.0	1025.8	22531.8	50965.6

MACROZOOPLANKTON

JULY 3, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0320M2	29.7	30392.2	336.2	7665.3	38393.7
0320M1	276.9	4926.8	765.7	15524.5	21217.0

MACROZOOPLANKTON

JULY 17, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1317M2	52.1	211.0	268.6	59144.6	59624.2
1317M1	193.2	1832.2	2655.2	42819.0	47306.4
1442S1	126.1	15.9	0.0	4212.4	4228.3
1442B1	126.1	1745.2	19324.6	6631.9	27701.8
2240S1	303.9	1546.3	259.9	529.7	2335.9
2240B1	223.8	16016.0	1831.7	2783.3	20630.9

MACROZOOPLANKTON

JULY 18, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0310M2	28.6	14842.6	14702.5	24854.3	54399.4
0310S1	209.7	8478.7	8221.2	12508.2	29208.1

MACROZOOPLANKTON

JULY 31, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0928B1	43.6	114.7	7295.3	45.9	7455.9
1326B1	163.8	763.3	2003.0	519.1	3285.4
1326M1	169.6	312.4	2876.6	5670.6	8859.6
1326S1	142.6	56.1	21.0	161.3	238.5
1448M1	220.3	508.4	4325.8	1979.1	6813.3
1718M1	157.9	31.7	240.7	183.7	456.1
1718B1	150.8	2586.3	3342.2	6.6	5935.1
2001M1	144.9	0.0	1283.6	13.8	1297.4
2104M1	180.2	6013.9	2651.9	11.1	8676.9

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0006B1	167.3	30916.3	13150.8	334.7	44401.9
0006M1	172.0	7999.9	4517.4	220.9	12738.2
0006S1	189.7	1407.7	4523.5	316.3	6247.6

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1310M2	53.0	18.9	0.0	5942.3	5961.1
1602S1	155.5	19.3	19.3	70.7	109.3
1602B1	160.2	99.9	162.3	1192.1	1454.2
2212M1	91.9	7225.9	4527.1	663.8	12416.8

MACROZOOPLANKTON

AUGUST 15, 1973

LOCATION:RDECH

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0212S1	226.2	154.7	420.0	39.8	614.5

MACROZOOPLANKTON

MARCH 13, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1028S1	202.6	0.0	0.0	0.0	0.0
1028B1	174.4	5.7	0.0	5.7	11.5

MACROZOOPLANKTON

MARCH 21, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1436S1	213.2	0.0	0.0	0.0	0.0
1450B1	340.5	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

APRIL 11, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0945S1	199.1	10.0	40.2	0.0	50.2
1150S1	272.1	7.3	3.7	0.0	11.0
			43.9		
			.9		

MACROZOOPLANKTON

MAY 10, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1028S1	229.7	0.0	4.4	0.0	4.4
1052S1	181.4	0.0	55.1	0.0	55.1
1929S1	188.5	0.0	0.0	0.0	0.0
1945S1	194.4	0.0	946.6	0.0	946.6

MACROZOOPLANKTON

MAY 22, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1145S1	185.0	5.4	0.0	0.0	5.4
1145S1	134.3	0.0	14.9	7.4	22.3
1740S1	179.1	11.2	0.0	0.0	11.2
1740S1	155.5	0.0	0.0	0.0	0.0
		13.2	6.6	0	19.5
		29.8	21.5	7.4	53.4
		14.9	10.7	3.7	29.2

MACROZOOPLANKTON

MAY 23, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0025S1	160.2	5405.0	561.7	131.1	6097.8
0025S1	160.2	6472.3	305.8	62.4	6840.5
0354S1	181.4	1300.8	49.6	77.2	1427.6
0354S1	181.4	2502.4	446.5	270.1	3218.9
0436M1	206.2	2114.8	286.2	160.1	2561.0
0436M1	206.2	2871.5	266.8	194.0	3332.2
0723S1	152.0	13.2	6.6	0.0	19.7

MACROZOOPLANKTON

JUNE 7, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1945S1	186.1	0.0	10.7	5.4	16.1
1945M1	174.4	1474.0	762.8	177.8	2414.6
1945N1	148.4	4250.9	94.3	101.1	4446.2
2013S1	222.7	0.0	18.0	71.9	89.8
2013M1	195.6	450.0	138.1	20.5	608.5

MACROZOOPLANKTON

JUNE 8, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0318S1	228.6	7880.1	161.9	2450.2	10492.2
0318S1	194.4	16703.8	113.2	10.3	16827.3
0440M1	123.7	96062.7	234.4	0.0	96297.1
0440M1	154.3	61257.9	226.8	32.4	61517.1
0720S1	24.7	0.0	0.0	40.4	40.4
0720S1	187.3	10.7	5.3	405.7	421.7
0845S1	175.5	5337.9	17.1	11.4	5366.4
0845S1	175.5	11.4	0.0	91.1	102.5

MACROZOOPLANKTON

JUNE 19, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1045S1	200.3	0.0	15.0	863.8	878.8
1045M1	203.8	755.6	9.8	4.9	770.3
1100S1	154.3	596.1	13.0	23929.1	24538.2
1753S1	213.2	9.4	0.0	267.3	276.7

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0510M1	210.9	5823.2	2622.3	7629.9	16075.5
0710S1	210.9	37.9	37.9	75.9	151.7

MACROZOOPLANKTON

JULY 2, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1421S1	215.6	51.0	9.3	4151.4	4211.7
1421M1	181.4	7242.6	314.2	41763.3	49320.0
1451S1	240.3	461.9	16.6	28897.5	29376.0
1451S2	51.2	0.0	58.5	75834.7	75893.3
2330S1	275.7	1828.2	526.0	347887.4	350241.6
2254M1	372.3	11958.8	290.1	15767.7	28016.6

MACROZOOPLANKTON

JULY 3, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0045S1	76.0	52039.3	5409.2	26467.1	83915.7
0045S1	162.6	41530.9	5400.5	22143.2	69074.6

MACROZOOPLANKTON

JULY 17, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1002S1	174.4	11.5	636.6	212.2	860.3
1024S1	338.1	239.6	53.2	27336.9	27629.7
1024S2	23.3	386.8	1160.5	33912.9	35460.2
1840M1	166.1	2335.8	4087.6	19354.4	25777.8
2300S1	164.9	11932.0	1667.3	20535.5	34134.9
2300M1	150.8	26048.3	3209.6	3899.3	33157.2

MACROZOOPLANKTON

JULY 18, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0024S2	74.2	3826.8	7033.7	242.5	11103.0
0024S1	253.3	3845.4	4911.3	5290.3	14047.1

MACROZOOPLANKTON

JULY 31,1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1356S1	248.6	16.1	40.2	104.6	160.9
1356M1	2205.4	85.2	205.4	344.6	635.3
1421S2	73.6	27.2	0.0	8828.5	8855.7
1421S1	200.3	174.8	109.8	384.5	669.1
2023M1	126.1	2538.5	2030.8	2784.5	7353.8
2042S1	272.1	99.2	3325.5	602.6	4027.3

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0035S1	176.7	1612.8	9127.7	101.9	10842.3
0035M1	209.7	17472.4	19332.2	190.7	36995.4
0103S2	31.8	39300.8	21882.7	14462.7	75646.1
0103S1	275.7	9779.6	9808.6	2771.4	22359.6
0523M1	230.9	9484.3	4742.2	4.3	14230.8

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1620S1	163.8	12.2	0.0	103.8	116.0
1620M1	154.3	71.3	97.2	835.9	1004.3
1638S2	2.7	754.6	754.6	61497.8	63007.0
1638S1	174.4	109.0	22.9	768.5	900.4

MACROZOOPLANKTON

AUGUST 15, 1973

LOCATION: RDE

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0226S1	202.6	231.9	3913.5	8606.7	12752.1
0247S1	210.9	0.0	0.0	0.0	0.0
0553M1	219.1	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

JULY 2,1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1233S2	9.7	102.9	308.7	54741.0	55152.5
1233M2	16.2	432.2	1605.2	12903.2	14940.6
1257S2	4.4	0.0	226.4	85342.4	85568.8

MACROZOOPLANKTON

JULY 3, 1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0050S2	18.8	27217.7	3607.8	22495.8	53321.3
0050M2	16.2	30622.0	5803.4	6482.5	42907.9

MACROZOOPLANKTON

JULY 17, 1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1210S2	30.3	395.6	230.8	11076.9	11703.2
1210M2	31.2	1185.3	3171.3	13934.7	18291.3
1210B2	39.2	3012.6	2476.5	17565.1	23054.2
1253S2	38.6	648.0	777.6	3006.8	4432.4
1253B2	11.5	3047.3	10709.2	6965.3	20721.8

MACROZOOPLANKTON

JULY 18, 1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0100S2	15.6	9610.1	10250.8	19476.6	39337.5
0100B2	12.7	61910.2	29296.8	10818.5	102025.5
0135S2	38.0	7343.9	3474.6	6317.4	17135.9
0135M2	66.3	3335.2	2399.5	4014.3	9749.1
0135B2	39.5	14773.3	5422.8	23237.0	43433.1

MACROZOOPLANKTON

JULY 31,1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0940S2	29.7	0.0	33.6	1546.5	1580.1
1042S2	7.7	522.4	130.6	261.2	914.2
1107S2	33.9	29.5	0.0	236.2	265.7
1107B2	37.4	80.2	53.5	4117.5	4251.2
1159B2	14.7	203.7	2580.6	0.0	2784.4
1256B2	56.0	786.3	5057.6	71.5	5915.5
1256S2	28.9	554.4	346.5	1316.7	2217.5
1350S2	10.0	99.9	399.5	99.9	599.2
1350B2	12.7	394.8	1737.3	0.0	2132.1
1408B2	31.5	476.0	825.1	0.0	1301.1
1545S2	22.7	0.0	485.1	308.7	793.8
1600S2	7.7	0.0	783.6	3787.4	4571.0
1600B2	6.8	147.6	147.6	1476.3	1771.6
1858S2	8.0	0.0	0.0	0.0	0.0
1942S2	32.7	30.6	489.5	0.0	520.0
1942B2	37.1	215.6	1536.1	1374.4	3126.1
2000B2	9.4	424.4	3607.8	0.0	4032.3
2135S2	38.3	4832.2	1750.0	26.1	6608.3
2135B2	42.7	7119.0	4004.4	46.8	11170.3
2150S2	10.3	34926.0	9507.6	970.2	45403.8

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0049S2	23.9	19954.3	6036.6	1760.7	27751.6
0049B2	30.9	10542.5	4171.7	2393.1	17107.3
0106S2	10.0	32158.2	9687.4	2996.1	44841.7
0106B2	9.4	66638.4	8807.3	4456.7	79902.4
0333B2	23.9	11737.8	4066.3	83.8	15888.0
0347B2	11.5	11666.9	3482.7	0.0	15149.5
0530S2	25.6	8040.1	1405.1	0.0	9445.2
0530B2	29.5	10865.9	1052.6	169.8	12088.3
0545S2	8.2	17220.5	3395.6	0.0	20616.1
0545B2	4.1	27892.3	8974.0	242.5	37108.9

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1323S2	35.6	0.0	140.3	954.1	1094.4
1323B2	39.8	25.2	0.0	3772.9	3798.0
1344S2	5.9	0.0	169.8	679.1	848.9
1344B2	8.5	0.0	0.0	3512.7	3512.7

MACROZOOPLANKTON

AUGUST 15,1973

LOCATION:RI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0105S2	9.7	8643.3	6070.9	6070.9	20785.1
0105B2	14.7	2988.1	1358.2	1901.5	6247.9
0120S2	7.7	12929.3	8750.2	22593.7	44273.2
0120B2	12.7	11134.4	14687.9	7738.8	33561.0

MACROZOOPLANKTON

JULY 17, 1973

LOCATION: RD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1233M2	164.9	412.3	1006.5	11156.9	12575.8
1305M2	22.1	1313.0	5070.7	14940.6	21324.3

MACROZOOPLANKTON

JULY 18, 1973

LOCATION: RD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0025M2	90.7	13229.6	10021.4	49136.8	72387.7

MACROZOOPLANKTON

JULY 31, 1973

LOCATION:RD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1010M2	156.1	76.9	76.9	153.8	307.5
1028M2	13.8	650.2	0.0	0.0	650.2
1128M2	104.0	48.1	423.2	2347.1	2818.4
1144M2	33.9	472.4	797.2	974.4	2244.0
1320M2	86.9	34.5	1381.3	0.0	1415.8
1336M2	6.5	1234.8	1543.4	30714.6	33492.8
1620M2	0.6	1697.8	1697.8	0.0	3395.6
1635M2	5.3	188.6	754.6	565.9	1509.1
2030M2	60.7	115.4	824.2	16.5	956.0
2045M2	8.0	754.6	1383.4	251.5	2389.5
2225M2	5.9	2207.1	2037.4	0.0	4244.5

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:RD

SAMPLES	VOLUME SAMPLED M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0132M2	0.3	61120.5	57725.0	3395.6	122241.1
0145M2	13.5	3174.1	959.6	0.0	4133.8
0403M2	187.9	6972.1	974.0	117.1	8063.2
0417M2	3.8	148361.0	45709.8	1828.4	195899.2
0615M2	67.7	5993.9	1771.6	29.5	7795.1
0627M2	35.9	695.8	417.5	0.0	1113.3

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: RD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1555M2	122.2	49.1	0.0	580.9	630.0
1615M2	33.9	295.3	413.4	1181.1	1889.7

MACROZOOPLANKTON

AUGUST 15, 1973

LOCATION: RD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0045M2	10.9	8351.3	13674.1	1468.4	23493.8
0055M2	25.3	5843.6	7225.5	1224.0	14293.0

MACROZOOPLANKTON

MAY 22,1973.

LOCATION:DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1200S1	153.2	0.0	0.0	0.0	0.0
1200B1	180.2	5.5	33.3	16.6	55.5
1200S2	39.8	0.0	0.0	25.2	25.2
1200M2	43.2	0.0	23.1	46.3	69.4
1200B2	40.3	24.8	99.1	24.8	148.7
1330S1	160.2	0.0	12.5	0.0	12.5
1330S2	31.2	0.0	0.0	96.1	96.1
1330M2	33.0	0.0	181.9	181.9	363.8
1330B2	32.4	0.0	0.0	30.9	30.9
1515S2	20.9	47.8	0.0	0.0	47.8
1515M2	21.8	0.0	0.0	91.8	91.8
1908S1	117.5	17.0	25.5	8.5	51.1
1908S2	30.0	33.3	0.0	33.3	66.6
1908B2	29.2	0.0	34.2	102.7	136.9
2100S1	115.2	703.0	1822.6	225.7	2751.3
2100S2	18.0	334.0	334.0	167.0	835.0
2100M2	18.6	4137.0	2955.0	752.2	7844.2
2100B2	20.1	13791.5	1095.4	348.5	15235.3

MACROZOOPLANKTON

MAY 23, 1973.

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
2400S1	205.9	262.2	349.6	145.7	757.5
2400S2	20.9	1434.8	956.5	239.1	2630.4
2400M2	24.3	494.5	164.8	0.0	659.3
2400B2	22.2	4092.7	629.6	89.9	4812.3
0325S1	119.0	722.8	874.0	437.0	2033.8
0325S2	13.8	578.0	433.5	361.2	1372.7
0325M2	8.0	3647.1	2389.5	251.5	6288.1
0325B2	16.5	6609.3	2243.5	909.5	9762.3
0425S1	62.4	768.7	848.8	576.6	2194.1
0425S2	14.1	495.2	283.0	141.5	919.6
0425M2	15.0	665.8	332.9	599.2	1597.9
0425B2	16.5	3577.5	848.9	970.2	5396.6
0525S1	63.6	15.7	31.4	94.3	141.5
0525S2	14.1	0.0	0.0	70.7	70.7
0525M2	14.7	882.9	543.3	67.9	1494.1
0525B2	14.4	69.3	69.3	138.6	277.2
0625S1	71.9	13.9	41.7	0.0	55.7
0625S2	14.7	67.9	0.0	67.9	135.8
0625M2	15.9	125.8	0.0	0.0	125.8
0625B2	16.2	0.0	0.0	0.0	0.0
0735S1	88.4	34.0	11.3	11.3	56.6
0735S2	17.7	56.6	113.2	56.6	226.4
0735M2	41.5	0.0	0.0	0.0	0.0
0735B2	43.9	136.7	45.6	0.0	182.3
0835S1	90.7	11.0	55.1	0.0	66.1
0835S2	20.9	143.5	143.5	47.8	334.8
0835M2	22.7	661.5	0.0	88.2	749.7
0835B2	22.7	44.1	132.3	0.0	176.4
0915S1	90.7	22.0	22.0	0.0	44.1
0940S2	38.9	0.0	25.7	0.0	25.7
0940M2	34.2	0.0	0.0	0.0	0.0
0940B2	21.2	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

JUNE 7,1973

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1702S1	137.8	696.5	565.9	14.5	1276.9
1830B1	58.9	0.0	169.8	34.0	203.7
2315S1	168.5	6861.8	759.8	83.1	7704.7
2315B1	188.5	24212.7	1188.4	74.3	25475.3
2319M2	30.6	7705.4	391.8	0.0	8097.2

MACROZOOPLANKTON

JUNE 8,1973

LOCATION:DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0034B1	7.3	21768.2	2053.6	821.4	24643.3
0215S1	136.3	1922.1	271.4	7.3	2200.9
0215B1	150.8	7122.2	371.4	19.9	7513.4
0215M2	31.2	7688.1	704.7	128.1	8521.0
0215B2	89.1	2804.4	145.8	11.2	2961.5
0325B1	51.8	14275.7	366.5	77.2	14719.4
0353S1	115.7	423.5	0.0	34.6	458.1
0353B1	259.2	3970.2	177.5	142.8	4290.4
0353M2	0.8	335785.7	16349.1	13833.9	365968.7
0644S1	121.1	3170.7	198.2	115.6	3484.5
0644B1	139.0	43.2	86.3	28.8	158.3
0644M2	21.4	0.0	561.3	0.0	561.3
0802B1	70.6	56.7	0.0	0.0	56.7
1145S1	94.2	0.0	10.6	10.6	21.2
1145B1	108.4	166.1	36.9	9.2	212.2
1145M2	47.1	0.0	0.0	21.2	21.2
1250B1	57.7	69.3	52.0	103.9	225.2
1500S2	57.7	52.0	0.0	0.0	52.0
1500B1	127.2	0.0	0.0	7.9	7.9
1830S1	154.3	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

JUNE 19, 1973

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0915B1	78.9	38.0	0.0	12.7	50.7
1106B1	193.2	0.0	0.0	657.3	657.3
2235B1	75.4	4270.6	464.2	1578.3	6313.1

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0055B1	69.9	19753.4	830.2	12338.7	32922.4

MACROZOOPLANKTON

JULY 2, 1973.

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1400S1	120.2	1098.5	3328.7	41109.7	45536.9

MACROZOOPLANKTON

JULY 17, 1973.

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1254S1	89.5	670.1	3685.7	3998.4	8354.2
1254B1	725.8	68.9	540.1	24.8	633.8
1257S2	29.7	1243.9	1075.8	28408.6	30728.4
1257M2	3.8	1567.2	45709.8	4179.2	51456.2
1257B2	30.0	632.5	6092.1	3329.0	10053.6
1331S2	11.8	848.9	6027.2	23005.1	29881.2

MACROZOOPLANKTON

JULY 18, 1973.

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0045B2	6.1	35914.8	8978.7	10937.7	55831.3
0045S2	21.3	3705.1	6753.7	515.9	10974.7
0210S2	25.5	5639.7	9125.4	822.5	15587.6
0210M2	31.4	9324.3	5282.7	5219.1	19826.1
0212S1	286.0	4663.6	1803.9	2433.2	8900.8

MACROZOOPLANKTON

JULY 31, 1973

LOCATION: DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1131S2	37.1	700.7	997.1	3826.8	5524.6
1131B2	25.6	3512.7	4098.1	18422.0	26032.8
1131B1	186.1	236.4	2621.7	1525.7	4383.8
1151M2	18.3	219.1	164.3	7722.2	8105.6
1151B2	15.6	768.8	1025.1	9930.5	11724.4
1437B1	90.7	639.4	815.8	683.5	2138.6
2143M2	51.2	39.0	6849.7	58.5	6947.3

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION:DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0017B1	48.3	13953.8	7825.7	2691.4	24471.0
0114M2	31.5	23102.7	14407.4	1967.5	39477.7
0134B2	34.5	16890.9	1073.8	3163.4	21128.1
0114B1	164.3	8883.8	4271.5	182.5	13337.8
0134S2	7.1	30701.8	4951.9	707.4	36361.1

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION:DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1123B1	378.3	243.2	195.6	452.0	890.9
1320S2	24.7	40.4	0.0	1657.4	1697.8
1348S1	156.7	19.1	89.3	3574.0	3682.5
1348S2	8.5	0.0	468.4	9952.6	10420.9

MACROZOOPLANKTON

AUGUST 15, 1973

LOCATION:DI

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0223S1	84.8	2440.4	5140.1	188.6	7769.1
0225S2	29.5	1765.7	18200.3	3327.7	23293.7
0247S2	10.3	3783.7	10962.9	5238.9	19985.4

MACROZOOPLANKTON

MAY 22, 1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1037M1	71.9	13.9	125.2	83.5	222.6
1245M1	141.4	0.0	0.0	35.4	35.4
1640M1	17.7	0.0	56.6	113.2	169.8
1826M1	173.2	5.8	0.0	23.1	28.9
1958M1	30.6	0.0	195.9	32.6	228.5
2145M1	27.1	0.0	73.8	0.0	73.8
2310M1	3.5	0.0	0.0	0.0	0.0

MACROZOOPLANKTON

MAY 23, 1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0254M1	7.1	0.0	0.0	0.0	0.0
0412M1	7.1	565.9	141.5	282.9	990.3
0511M1	16.5	424.4	242.5	60.6	727.6
0625M1	20.0	99.9	99.9	49.9	249.7
0710M1	11.8	84.9	0.0	84.9	169.8

MACROZOOPLANKTON

JUNE 7, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
2220M1	35.3	0.0	0.0	0.0	0.0
2335M1	459.5	5032.0	235.1	0.0	5267.1

MACROZOOPLANKTON

JUNE 8, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0035M1	99.0	8953.1	111.2	0.0	9064.2
0250M1	16.5	19704.9	666.9	0.0	20371.8
0430M1	123.3	0.0	0.0	0.0	0.0
0532M1	52.2	325.7	0.0	0.0	325.7
0722M1	10.6	754.5	377.3	0.0	1131.8
1300M1	147.3	6.8	0.0	0.0	6.8
1645M1	842.3	0.0	2.4	0.0	2.4

MACROZOOPLANKTON

JUNE 19, 1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1402M1	38.9	51.4	128.6	643.0	823.1
1420M1	2.4	5941.8	2122.1	11459.1	19523.0
1650M1	75.4	26.5	13.3	305.0	344.8
1910M1	146.1	0.0	0.0	6.8	6.8
2115M1	55.4	5996.0	325.1	0.0	6321.0
2345M1	155.7	2516.9	764.1	19.3	3300.3

MACROZOOPLANKTON

JUNE 20, 1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0301M1	149.5	809.4	341.1	153.8	1304.3
0320M1	148.0	1601.7	432.5	8589.6	10623.8

MACROZOOPLANKTON

JULY 2,1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1245M1	30.6	587.6	8227.1	241196.7	250011.4
1332M1	34.2	409.8	3512.4	27162.4	31084.5
2230M1	34.2	23357.3	3014.8	32196.8	58568.9
2246M1	14.1	55032.1	4314.9	8912.7	68259.6

MACROZOOPLANKTON

JULY 17, 1973

LOCATION:DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1210M1	90.7	77.2	3891.4	9160.7	13129.2
1359M1	245.0	110.2	559.1	6423.3	7092.6
1418M1	38.9	385.8	1774.8	6199.0	8359.6

MACROZOOPLANKTON

JULY 18, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0105M1	74.3	3524.4	3954.9	3363.0	10842.4
0120M1	31.9	5544.0	4635.6	1942.0	12121.6

MACROZOOPLANKTON

JULY 31, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1331M1	102.5	624.4	1483.0	995.2	3102.6
1341M1	221.5	352.2	605.0	686.3	1643.5
1713M1	97.8	92.0	122.7	0.0	214.8

MACROZOOPLANKTON

AUGUST 1, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
0040M1	339.3	13097.8	2788.2	153.3	16039.2
0056M1	221.5	3088.3	1246.1	63.2	4397.6
0539M1	86.0	1313.9	1360.4	23.3	2697.6

MACROZOOPLANKTON

AUGUST 14, 1973

LOCATION: DD

SAMPLES	VOLUME SAMPLED (M*3)	AMPHIPODS PER 1000 M*3	DIPTERA PER 1000 M*3	OTHERS PER 1000 M*3	TOTAL PER 1000 M*3
1430M1	23.6	636.6	127.3	339.5	1103.5

APPENDIX IV-A

APPENDIX IV-A

ROSETON/DANSKAMMER POINT
1973
BENTHOS

TOTAL NUMBER AND BIOMASS OF BENTHOS COLLECTED FROM DEPTH 3 AT TRANSECT MAXIMUM ΔT DURING JULY, SEPTEMBER, AND NOVEMBER, 1973. VALUES GIVEN ARE NUMBER AND WEIGHT PER m^2.

	JULY				SEPTEMBER				NOVEMBER			
ORGANISMS COLLECTED	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea												
Oligochaeta	4047	63.52	801.70	32.83	2497	10.51	99.89	3.82	5985	83.74	1199.11	72.17
Polychaeta												
Arthropoda: Arachnidia												
Crustacea:												
Amphipoda	172	2.70	882.65	36.14	17567	73.91	1467.78	56.09	344	4.81	50.81	3.06
Isopoda:												
Chiridotea	86	1.35	16.36	0.67	301	1.27	238.96	9.13				
Cyathrua	86	1.35	174.81	7.16	388	1.63	239.82	9.16				
Total Crustacea	344	5.40	1073.82	43.97	18256	76.81	1946.56	74.38	344	4.81	50.81	3.06
Insecta:												
Coleoptera					43	0.18	48.65	1.86				
Collembola												
Diptera	775	12.16	27.56	1.13	1507	6.34	277.28	10.60	474	6.63	320.34	19.28
Trichoptera												
Total Insecta	775	12.16	27.56	1.13	1550	6.52	325.93	12.46	474	6.63	320.34	19.28
Mollusca: Gastropoda												
Pelecypoda	1119	17.56	103.76	4.25	732	3.08	178.25	6.81	301	4.21	86.11	5.18
Platyhelminthes: Turbellaria	86	1.35	435.30	17.82	732	3.08	66.31	2.53	43	0.60	5.17	0.31
SAMPLE TOTAL	6371		2442.14		23767		2616.94		7147		1661.54	

TOTAL NUMBER AND BIOMASS OF BENTHOS COLLECTED FROM DEPTH 3 AT TRANSECT SC DURING JULY, SEPTEMBER, AND NOVEMBER, 1973. VALUES GIVEN ARE NUMBER AND WEIGHT PER m^2.

	JULY				SEPTEMBER				NOVEMBER			
ORGANISMS COLLECTED	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea												
Oligochaeta	15500	79.83	15648.70		2024	34.07	162.75	24.75	517	29.28	75.35	4.98
Polychaeta												
Arthropoda: Arachnidia					43	0.72	72.33	11.00				
Crustacea:												
Amphipoda	344	1.77	382.77		861	14.49	31.00	4.72	732	41.45	989.86	65.39
Isopoda:												
Chiridotea												
Cyathura	129	0.66	849.06		215	3.62	71.90	10.94	43	2.43	272.98	18.03
Total Crustacea	516	2.66	---		1076	18.11	102.90	15.66	775	43.88	1262.84	83.42
Insecta:												
Coleoptera												
Collembola	129	0.66	0.43									
Diptera	2110	10.87	654.02		2411	40.58	279.86	42.57	431	24.41	172.22	11.38
Trichoptera												
Total Insecta	2239	11.53	654.45		2411	40.58	279.86	42.57	431	24.41	172.22	11.38
Mollusca: Gastropoda	43	0.22	17.22									
Pelecypoda	689	3.55	42.63		86	1.45	3.01	0.46	43	2.43	3.44	0.23
Platyhelminthes: Turbellaria	430	2.21	37.03		301	5.07	36.60	5.57				
SAMPLE TOTAL	19417		---		5941		657.45		1766		1513.85	

ROSETON BENTHOS

MOLLUSCA BIOMASS DISTRIBUTION

($mg\ m^{-2}$)

		NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
		1	2	3	1	2	3	1	2	3	1	2	3
1971:	Fall												
	Winter		5127.55	4311.62	273.40	442.19	384.05		41.77	582.54	NB	9268.73	99.03
1972:													
	Spring	1270.57	NB	NB	114.09	1221.49	848.21				1818.25	34.44	
	Summer	264.37	64.16	324.65	122.28	339.71	47.36		30.14	189.45	993.74	74.49	
	Fall	NB	118.41	NB	147.68	189.87	146.39	NB	NB	63.29	19.37	54.25	NB
	Winter	89.56	53.82	361.67	9.48	562.31	234.22			501.60		4.30	NB
1973:													
	Spring	740.13		139.07	24.54	509.78	1212.89	124.00	157.58	196.33	121.41	271.25	
	Summer	462.43	134.33	258.33		NB	315.60		21.09	376.30	1147.01	NB	63.29
	Fall	184.28	124.86	24.54	56.83	261.35	119.26		122.28	712.14	29.28	130.89	38.31
	Winter		27.99		41.76	106.77	NB	21.53		108.50	96.01	5.59	8.18

ROSETON BENTHOS

TURBELLARIA BIOMASS DISTRIBUTION

($mg\ m^{-2}$)

		NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL	
	1	2	3	1	2	3	1	2	3	1	2	3
1971:												
Fall												
Winter		110.65	1658.96	607.09	317.76	68.46	2.17		682.86	80.09	163.61	437.88
1972:												
Spring						NB			NB			42.62
Summer			6.89	570.92	58.13	41.77	107.20	3.44	29.71	59.84	108.50	92.57
Fall	65.46		82.67	158.12	25.40	27.55	16.79	39.17	21.53	NB	42.19	168.78
Winter	266.08	7.32	47.79	377.17	82.67	415.06		139.50	15.93		NB	357.36
1973:												
Spring				28.85		20.24	869.73	31.00		59.85		3.44
Summer	37.03	28.41	34.45		40.90	21.96		1.72	78.79	1.72		2912.30
Fall		6.02	21.09	24.97	58.55	8.18	8.61	42.19	31.00	NB	NB	
Winter		NB	20.66	45.64	106.78	39.61	50.00	28.84	89.98	186.86	110.65	11.62

ROSETON BENTHOS

INSECTA BIOMASS DISTRIBUTION

($mg\ m^{-2}$)

		NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
		1	2	3	1	2	3	1	2	3	1	2	3
1971:													
	Fall	384.06	211.83	NB	46.07	205.81	NB	409.89	414.21	396.56	390.94	NB	
	Winter	53.26	1758.85	1231.83				873.61	758.65	1222.35	1047.98	2006.40	2285.40
1972:													
	Spring	61.14	1214.60	99.03	223.89	1286.95	332.39	229.49	238.54	347.89	513.66	279.43	183.85
	Summer	110.65	437.88	528.73	291.92	662.20	165.76	339.28	504.19	402.14	502.46	344.88	216.14
	Fall	504.61	793.95	885.66	NB	NB	NB	NB	61.14	NB	NB	NB	580.39
	Winter	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
1973:													
	Spring	128.30	497.72	492.98	191.59	698.37	436.15	355.63	567.47	535.61	147.25	95.58	195.90
	Summer	499.02	198.06	750.46	711.28	899.00	7920.14	561.01	1126.77	1910.82	1215.89	42.63	1466.05
	Fall	361.67	184.28	255.32	939.90	116.69	20.24	288.47	338.41	874.90	129.58	170.93	637.66
	Winter		1635.26	888.24	879.63	297.08	NB	1085.87	919.24	914.94	799.54	386.64	121.41

NB - indicates no weights were determined

ROSETON BENTHOS

CRUSTACEA BIOMASS DISTRIBUTION

($mg\ m^{-2}$)

		NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
		1	2	3	1	2	3	1	2	3	1	2	3
1971:													
	Fall				466.29	478.35	90.85		5.59	260.06			327.65
	Winter			8216.38	NB	1842.36	226.90		241.98	68.03		678.56	3506.05
1972:													
	Spring	4.74	247.99	2524.79		1189.22	689.32	NB	285.47	51.24	74.92	1284.79	2915.33
	Summer	124.44	10980	969.62	183.85	1473.38	1497.92	175.67	1199.96	69.32	NB	12121.56	2026.63
	Fall	NB	101.61	315.16	897.85	1156.04	NB	210.54	205.81	514.09	380.48	8.17	1426.88
	Winter		44.35	NB	NB	298.38	1825.58	NB	48.65		232.07	4.74	3260.64
1973:													
	Spring		66.73	238.96	38.31	39.61	263.08	55.54	198.92	50.80	371.99	28.41	868.43
	Summer		65.44	79.22	NB	154.57	1634.82	98.16	102.04	1091.90	237.66	41.33	3066.01
	Fall	103.33	25.83	52.09	168.77	241.53	125.73	40.90	23.68	134.76	460.26	197.62	64.59
	Winter		NB		1294.25	346.60	4267.27	99.89	400.42	601.24	895.99	NB	4696.12

ROSETON BENTHOS

OLIGOCHAETA BIOMASS DISTRIBUTION

(mg m^{-2})

		NORTH CONTROL			MAXIMUM ΔT			75 ΔT			SOUTH CONTROL		
		1	2	3	1	2	3	1	2	3	1	2	3
1971:													
	Fall	227.72	NB	1176.71		835.72	3050.94	1355.83	4734.43	2676.79	4375.77	172.22	133.90
	Winter	3385.06	4950.58	4890.29	795.24	1825.14	1629.67	1121.17	2542.45	3642.10	1340.34	3480.65	1795.44
1972:													
	Spring	8121.65	9226.89	760.79	17272.77	48294.19	2108.45	5826.77	16707.01	6548.81	3810.89	2963.12	851.65
	Summer	4609.14	7690.66	2768.50	1537.64	13298.71	NB	8637.46	4362.39	5962.39	5821.60	1866.04	852.06
	Fall	985.98	3000.14	3610.68	9905.89	3518.53	570.06	NB	6777.01	2620.39	748.74	659.62	2807.25
	Winter	1553.46	1641.30	1101.38	1119?46	937.33	5696.74	NB	984.69	2452.04	994.15	1534.94	904.18
1973:													
	Spring	1212.02	2414.15	5348.84	1762.27	1057.88	1654.21	2627.27	822.80	1315.78	176.96	237.24	33.15
	Summer	2501.54	5585.65	4868.44	1867.77	3047.93	1423.85	1241.73	634.10	1339.46	2282.40	189.01	7745.77
	Fall	243.26	1610.72	2684.97	865.42	1299.42	284.16	1456.15	790.50	8082.90	883.51	280.72	145.53
	Winter	42.19	1693.39	3745.87	724.63	1832.90	783.18	1562.07	3540.92	261.91	1082.86	519.26	61.57

Transect: North Control
Sampling Date: October 7, 1971
Season: Fall

Organisms Collected	1				1R				Total 1 and 1R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea					43	5.78	303.97	21.59	43	2.44	303.97	10.27
Oligochaeta Polychaeta	646	65.25	1330.87	85.81	258	34.68	896.85	63.70	904	51.25	2227.72	75.29
Arthropoda: Arachnidia					129	17.34	43.05	3.06	129	7.31	43.05	1.45
Crustacea: Amphipoda Isopoda: Chiridotea Cyathura Total Crustacea												
Insecta: Coleoptera Collembola Diptera Trichoptera	344	34.75	220.02	14.19	344	46.24	164.04	11.65	688	39.00	384.06	12.98
Total Insecta	344	34.75	220.02	14.19	344	46.24	164.04	11.65	688	39.00	384.06	12.98
Mollusca: Gastropoda Pelecypoda												
Platyhelminthes: Turbellaria												
Sample Total	990		1550.89		744		1407.91		1764		2958.8	
% of Transect Total	27.39		---		20.58		---		48.80		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	20.00	NB		474	64.75	335.41	68.21	517	54.59	---	---
43	20.00	12.49	18.36					43	4.54	12.49	---
129	60.00	55.54	81.64	258	35.25	156.29	31.79	387	40.87	211.83	---
129	60.00	55.54	81.64	258	35.25	156.29	31.79	387	40.87	211.83	---
215 5.95		--- ---		732 20.25		491.7 ---		947 26.20		--- ---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	7.13	298.81	42.84					43	4.76	298.81	20.25
388	64.34	398.69	57.16	301	100	778.02	100	689	76.22	1176.61	79.75
43	7.13	NB						43	4.76	---	---
129	21.39	NB	---					129	14.27	---	---
129	21.39	---	---					129	14.27	---	---
603		---		301		778.02		904		---	
16.68		---		8.33		---		25.01		---	

TRANSECT TOTAL

#	%	mg	%
86	2.38	602.78	---
2110	58.37	---	---
215	5:95	---	---
1204	33.31	---	---
1204	33.31	---	---
3615		---	

Transect: 75 AT
Sampling Date: October 7, 1971
Season: Fall

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea Oligochaeta Polychaeta		258	50.00	578.24	71.89	172	44.44	777.59	80.88	430	47.62	1355.83	76.79
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea												
	Insecta:	Coleoptera												
		Collembola												
		Diptera	258	50.00	226.04	28.10	215	55.55	183.85	19.12	473	52.38	409.89	23.21
		Trichoptera												
		Total Insecta	258	50.00	226.04	28.10	215	55.55	183.85	19.12	473	52.38	409.89	23.21
Mollusca:	Gastropoda													
	Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		516		804.28		387		961.44		903		1765.72	
	% of Transect Total		13.78		7.27		10.34		8.69		24.12		15.96	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
86	28.57	492.13	79.05	732	70.86	4242.30	93.22	818	61.32	4734.43	91.52
43	14.28	18.94	3.04					43	3.22	18.94	0.37
43	14.28	5.59	0.89					43	3.22	5.59	0.11
43	14.28	5.59	0.89					43	3.22	5.59	0.11
129	42.86	105.92	17.01	301	29.14	308.29	6.78	430	32.23	414.21	8.01
129	42.86	105.92	17.01	301	29.14	308.29	6.78	430	32.23	414.21	8.01
301		622.58		1033		4550.59		1334		5173.17	
8.04		5.63		27.59		41.12		35.63		46.75	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	8.33	793.52	43.49					43	2.85	793.52	19.23
344	66.66	720.32	39.48	560	56.51	1956.47	84.97	904	59.99	2676.79	64.86
				43	4334	15.50	0.67	43	2.85	15.50	0.38
43	8.33	244.56	13.40					43	2.85	244.56	5.92
43	8.33	244.56	13.40	43	4.34	15.50 f	0.67	86	5.70	260.06	6.30
86	16.66	65.88	3.61	388	39.15	330.68	14.36	474	31.45	396.56	9.61
86	16.66	65.88	3.61	388	39.15	330,68	14.36	474	31.45	396.56	9.61
516		1824.28		991		2302.65		1507		4126.93	
13.78		16.49		26.47		20.81		40.25		37.29	

TRANSECT TOTAL

#	%	mg	%
43	1.15	793.52	7.17
2152	57.48	8767.05	79.23
43	1.15	18.94	0.17
86	2.29	21.09	0.19
43	1.15	244.56	2.21
129	3.44	265.65	2.40
1377	36.78	1220.66	11.03
1377	36.78	1220.66	11.03
3744		11065.82	

Transect: Maximum ΔT
Sampling Date: October 7, 1971
Season: Fall

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea													
	Oligochaeta													
	Polychaeta													
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	43	10.00	11.62	3.72					43	5.90	11.62	2.27
		Isopoda: Chiridotea	43	10.00	148.54	47.52					43	5.90	148.54	28.99
		Cyathura	129	30.00	133.04	42.56	129	42.86	173.09	86.64	258	35.29	306.13	59.74
		Total Crustacea	215	50.00	293.20	93.80	129	42.86	173.09	86.64	344	47.09	466.29	91.00
	Insecta:	Coleoptera												
		Collembola												
		Diptera	215	50.00	19.38	6.20	172	57.14	26.69	13.35	387	52.94	46.07	9.00
		Trichoptera												
		Total Insecta	215	50.00	19.38	6.20	172	57.14	26.69	13.35	387	52.94	46.07	9.00
Mollusca:	Gastropoda													
	Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		430		312.58		301		199.78		731		512.36	
	% of Transect Total		11.62		---		8.13		---		19.75		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2.R				Total 2 and 2.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
86	33.33	269.10	95.27	301	36.79	566.62	17.98	387	35.97	835.72	24.34
				43	5.26	1913.84	60.73	43	3.99	1913.84	55.74
				43	5.26	207.53	6.58	43	3.99	207.53	6.04
				43	5.26	270.82	8.59	43	3.99	270.82	7.89
				86	10.52	478.35	15.17	86	7.98	478.35	13.93
172	66.67	13.35	4.73	388	47.43	192.46	6.11	560	52.04	205.81	5.99
172	66.67	13.35	4.73	388	46.43	192.46	6.11	560	52.04	205.81	5.99
258		282.45		818		3151.27		1076		3433.72	
6.97		---		22.10		---		29.07		---	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
129	37.50	837.01	36.34	1421	91.68	2213.93	91.29	1550	81.84	3050.94	64.75
43	12.50	1303.73	57.61	43	2.78	120.13	4.95	86	4.54	1423.86	30.22
				43	2.78	90.85	3.75	43	2.27	90.85	1.93
				43	2.78	90.85	3.75	43	2.27	90.85	1.93
172	50.00	145.95	6.38	43	2.78	NB		215	11.35	---	---
172	50.00	145.95	6.38	43	2.78	---		215	11.35	---	---
344		2286.69		1550		2424.91		1894		4711.60	
9.29		---		41.88		---		51.18		---	

TRANSECT TOTAL			
#	%	mg	%
1937	52.34	3886.66	---
129	3.48	3337.70	---
43	1.16	11.62	---
86	2.32	356.07	---
344	9.29	667.80	---
473	12.77	1035.49	---
1162	31.39	---	---
1162	31.39	---	---
3701		---	

TRANSECT: South Control
SAMPLING DATE: October 7, 1971
SEASON: Fall

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea, Oligochaeta, Polychaeta	559	65.00	1994.35	90.59	1205	80.01	2381.42	92.36	1764	74.55	4375.77	9155
Arthropoda: Arachnidia					43	2.85	12.92	0.50	43	1.82	12.92	0.27
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera												
Collembola												
Diptera	301	35.00	207.09	9.41	258	17.13	183.85	7.13	559	23.63	390.94	8.18
Trichoptera												
Total Insecta	301	35.00	207.09	9.41	258	17.13	183.85	7.13	559	23.63	390.94	8.18
Mollusca: Gastropoda, Pelecypoda												
Platyhelminthes: Turbellaria												
Sample Total	860		2201.44		1506		2578.19		2366		4779.63	
% of Transect Total	26.26		-		45.98		-		72.24		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				^{2}R				Total $_2$ and $_2$R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
603	8238	172.22	-					603	81.82	172.22	-
86	11.75	24.11	-					86	11.67	24.11	-
43	5.87	NB	-	5	100.00	278.57	100.00	48	6.51	-	-
43	5.87	-	-	5	100.00	278.57	100.00	48	6.51	-	-
132		-		5		278.57		737		-	
22.35		-		0.15		-		22.50		-	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	50.00	42.62	11.51	86	100.00	91.28	100.00	129	75.00	133.90	93.00
43	50.00	327.65	88.49					43	25.00	327.65	6.99
43	50.00	327.65	88.49					43	25.00	327.65	6.99
86 2.63		370.27 -		86 2.63		91.28 -		172 5.25		461.55 -	

Transect Total

#	%	mg	%
2496	76.21	4681.89	-
129	3.94	37.03	-
43	1.31	327.65	-
43	1.31	327.65	-
607	18.53	-	-
607	18.53	-	-
3275		-	

TRANSECT: North Control
SAMPLING DATE: December 7, 1971
SEASON: Winter

Organisms Collected	1				1R				Total 1 and 1R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea, Oligochaeta, Polychaeta	1206	48.28	3058.27	89.22	560	38.25	326.79	49.13	1766	44.57	3385.06	82.71
Arthropoda: Arachnidia	43	1.72	42.19	1.23	43	2.94	10.33	1.55	86	2.17	52.52	1.28
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera												
Collembola												
Diptera	1249	50.00	327.22	9.55	861	58.81	328.09	49.32	2110	53.26	655.31	16.01
Trichoptera												
Total Insecta	1249	50.00	327.22	9.55	861	58.81	328.09	49.32	2110	53.26	655.31	16.01
Mollusca: Gastropoda												
Pelecypoda												
Platyhelminthes: Turbellaria												
Sample Total	2498		3427.68		1464		665.21		3962		4092.89	
% of Transect Total	6.06		9.21		3.55		1.79		9.61		10.99	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				43	0.81	139.08	1.83	43	0.32	139.08	1.15
5038	61.26	2785.29	62.08	2583	48.77	2165.29	2.17	7621	56.37	4950.58	40.93
43	0.52	7.75	0.17					43	0.32	7.75	0.06
2024	24.61	740.57	16.51	1938	36.59	1018.28	13.38	3962	29.30	1758.85	14.54
2024	24.61	740.57	16.51	1938	36.59	1018.28	13.38	3962	29.30	1758.85	14.54
43	0.52	501.18	11.17	43	0.81	474.05	6.23	86	0.64	975.23	8.06
904	10.99	406.45	9.06	517	9.76	3745.87	49.24	1421	10.51	4152.32	34.33
172	2.09	45.209	1.01	172	3.25	65.44	0.86	344	2.54	110.65	0.91
8224		4486.449		5296		7608.01		13520		12094.45	
19.96		12.05		12.85		20.43		32.81		32.48	

3				3_R				Total 3 and 3_R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	0.24	89.12	0.78	43	0.70	647.13	6.74	86	0.36	736.25	3.50
9645	54.90	3309.28	28.91	2368	38.47	1581.01	16.47	12013	50.64	4890.29	23.24
517	2.94	1946.99	17.01	1076	17.48	6269.39	65.31	1593	6.71	8216.38	39.04
517	2.94	1946.99	17.01	1076	17.48	6269.39	65.31	1593	6.71	8216.38	39.04
2110	12.01	852.94	7.45	1851	30.07	378.89	3.95	3961	16.70	1231.83	5.85
2110	12.01	852.94	7.45	1851	30.07	378.89	3.95	3961	16.70	1231.83	5.85
258	1.47	2340.09	20.44					258	1.09	2340.09	11.12
2713	15.44	1449.69	12.67	603	9.80	521.84	5.44	3316	13.98	1971.53	9.37
2282	12.99	1457.88	1274	215	3.49	201.08	2.09	2497	10.53	1658.96	7.88
17568		11445.99		6156		9599.34		23724		2104.33	
42.63		30.74		14.94		25.78		57.57		56.52	

Transect Total			
#	%	mg	%
129	0.31	875.33	2.35
21400	51.93	13225.93	35.52
129	0.31	60.27	0.16
1593	3.87	8216.38	22.07
1593	3.87	8216.38	22.07
10033	24.35	36545.99	9.79
10033	24.35	36545.99	9.79
344	0.83	3315.32	8.90
4737	11.50	6123.85	16.45
2841	6.89	1769.609	4.75
41206		37232.679	

Transect: South Central
Sampling date: December 7, 1971
Season: Winter

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea, Oligochaeta, Polychaeta	431	27.81	638.95	---	344	36.36	701.39	43.96	775	31.05	1340.34	---
Arthropoda: Arachnidia												
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera												
Collembola												
Diptera	1076	69.42	785.34	---	301	31.81	262.64	16.46	1377	55.17	1047.98	---
Trichoptera												
Total Insecta	1076	69.42	785.34	---	301	31.81	262.64	16.46	1377	55.17	1047.98	---
Mollusca: Gastropoda, Pelecypoda	43	2.77	NB	---	43	4.54	551.55	34.57	86	3.45	---	---
Platyhelminthes: Turbellaria					258	27.27	80.09	5.02	258	10.34	80.09	000
Sample Total	1550		---		946		1595.67		2496		---	
% of Transect Total	11.69		---		7.13		---		18.82		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2.R				Total 2 and 2.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
190	47.92	661.77	29.71	2368	61.13	2818.88	21.08	3358	56.53	3480.65	22.32
				43	1.11	7.75	0.06	43	0.72	7.75	0.05
				43	1.11	122.71	0.92	43	0.72	122.71	0.79
86	4.16	548.10	24.60					86	1.45	548.10	3.51
86	4.16	548.10	24.60	43	1.11	122.71	0.92	129	2.17	678.56	4.30
990	47.92	1017.84	45.69	1076	27.77	988.56	7.39	2066	34.78	2006.40	12.86
990	47.92	1017.84	45.69	1076	27.77	988.56	7.39	2066	34.78	2006.40	12.86
				43	1.11	9268.33	69.32	43	0.72	9268.73	59.42
				301	7.77	163.61	1.22	301	5.07	163.61	1.05
2066		2227.71		3874		13369.74		5940		15597.45	
15.58		---		29.22		---		44.80		---	

3				3R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	1.78	198.49	4.41					43	0.89	198.49	2.39
560	23.22	904.18	20.08	560	23.23	891.26	23.33	1120	23.22	1795.44	21.57
431	17.87	1493.61	33.17	172	7.13	210.97	5.52	603	12.50	1704.58	20.48
129	5.35	602.79	13.39	215	8.92	1198.68	31.38	344	7.13	1801.47	21.65
560	23.22	2096.40	46.56	387	16.05	1409.65	36.90	947	19.63	3506.05	42.13
818	33.91	936.89	20.81	1292	53.59	1348.51	35.30	2110	43.75	2285.40	27.46
818	33.91	936.89	20.81	1292	53.59	1348.51	35.30	2110	43.75	2285.40	27.46
				129	5.35	99.03	2.59	129	2.67	99.03	1.19
431	17.87	366.41	8.14	43	1.78	71.47	1.87	474	9.83	437.88	5.26
2412		4502.37		2411		3819.92		4823		8322.29	
18.19		---		18.18		---		36.38		---	

TRANSECT TOTAL

#	%	mg	%
43	0.32	198.49	---
5253	39.62	6616.43	---
43	0.32	7.75	---
646	4.87	1827.29	---
86	0.65	548.10	---
344	2.59	1801.47	---
1076	8.11	4176.86	---
5553	41.88	5339.78	---
5553	41.88	5339.78	---
86	0.65	---	---
172	1.30	9367.26	---
1033	7.79	681.58	---
13259		---	

Transect: 75 AT
Sampling Date: December 7, 1971
Season: Winter

Organisms Collected			1 #	1 %	1 mg	1 %	R #	R %	R mg	R %	Total 1 and R1 #	Total 1 and R1 %	Total 1 and R1 mg	Total 1 and R1 %
Annelida:	Hirudinea													
	Oligochaeta		603	53.84	665.21	56.61	215	24.97	455.96	54.47	818	41.29	1121.17	55.72
	Polychaeta													
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea												
	Insecta:	Coleoptera												
		Collembola												
		Diptera	517	46.16	509.79	43.39	603	70.03	363.82	43.47	1120	56.54	873.61	43.42
		Trichoptera												
		Total Insecta	517	46.16	509.79	43.39	603	70.03	363.82	43.47	1120	56.54	873.61	43.42
Mollusca:	Gastropoda													
	Pelecypoda													
Platyhelminthes:	Turbellaria						43	4.99	17.22	2.06	43	2.17	17.22	0.08
	Sample Total		1120		1175.00		861		837.00		1981		2012.00	
	% of Transect Total		12.27		9.27		9.44		6.89		21.71		15.87	

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1421	84.63	1612.88	83.15	2110	72.06	929.57	56.50	3531	76.64	2542.45	76.92
43	2.56	134.77	6.95	43	1.47	107.21	6.52	86	1.87	241.98	6.75
43	2.56	134.77	6.95	43	1.47	107.21	6.52	86	1.87	241.98	6.75
215	12.80	192.03	9.90	732	25.00	566.62	34.44	947	20.55	758.65	21.16
215	12.80	192.03	9.90	732	25.00	566.62	34.44	947	20.55	758.65	21.16
				43	1.47	41.77	2.54	43	0.93	41.77	1.16
1679		1939.68		2928		1645.17		4607		3584.85	
18.40		15.30		32.09		12.98		50.49		28.28	

3				3.R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				86	7.68	880.92	28.62	86	3.39	880.92	12.44
818	45.24	2786.15	69.64	215	19.21	855.95	27.80	1033	46.72	3642.10	51.45
43	2.38	68.03	1.70					43	1.69	68.03	0.96
								43	1.69	68.03	0.96
517	28.59	699.66	17.49	431	38.52	522.69	16.98	558	21.99	1222.35	17.27
517	28.59	699.66	17.49	431	38.52	522.69	16.98	558	21.99	1222.35	17.27
172	9.51	286.32	7.16	129	11.53	296.22	9.62	301	11.86	582.54	8.22
258	14.26	160.17	4.00	258	23.06	522.69	16.98	516	26.34	682.86	9.65
1808		4000.33		1119		3078.47		2537		7078.80	
19.81		31.56		12.26		24.29		27.80		55.85	

TRANSECT TOTAL			
#	%	mg	%
86	0.94	880.92	6.95
5382	58.98	7305.72	51.63
43	0.47	68.03	0.54
86	0.94	241.98	1.91
129	1.41	310.01	2.45
2625	28.77	2854.61	22.52
2625	28.77	2854.61	22.52
344	3.77	624.31	4.92
559	6.13	700.68	5.52
9125		12675.65	

Transect: Maximum A.
Sampling Date: December 7, 1971
Season: Winter

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea Oligochaeta Polychaeta		517	100.00	136.48	100.00	818	73.10	658.76	---	335	81.60	795.24	---
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda					43	3.84	NB	---	43	2.63	---	---
		Isopoda: Chiridotea Cyathura												
		Total Crustacea					43	3.84	---	---	43	2.63	---	---
	Insecta:	Coleoptera												
		Collembola												
		Diptera												
		Trichoptera												
		Total Insecta												
Mollusca:	Gastropoda Pelecypoda						129	11.53	273.40	---	129	7.88	273.40	---
Platyhelminthes:	Turbellaria						129	11.53	607.09	---	129	7.88	607.09	---
	Sample Total		517		136.48		1119		---		1636		---	
	% of Transect Total		7.42		---		16.05		---		23.47		---	

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1205	70.02	960.15	54.50	1679	76.49	864.99	32.48	2884	73.65	1825.14	41.22
86	4.99	442.61	25.08	172	7.83	733.24	27.54	258	6.58	1175.85	26.56
				43	1.96	527.87	19.82	43	1.09	527.87	11.92
43	2.49	138.64	7.85					43	1.09	138.64	3.13
129	7.48	581.25	32.93	215	9.79	1261.11	47.36	344	8.76	1842.36	41.61
				43	1.96	14.64	0.55	43	1.09	14.64	0.33
				86	3.92	427.55	16.06	86	2.19	427.55	9.66
387	2.25	223.47	12.66	172	7.83	94.29	3.54	559	14.27	317.76	7.18
1721		1764.87		2195		2662.58		3916		4427.45	
24.69		---		31.49		---		56.18		---	

3				3R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
301	33.33	750.47	65.50	258	50.00	879.20	75.57	559	39.39	1629.67	70.58
86	9.52	176.96	15.44	43	8.33	49.94	4.29	129	9.09	226.90	9.83
86	9.52	176.96	15.44	43	8.33	49.94	4.29	129	9.09	226.90	9.83
387	42.85	151.98	13.26	172	33.33	232.07	19.95	559	39.36	384.05	16.63
129	14.28	66.31	5.78	43	8.33	2.15	0.18	172	12.12	68.46	2.96
903 12.95		1145.72 ---		516 7.40		1163.36 ---		1419 20.36		2309.08 ---	

TRANSECT TOTAL			
		mg	
4778	68.54	4250.05	---
430	6.17	---	---
43	0.62	527.87	---
43	0.62	138.64	---
516	7.41	---	---
43	0.62	14.64	---
774	11.10	1085.00	---
860	12.34	993.31	---
6971		---	

Sampling Date: June 20, 1972
Season: Spring

Organisms Collected			1				1R				Total 1 and 1 R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea													
	Oligochaeta		3703	87.75	3067.31	92.91	4693	90.84	2759.46	---	8396	89.45	5826.77	---
	Polychaeta													
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	129	3.06	89.99	2.73	172	3.33	NB	---	301	3.21	---	---
		Isopoda: Chiridotea												
		Cyathura					43	0.83	72.33	---	43	0.46	72.33	---
		Total Crustacea	129	3.06	89.99	2.73	215	4.16	72.33	---	344	3.67	162.32	---
	Insecta:	Coleoptera												
		Collembola												
		Diptera	388	9.19	144.24	4.37	258	4.99	85.25	---	646	6.88	229.49	---
		Trichoptera												
		Total Insecta	388	9.19	144.24	4.37	258	4.99	85.25	---	646	6.88	229.49	---
Mollusca:	Gastropoda													
	Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		4220		3301.54		5166		---		9386		---	
	% of Transect Total		15.56		---		19.05		---		34.61		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas $1m^2$.

2				2_R				Total 2 and 2_R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1300	97.30	11483.89	96.54	3143.	93.60	5223.12	97.46	12443	96.34	16707.01	96.83
				43	1.28	23.25	0.43	43	0.33	23.25	0.13
43	0.45	71.04	0.60	43	1.28	21.96	0.41	86	0.67	93.00	0.54
43	0.45	192.47	1.62					43	0.33	192.47	1.12
86	0.90	263.51	2.22	43	1.28	21.96	0.41	129	1.00	285.47	1.65
172	1.80	147.69	1.24	129	3.84	90.85	1.70	301	2.33	238.54	1.38
172	1.80	147.69	1.24	129	3.84	90.85	1.70	301	2.33	238.54	1.38
9558		11895.09		3358		5359.18		12916		17254.27	
35.24		---		12.38		---		47.62		---	

3				3.R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1033	100	3459.12	100	3358.	88.65	3089.69	88.17	4391	91.08	6548.81	---
				43	1.14	15.50	0.44	43	0.89	15.50	---
				129	3.41	51.24	1.46	129	2.68	51.24	---
				129	3.41	51.24	1.46	129	2.68	51.24	---
				215	5.68	347.89	9.93	215	4.46	347.89	---
				215	5.68	347.89	9.93	215	4.46	347.89	---
				43	1.14	NB		43	0.89	NB	---
1033		3459.12		3788		3504.32		4821		---	
3.81		---		13.97		---		17.77		---	

TRANSECT TOTAL			
#	%	mg	%
25230	93.02	29082.59	---
86	0.32	38.75	---
516	1.90	234.23	---
86	0.32	264.80	---
602		499.03	---
1162	4.28	815.92	---
1162	4.28	815.92	---
43	0.16	---	---
27123		---	

Transect: North Control
Sampling Date: June 20, 1972
Season: Spring

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea												
Oligochaeta	1464	77.30	2151.94	65.04	20.67	96.01	5969.71	96.99	3531	87.25	8121.65	85.82
Polychaeta	43	2.27	6.03	0.18					43	1.06	6.03	.06
Arthropoda: Arachnidia												
Crustacea: Amphipoda	43	2.27	4.74	0.14					43	1.06	4.74	0.05
Isopoda: Chiridotea												
Cyathura												
Total Crustacea	43	2.27	4.74	0.14					43	1.06	4.74	0.14
Insecta: Coleoptera												
Collembola												
Diptera	172	9.08	55.11	1.67	43	2.00	6.03	.10	215	5.31	61.14	0.65
Trichoptera												
Total Insecta	172	9.08	55.11	1.67	43	2.00	6.03	0.10	215	5.31	61.14	0.65
Mollusca: Gastropoda					43	2.00	179.54	2.92	43	1.06	179.54	1.90
Pelecypoda	172	9.08	1091.03	32.97					172	4.25	1091.03	11.53
Platyhelminthes: Turbellaria												
Sample Total	1894		3308.85		2153		6155.28		4047		9464.13	
% of Transect Total	8.46		---		9.62		---		18.08		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas $1m^2$

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	.48	NB	---					43	0.30		
8396	93.76	4414.10	---	5124	92.26	4812.79	---	13520	93.18	9226.89	---
215	2.40	234.65	---	43	0.77	13.34	---	258	1.78	247.99	---
215	2.40	234.65	---	43	0.77	13.34	---	258	1.78	247.99	---
301	3.36	595.03	---	301	5.42	619.57	---	602	4.15	1214.60	---
301	3.36	595.03	---	301	5.42	619.57	---	602	4.15	1214.60	---
				86	1.55	NB		86	0.59	---	---
8955		---		5554		---		14509		---	
40.00		---		24.81		---		64.81		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
										---	---
603	48.32	368.98	---	1636	63.34	391.81	---	2239	58.44	760.79	---
258	20.67	491.69	---	732	28.34	1487.59	---	990	25.84	1979.28	---
43	3.45	545.51	---					43	1.12	545.51	---
301	24.12	1037.20	---	732	28.34	1487.59	---	1033	26.96	2524.79	---
129	10.34	34.88	---	172	6.66	64.15	---	301	7.86	99.03	---
129	10.34	34.88	---	172	6.66	64.15	---	301	7.86	99.03	---
43	3.45	NB	---					43	1.12	---	---
172	13.78	95.15	---	43	1.66	NB	---	215	5.61	---	---
1248		---		2583		---		3831		---	
5.57		---		11.54		---		17.11		---	

TRANSECT TOTAL			
#	%	mg	%
43	0.19	---	---
19290	86.17	18109.33	---
43	0.19	6.03	---
1291	5.77	2232.01	---
43	0.19	545.51	---
1334	5.96	2777.52	---
1118	4.99	1374.77	---
1118	4.99	1374.77	---
86	0.38	---	---
473	2.11	---	---
22387		---	

Transect: South Control
Sampling Date: June 20, 1972
Season: Spring

Organisms Collected			1 #	1 %	1 mg	1 %	1^R #	1^R %	1^R mg	1^R %	Total 1 and 1^R #	Total 1 and 1^R %	Total 1 and 1^R mg	Total 1 and 1^R %
Annelida:	Hirudinea		86	2.73	65.01	1.57					86	2.41	65.01	1.03
	Oligochaeta		2756	87.68	3810.89	91.83					2756	77.13	3810.89	60.66
	Polychaeta													
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	86	2.73	64.59	1.57	43	10.00	10.33	0.48	129	3.61	74.92	1.19
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea	86	2.73	64.59	1.57	43	10.00	10.33	0.48	129	3.61	74.92	1.19
	Insecta:	Coleoptera												
		Collembola												
		Diptera	129	4.10	176.53	4.25	258	60.00	337.13	15.81	387	10.83	513.66	8.18
		Trichoptera												
		Total Insecta	129	4.10	176.53	4.25	258	60.00	337.13	15.81	387	10.83	513.66	8.18
Mollusca:	Gastropoda						86	20.00	1750.66	82.08	86	2.41	1750.66	27.86
	Pelecypoda		86	2.73	32.72	0.79	43	10.00	34.87	1.63	129	3.61	67.59	1.08
Platyhelminthes:	Turbellaria													
	Sample Total		3143		4149.74		430		2132.99		3573		6282.73	
	% of Transect Total		12.5		---		1.7		---		14.2		---	

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
6545	83.99	2546.77	78.07	7750	79.65	416.35	32.04	14295	81.58	2963.12	64.96
1076	13.81	489.55	15.01	1205	12.38	600.63	46.22	2281	13.02	1090.18	23.90
43	0.55	194.61	5.97					43	0.25	194.61	4.27
1119	14.36	684.16	20.98	1205	1238	600.63	46.22	2324	13.26	1284.79	28.16
86	1.10	10.33	0.32	646	6.64	269.10	20.71	732	4.18	279.43	6.13
86	1.10	10.33	0.32	646	6.64	269.10	20.71	732	4.18	279.43	6.13
43	0.55	21.09	0.65	729	1.33	13.35	1.03	172	0.98	34.44	0.75
7793		3262.35		9730		1299.43		17523		4561.78	
31.0		---		38.8		---		69.8		---	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
344	27.59	165.76	---	1722	62.50	685.89	---	2066	51.62	851.65	---
43	3.45	330.67	---					43	1.07	330.67	---
43	3.45	NB	---			---	---	43	1.07	---	---
344	27.59	271.69	---	646	23.45	682.87	---	990	24.74	954.56	---
344	27.59	906.33	---	258	9.36	1054.44	---	602	15.04	1960.77	---
688	55.17	1178.02	---	904	32.81	1737.31	---	1592	39.78	2915.33	---
43	3.45	43.49	---	129	4.68	140.36	---	172	4.30	183.85	---
43	3.45	43.49	---	129	4.68	140.36	---	172	4.30	183.85	---
86	6.90	42.62	---			---		86	2.15	42.62	---
1247		---		2755		---		4002		---	
4.9		---		11.0		---		15.9		---	

TRANSECT TOTAL			
#	%	mg	%
86	0.34	65.01	---
19117	76.17	7625.66	---
43	0.17	330.67	---
43	0.17	---	---
4045	16.17	4275.04	---
1291	5.14	976.94	---
86	0.34	1750.66	---
301	1.20	102.03	---
86	0.34	42.62	---
25098		---	

Transect: Maximum ΔT
Sampling Date: June 20, 1972
Season: Spring

Organisms Collected			1				1 R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		10721	98.81	9596.32	98.89	8310	93.23	7676.45	97.09	19031	96.30	17272.77	98.08
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea												
	Insecta:	Coleoptera					43	0.48	8.61	0.11	43	0.22	8.61	0.05
		Collembola												
		Diptera	129	1.19	107.64	1.11	86	0.96	107.64	1.36	215	1.09	215.28	1.22
		Trichoptera												
		Total Insecta					129	1.44	116.25	1.47	258	1.31	223.89	1.27
Mollusca:	Gastropoda Pelecypoda						474	5.32	114.09	1.44	474	2.40	114.09	0.65
Platyhelminthes:	Turbellaria													
	Sample Total		10850		9703.96		8913		7906.79		19763		17610.75	
	% of Transect Total		12.59		---		10.34		---		22.93		---	

S[illegible]ING [illegible]PTH

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

$_2$				$_2R$				Total $_2$ and $_2R$			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				43	0.15	NB	---	43	0.07	---	---
29278	94.18	20030.51	90.32	27986	94.89	28263.68	---	57264	94.53	48294.19	---
474	1.52	484.39	2.18	947	3.21	704.83	---	1421	2.35	1189.22	---
474	1.52	484.39	2.18	947	3.21	704.83	---	1421	2.35	1189.22	---
517	1.66	443.91	2.00	474	1.61	843.04	---	991	1.64	1286.95	---
517	1.66	443.91	2.00	474	1.61	843.04	---	991	1.64	1286.95	---
43	0.14	7.32	0.03					43	0.07	7.32	---
775	2.49	1211.59	5.46	43	0.15	258	---	818	1.35	1214.17	---
31087		22177.72		29493		---		60580		---	
36.06	---	---		34.22		---		70.28		---	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3401	78.22	1464.33	---	1163	77.17	644.12	43.68	4564	77.95	2108.45	---
388	8.92	193.32	---	129	8.56	496.00	33.63	517	8.83	689.32	---
388	8.92	193.32	---	129	8.56	496.00	33.63	517	8.83	689.32	---
172	3.96	258.77	---	43	2.85	73.62	4.99	215	3.67	332.39	---
172	3.96	258.77	---	43	2.85	73.62	4.99	215	3.67	332.39	---
344	7.91	587.29	---	172	11.41	260.92	17.69	516	8.81	848.21	---
43	0.99	NB	---					43	0.73	---	---
4348 5.04		--- ---		1507 1.75		1474.66 ---		5855 6.79		---	

TRANSECT TOTAL

#	%	mg	%
43	0.05	---	---
80859	93.81	67675.41	---
1938	2.25	1878.54	---
1938	2.25	1878.54	---
1421	1.65	1834.62	---
1421	1.65	1834.62	---
43	0.05	7.32	---
1808	2.10	2176.47	---
43	0.05	---	---
86198		---	

Transect: 75 AT
Sampling Date: August 17, 1972
Season: Summer

Organisms Collected			1				1 R				Total 1 and 1 R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		1938	67.18	4195.81	92.62	2196	77.30	4441.65	93.92	4134	72.20	8637.46	93.28
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	215	7.45	37.03	0.82	172	6.05	126.59	2.68	387	6.76	163.62	1.77
		Isopoda: Chiridotea												
		Cyathura	43	1.49	12.05	0.27					43	0.75	12.05	0.13
		Total Crustacea	258	8.94	49.08	1.08	172	6.05	126.59	2.68	430	7.51	175.67	1.90
	Insecta:	Coleoptera												
		Collembola												
		Diptera	517	17.92	220.45	4.87	344	12.11	118.83	2.51	861	15.04	339.28	3.66
		Trichoptera												
		Total Insecta	517	17.92	220.45	4.87	344	12.11	118.83	2.51	861	15.04	339.28	3.66
Mollusca:	Gastropoda													
	Pelecypoda													
Platyhelminthes:	Turbellaria		172	5.96	65.01	1.43	129	4.54	42.19	0.89	301	5.26	107.20	1.16
	Sample Total		2885		4530.35		2841		4729.26		5726		9259.61	
	% of Transect Total		---		---		---		---		---		---	

SA ING THS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

	2				2R				Total 2 and 2R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
					2411	76.71	4362.43	88.64	---	---	---	---
INCOMPLETE					129	4.10	21.09	0.43	---	---	---	---
SAMPLE					129	4.10	21.09	0.43	---	---	---	---
					474	15.08	504.19	10.25	---	---	---	---
					474	15.08	504.19	10.25	---	---	---	---
					86	2.74	30.14	0.61	---	---	---	---
					43	1.37	3.44	0.01	---	---	---	---
					3143		4921.29		---		---	
					---		---		---		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				86	2.13	277.29	5.11	86	1.68	277.29	4.00
382	35.67	1098.35	73.07	3444	85.10	4864.04	89.62	3826	74.76	5962.39	86.03
172	16.06	69.32	4.61					172	3.36	69.32	1.00
172	16.06	69.32	4.61					172	3.36	69.32	1.00
388	36.23	124.00	8.25	474	11.71	278.14	5.12	862	16.84	402.14	5.80
388	36.23	124.00	8.25	474	11.71	278.14	5.12	862	16.84	402.14	5.80
43	4.01	189.45	12.60					43	0.84	189.45	2.73
86	8.03	21.96	1.46	43	1.06	7.75	0.14	129	2.52	29.71	0.43
1071		1503.08		4047		5427.22		5118		6930.30	
---		---		---		---		---		---	

TRANSECT TOTALS

		mg	
---	---	---	---
---	---	---	---
---	---	---	---
---	---	---	---
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---	---	---	---

Transect: South Control
Sampling Date: August 17, 1972
Season: Summer

Organisms Collected			1				1R				Total 1 and 1R		
			#	%	mg	%	#	%	mg	%	#	%	mg
Annelida:	Hirudinea												
	Oligochaeta		2497	62.36	2665.17	---	2153	64.09	3156.43	73.49	4650	63.15	5821.60
	Polychaeta		43	1.07	NB	---					43	0.58	--- -
Arthropoda:	Arachnidia												
	Crustacea:	Amphipoda											
		Isopoda: Chiridotea	43	1.07	NB	---	129	3.84	9.48	0.02	172	2.34	--- -
		Cyathura											
		Total Crustacea	43	1.07	---	---	129	3.84	9.48	0.02	172	2.34	---
	Insecta:	Coleoptera											
		Collembola											
		Diptera	1206	30.12	380.61	---	431	12.83	121.85	2.84	1637	22.23	502.46
		Trichoptera											
		Total Insecta	1206	30.12	380.61	---	431	12.83	121.85	2.84	1637	22.23	502.46
Mollusca:	Gastropoda												
	Pelecypoda		86	2.15	13.35	---	474	14.11	980.39	2283	560	7.60	993.74
Platyhelminthes:	Turbellaria		129	3.22	33.15	---	172	5.12	26.69	0.62	301	4.08	59.84
	Sample Total		4004		---		3359		4294.84		7363		---
	% of Transect Total		17.99		---		15.09		---		33.08		---

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1206	59.58	383.19	---	2756	40.77	482.85	10.88	3962	45.11	1866.04	---
43	2.12	NB	---	86	1.27	6.89	0.05	129	1.47	--- ---	
560	27.67	417.64	---	1636	24.20	10811.37	79.29	2196	25.00	11229.01	---
86	4.25	12.92	---	172	2.54	879.63	6.45	258	2.94	892.55	---
646	31.92	430.56	---	1808	26.74	1169.00	85.74	2454	27.94	12121.56	---
129	6.37	74.49	---	1550	22.93	270.39	1.98	1679	19.12	344.88	---
129	6.37	74.49	---	1550	22.93	270.39	1.98	1679	19.12	344.88	---
				258	3.82	74.49	0.54	258	2.94	74.49	---
				301	4.45	108.50	0.79	301	3.43	108.50	---
2024		---		6759		13634.12		8783		---	
9.09		---		30.37		---		39.46		---	

3				3R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
990	37.11	375.87	26.07	947	27.49	476.19	27.17	1937	31.69	852.06	26.68
43	1.61	6.46	0.45					43	0.70	6.46	0.20
990	37.11	174.38	2.09	1981	57.52	518.39	29.48	2971	48.61	692.77	21.69
43	1.61	52.09	3.61					43	0.70	52.09	1.63
215	8.06	664.35	46.08	258	7.49	617.42	35.23	473	7.74	1281.77	46.13
1248	46.78	990.82	61.78	2239	65.01	1135.81	64.81	3487	57.05	2026.63	69.45
301	11.28	101.61	7.05	129	3.74	19.38	1.10	430	7.03	120.99	3.79
				43	1.25	95.15	5.43	43	0.70	95.15	2.98
301	11.28	101.61	7.05	172	4.99	114.53	6.53	473	7.73	216.14	6.77
86	3.22	66.74	4.63	86	2.49	25.83	1.47	172	2.81	92.57	2.89
2668		1441.50		3444		1752.36		6112		3193.86	
11.99		---		15.47		---		27.46		---	

TRANSECT TOTAL

#	%	mg	%
105.49	47.39	8539.70	---
172	6.77	---	---
43	0.19	6.46	---
5339	23.99	---	---
43	0.19	52.09	---
731	3.28	2174.32	---
6113	27.46	---	---
3746	16.83	968.33	---
43	0.19	95.15	---
3789	17.02	1063.48	---
818	3.67	1068.23	---
774	3.47	260.91	---
22258		---	

TRANSECT: North Control
SAMPLING DATE: August 17, 1972
SEASON: Summer

Organisms Collected			1				1_R				Total 1 and 1_R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		1679	79.61	2084.77	87.78	2626	88.42	2524.37	92.35	4305	84.76	4609.14	90.22
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	43	2.04	11.63	0.49					43	0.85	11.63	0.23
		Isopoda: Chiridotea												
		Cyathura	43	2.04	112.81	4.75					43	0.85	112.81	2.21
		Total Crustacea	86	4.08	124.44	5.24					86	1.70	124.44	2.44
	Insecta:	Coleoptera												
		Collembola												
		Diptera					129	4.34	110.65	4.05	129	2.54	110.65	2.17
		Trichoptera												
		Total Insecta					129	4.34	110.65	4.05	129	2.54	110.65	2.17
Mollusca:	Gastropoda Pelecypoda		344	16.31	165.77	6.98	215	7.24	98.60	3.61	559	11.01	264.37	5.17
Platyhelminthes:	Turbellaria													
	Sample Total		2109		2374.98		2970		2733.62		5079		5108.60	
	% of Transect Total		9.26		13.00		13.04		14.97		22.30		27.97	

Sampling Depths

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				86	2.47	242.41	7.98	86	1.04	242.41	2.84
3961	82.14	5161.12	93.68	2842	81.50	2529.54	83.32	6803	81.88	7690.66	90.00
388	8.05	89.56	1.63	215	6.17	20.24	0.67	603	7.26	109.80	1.28
388	8.05	89.56	1.63	215	6.17	20.24	0.67	603	7.26	109.80	1.28
344	7.13	207.96	3.77	258	7.40	229.92	7.57	602	7.25	437.88	5.12
344	7.13	207.96	3.77	258	7.40	229.92	7.57	602	7.25	437.88	5.12
129	2.68	50.38	0.91	86	2.47	13.78	0.45	215	2.59	64.16	.75
4822		5509.02		3487		3035.89		8309		8544.91	
21.17		30.17		15.31		16.62		36.48		46.79	

3				3R				Total 3 and 3R				Transect Total			
#	%	mg	%	#	%	mg	%	#	%	mg	%	#	%	mg	%
												86	0.38	242.41	1.33
1421	0.48	658.76	49.09	4521	70.46	2109.74	64.58	5942	63.30	2768.50	60.07	17050	74.86	15068.30	82.51
				43	0.67	10.33	0.32	43	0.46	10.33	0.22	43	0.19	10.33	0.06
1163	39.15	549.39	40.94	861	13.42	420.23	12.86	2024	21.56	969.62	21.04	2670	11.72	1091.05	5.97
												43	0.19	112.81	0.06
1163	39.15	549.39	40.94	861	13.42	420.23	12.86	2024	21.56	969.62	21.04	2713	11.91	1203.86	6.59
258	8.68	122.28	9.11	560	8.73	406.45	12.44	818	8.71	528.73	11.47	1549	6.80	1077.26	5.90
258	8.68	122.28	9.11	560	8.73	406.45	12.44	818	8.71	528.73	11.47	1549	6.80	1077.26	5.90
				43	0.67	43.92	1.34	43	0.46	43.92	0.95	43	0.19	43.92	0.24
86	2.89	4.74	0.35	388	6.05	275.99	8.45	474	5.05	280.73	6.09	1248	5.48	609.26	3.34
43	1.45	6.89	0.51					43	0.46	6.89	0.15	43	0.19	6.89	0.04
2971		1342.06		6416		3266.66		9387		4608.72		22775		18262.23	
13.05		7.35		28.17		17.89		41.22		25.24					

Transect: Maximum ΔT
Sampling Date: August 17, 1972
Season: Summer

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea Oligochaeta Polychaeta		4564	65.84	6791.65	91.57	5554	75.44	8565.99	94.03	10118	70.78	15357.64	92.93
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	431	6.22	82.67	1.11	301	4.09	101.18	1.11	732	5.12	183.85	1.11
		Isopoda: Chiridotea Cyathura												
		Total Crustacea	431	6.22	82.67	1.11	301	4.09	101.18	1.11	732	5.12	183.85	1.11
	Insecta:	Coleoptera Collembola												
		Diptera Trichoptera	344	4.96	74.92	1.01	603	8.19	217.00	2.38	947	6.63	291.92	1.77
		Total Insecta	344	4.96	74.92	1.01	603	8.19	217.00	2.38	947	6.63	291.92	1.77
Mollusca:	Gastropoda		43	0.62	8.61						43	0.30	8.61	0.05
	Pelecypoda		215	3.10	74.06	1.00	172	2.34	39.61	0.43	387	2.71	113.67	.69
Platyhelminthes:	Turbellaria		1335	19.26	384.92	5.19	732	9.94	186.00	2.04	2067	14.46	570.92	3.45
		Sample Total	6932 16.56		7416.83 ---		7362 17.59		9109.78 ---		14294 34.16		16526.61 ---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
8826	77.07	8317.13	90.23	7061	84.97	4981.58	75.31	15887	80.39	13298.71	84.00
646	5.64	166.20	1.80	388	4.66	89.99	1.36	1034	5.23	256.19	1.62
43	0.38	74.49	0.80	86	1.03	225.61	3.41	129	0.65	300.10	1.89
				86	1.03	917.09	15.86	86	0.43	917.09	5.79
689	6.02	240.69	2.61	560	6.73	1232.69	18.64	1249	6.32	1473.38	9.30
560	4.89	437.02	4.74	172	2.06	225.18	3.40	732	3.70	662.20	4.18
560	4.89	437.02	4.74	172	2.06	225.18	3.40	732	3.70	662.20	4.18
1033	9.02	164.47	1.78	517	6.22	175.24	2.64	1550	7.84	339.71	2.14
344	3.00	58.13	0.63					344	1.74	58.13	0.37
11452		9217.44		8310		6614.69		19762		15832.13	
27.37		---		19.86		---		47.22		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1636	38.78	691.91	45.95	1550	43.38	NB	---	3186	40.89	---	---
1938	45.93	480.94	31.94	1206	33.75	228.20	---	3144	40.35	709.14	---
86	2.03	155.86	10.35	172	4.81	313.88	---	258	3.31	469.74	---
				215	6.02	319.04	---	215	2.76	319.04	---
2014	47.74	636.80	42.29	1593	44.58	861.12	---	3617	46.42	1497.92	---
215	5.09	116.68	7.75	129	3.61	49.08	---	344	4.41	165.76	---
215	5.09	116.68	7.75	129	3.61	49.08	---	344	4.41	165.76	---
258	6.11	33.15	2.20	215	6.02	14.21	---	473	6.07	47.36	---
86	2.03	27.13	1.80	86	2.40	14.64	---	172	2.21	41.77	---
4219		1505.67		3573		---		7792		---	
10.08		---		8.54		---		18.62		---	

TRANSECT TOTAL

#	%	mg	%
29191	69.75	---	---
4910	11.73	1149.18	---
387	0.92	769.84	---
301	0.72	1236.13	---
5598	13.37	3155.15	---
2023	4.83	1119.88	---
2023	4.83	1119.88	---
43	0.10	8.61	---
2410	5.76	500.74	---
2583	6.17	670.82	---
41848		---	

Transect: North Control
Sampling Date: October 18, 1972
Season: Fall

Organisms Collected	1				1 R				Total 1 and 1 R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea					43	2.86	81.81	---	43	1.03	81.81	---
Oligochaeta	947	35.48	716.02	53.79	818		269.96	---	1765	42.28	985.98	---
Polychaeta					43	2.86	NB	---	43	1.03	---	---
Arthropoda: Arachnidia												
Crustacea: Amphipoda					43	2.86	NB	---	43	1.03	---	---
Isopoda: Chiridotea												
Cyathura												
Total Crustacea					43	2.86	---	---	43	1.03	---	---
Insecta: Coleoptera												
Collembola												
Diptera	990	37.09	427.97	32.16	301	19.99	76.64	---	1291	30.93	504.61	---
Trichoptera												
Total Insecta	990	37.09	427.97	32.16	301	19.99	76.64	---	1291	30.93	504.61	---
Mollusca: Gastropoda					43	2.86	NB	---	43	1.03	---	---
Pelecypoda	603	22.59	155.00	11.65	86	1.43	52.09	---	689	16.50	207.09	---
Platyhelminthes: Turbellaria	129	4.83	31.87	2.40	129	8.57	33.59	---	258	6.18	65.46	---
Sample Total	2669		1330.86		1506		---		4175		---	
% of Transect Total	14.06		---		7.93		---		21.99		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

$_2$				$_2R$				Total $_2$ and $_2$ R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				43	1.47	169.21	7.34	43	0.82	169.21	3.99
1206	51.87	1238.29	63.75	1765	60.28	1761.85	76.68	2971	56.56	3000.14	70.75
258	11.10	44.78	2.32	86	2.94	11.62	0.52	344	6.55	56.40	1.32
215	9.25	56.83	2.94	388	13.25	44.78	1.96	603	11.48	101.61	2.41
215	9.25	56.83	2.94	388	13.25	44.78	1.96	603	11.48	101.61	2.41
560	24.09	527.00	27.14	431	1.47	266.95	11.62	991	18.87	793.95	18.73
560	24.09	527.00	27.14	431	1.47	266.95	11.62	991	18.87	793.95	18.73
86	3.70	74.92	3.86	215	7.34	43.49	1.87	301	5.73	118.41	2.78
2325		1941.82		2928		2297.90		5253		4239.72	
12.25		---		15.42		---		27.67		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
129	2.56	512.37	17.20	258	5.71	473.62	---	387	0.91	985.99	---
3100	61.54	1613.74	54.23	2067	45.72	1996.94	---	5167	54.06	3610.68	---
43	0.85	63.29	2.12					43	0.45	63.29	---
43	0.85	6.89	0.24	86	1.90	12.05	---	129	1.35	18.94	---
474	9.41	172.22	5.78	603	13.34	142.94	---	1077	11.27	315.16	---
474	9.41	172.22	5.78	603	13.34	142.94	---	1077	11.27	315.16	---
818	16.24	542.94	18.25	431	9.53	342.72	---	1249	13.07	885.66	---
818	16.24	542.94	18.25	431	9.53	342.72	---	1249	13.07	885.66	---
				43	0.95	NB	---	43	0.45	---	---
258	5.12	43.06	1.44	775	17.14	182.98	---	1033	10.81	226.04	---
172	3.41	21.96	0.74	258	5.71	60.71	---	430	4.50	82.67	---
5037		2976.47		4521		---		9558		---	
26.53		---		23.81		---		50.34		---	

TRANSECT TOTAL

#	%	mg	%
473	2.49.	1237.01	---
9903	52.16	7596.80	---
86	0.45	---	---
473	2:49	75.34	---
1723	9.08	---	---
1723	9.08	---	---
3531	18.60	2184.22	---
3531	18.60	2184.22	---
86	0.45	---	---
2023	10.66	551.54	---
688	3.62	148.13	---
18986		---	

Transect: 75 AT
Sampling Date: October 18, 1972
Season: Fall

Organisms Collected	1				1R				Total 1 and 1R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea												
Oligochaeta	86	5.87	NB	-----	1163	36.02	377.17	49.24	1249	26.61	---	---
Polychaeta												
Arthropoda: Arachnidia					86	2.66	19.38	2.53	86	1.83	19.38	---
Crustacea: Amphipoda					129	4.00	39.61	5.17	129	2.75	39.61	---
Isopoda: Chiridotea	43	2.94	170.93	---					43	0.92	170.93	---
Cyathura												
Total Crustacea	43	2.94	170.93	---	129	4.00	39.61	5.17	172	3.67	210.54	---
Insecta: Coleoptera												
Collembola												
Diptera	1249	85.31	NB		1679	52.00	313.02	40.89	2928	62.39	---	---
Trichoptera	43	2.94	16.79	---					43	0.92	16.79	---
Total Insecta	1292	88.25	---	---	1679	52.00	313.02	40.89	2972	63.33	---	---
Mollusca: Gastropoda												
Pelecypoda	43	2.94	NB	---					43	0.92	---	---
Platyhelminthes: Turbellaria					172	5.33	16.79	2.19	172	3.67	16.79	---
Sample Total	1464		---		32.29		765.97		46.93		---	
% of Transect Total	10,56		---		23.29		---		33.85		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	3.33	2335.36	---					43	1.17	2335.36	---
775	60.03	1905.66	---	1292	54.54	4871.35	96.56	2067	56.48	6777.01	---
258	19.98	46.50	---	603	25.45	159.31	3.16	861	23.52	205.81	---
258	19.98	46.50	---	603	25.45	159.31	3.16	861	23.52	205.81	---
86	6.66	51.24	---	431	18.19	9.90	0.20	517	14.13	61.14	---
86	6.66	51.24	---	431	18.19	9.90	0.20	517	14.13	61.14	---
43	3.33	NB	---					43	1.17	---	---
86	6.66	34.87	---	43	1.82	4.30	0.09	129	3.52	39.17	---
1291		---		2369		5044.86		3660		---	
9.31		---		17.09		---		26.40		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1636	37.99	1135.39	---	947	78.59	1485.00	---	2583	46.87	2620.39	---
1163	27.01	155.00	---	129	10.71	314.74	---	1292	23.44	469.74	---
775	18.00	44.35	---					775	14.06	44.35	---
1938	45.01	199.35	---	129	10.71	314.74	---	2067	37.51	514.09	---
431	10.01	NB	---	129	10.71	NB	---	560	10.16	---	---
431	10.01	---	---	129	10.71	---	---	560	10.16	---	---
215	4.99	63.29	---					215	3.90	63.29	---
86	2.00	21.53	---					86	1.56	21.53	---
4306		---		1205		---		5511		---	
81.06		---		8.69		---		39.75		---	

TRANSECT TOTAL

		mg	
43	0.31	2335.36	---
5899	42.55	---	---
86	0.62	19.38	---
2282	16.46	715.16	---
818	5.90	215.28	---

3100	22.36	930.44	---
4005	28.89	---	---
43	0.31	16.79	---
4048	29.20	---	---
301	2.17	---	---
387	2.79	77.49	---
13864		---	

Transect: Maximum ΔT
Sampling Date: October 18, 1972
Season: Fall

Organisms Collected			I				IR				Total I and IR			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea													
	Oligochaeta		7018	88.11	7896.04	92.78	3143	63.47	2009.85	---	10161	78.66	9905.89	---
	Polychaeta													
Arthropoda:	Arachnidia						43	0.87	8.6 ±	---	43	0.33	8.61	---
	Crustacea:	Amphipoda					431	8.70	38.75	---	431	3.34	38.75	---
		Isopoda: Chiridotea					86	1.74	455.53	---	86	0.67	455.53	---
		Cyathura	129	1.62	403.57	4.74					129	1.00	403.57	---
		Total Crustacea	129	1.62	403.57	4.74	560	11.31	502.89	---	646	5.01	897.85	---
	Insecta:	Coleoptera												
		Collembola												
		Diptera	43	0.54	56.83	0.67	517	10.44	NB	---	560	4.34	---	---
		Trichoptera												
		Total Insecta	43	0.54	56.83	0.67	517	10.44	---	---	560	4.34	---	---
Mollusca:	Gastropoda													
	Pelecypoda		215	2.70	15.07	0.18	388	7.84	132.61	---	603	4.67	147.68	---
Platyhelminthes:	Turbellaria		560	7.03	138.74	1.63	344	6.95	19.38	---	904	7.00	158.12	---
	Sample Total		7965		8510.25		4952		---		12917		---	
	% of Transect Total		21.72		---		13.50		---		35.22		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3875	51.43	1955.60	65.84	6760	83.52	1562.93	---	10635	68.05	3518.53	---
43	0.57	277.71	9.35					43	0.28	277.71	---
344	4.57	136.49	4.59	215	2.66	58.12	---	559	3.58	194.61	---
43	0.57	50.81	1.71	43	0.53	52.09	---	86	0.55	102.90	---
43	0.57	188.15	6.33	43	0.53	670.38	---	86	0.55	858.53	---
430	5.71	375.45	12.63	301	3.72	780.59	---	731	4.68	1156.04	---
2067	27.44	198.06	6.67	732	9.04	NB	---	2799	17.91	---	---
2067	27.44	198.06	6.67	732	9.04	---	---	2799	17.91	---	---
1033	13.71	149.83	5.04	258	3.19	40.04	---	1291	8.26	189.87	---
86	1.14	13.78	0.46	43	0.53	11.62	---	129	0.83	25.40	---
7534		2970.43		8094		---		15628		---	
20.54		---		22.07		---		42.61		---	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1163	31.44	348.75	22.77	1249	28.17	221.31	---	2412	29.66	570.06	---
1633	44.15	287.19	18.75	1119	25.24	98.17	---	2752	33.84	385.36	---
258	6.97	625.18	40.82	86	1.94	NB	---	344	4.23	---	---
129	3.49	103.76	6.78	129	2.91	309.14	---	258	3.17	412.90	---
2020	54.61	1016.13	66.35	1334	30.09	407.31	---	3354	41.24	---	---
258	6.97	131.32	8.57	947	21.36	NB	---	1205	14.82	---	---
86	2.32	13.78	0.90					86	1.06	13.78	---
344	9.29	145.10	9.47	947	21.36	---	---	1291	15.88	---	---
86	2.32	12.49	0.82	732	16.51	133.90	---	818	10.06	146.39	---
86	2.32	9.04	0.59	172	3.88	18.51	---	1258	3.17	27.55	---
3699		1531.51		4434		---		8133		---	
10.09		---		12.09		---		22.17		---	

TRANSECT TOTAL

#	%	mg	%
23208	63.27	13994.48	---
43	0.12	277.71	---
43	0.12	8.61	---
3742	10.20	618.72	---
516	1.41	---	---
473	1.29	1675.00	---
4731	12.90	---	---
4564	12.44	---	---
86	.23	13.78	---
4650	12.67	---	---
2712	7.39	483.94	2.57
1291	3.52	211.07	1.12
36678		---	

Transect: South Control
Sampling Date: October 18, 1972
Season: Fall

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea													
	Oligochaeta		4478	75.36	591.59	40.69	2281	69.73	157.15	---	6759	73.36	748.74	---
	Polychaeta		43	0.72	185.57	12.76	43	1.31	425.39	---	86	0.93	610.96	---
Arthropoda:	Arachnidia		86	1.45	18.08	1.24					86	0.93	18.08	---
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura	43	0.72	380.48	26.17					43	0.47	380.48	---
		Total Crustacea	43	0.72	380.48	26.17					43	0.47	380.48	---
	Insecta:	Coleoptera												
		Collembola												
		Diptera	1163	19.57	217.00	14.93	818	25.01	NB	---	1981	21.50	---	---
		Trichoptera	43	0.72	31.57	2.17					43	0.47	31.57	---
		Total Insecta	1206	20.30	248.57	17.10	818	25.01	---	---	2024	21.97	---	---
Mollusca:	Gastropoda													
	Pelecypoda		43	0.72	16.36	1.13	86	2.63	3.01	---	129	1.40	19.37	---
Platyhelminthes:	Turbellaria		43	0.72	13.12	0.90	43	1.31	NB	---	86	0.93	---	---
	Sample Total		5942		1453.37		3271		---		9213		---	
	% of Transect Total		28.70		---		15.80		---		44.49		---	

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$

2				2.R				Total 2 and 2.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
689	61.57	345.31	---	689	34.06	314.31	---	1378	43.90	659.62	---
43	3.84	2.58	---	129	6.38	5.59	---	172	5.50	8.17	--
43	3.84	2.58	---	129	6.38	5.59	---	172	5.50	8.17	--
				43	2.13	21.96	---	43	1.40	21.96	--
258	23.06	NB	---	947	46.81	NB	---	1205	38.40	---	--
344	30.74	22.82	---	990	48.94	---	---	1334	42.50	---	--
43	3.84	37.89	---					43	1.40	37.89	--
				86	4.25	16.36	---	86	2.70	16.36	--
				129	6.38	42.19	---	129	4.10	42.19	--
1119		---		2023		---		3142		---	
5.40		---		9.77		---		15.17		---	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
2282	58.24	1194.80	57.28	2282	51.47	1612.45	---	4564	54.65	2807.25	---
				43	0.97	4.30	---	43	0.51	4.30	---
560	14.29	129.17	6.19	1119	25.24	221.74	---	1679	20.10	350.91	---
344	8.78	374.59	17.96	172	3.88	701.38	---	516	6.18	1075.97	---
904	23.07	503.76	24.15	1291	29.12	923.12	---	2195	26.28	1426.88	---
603	15.39	316.89	15.19	517	11.66	245.85	---	1120	13.41	562.74	---
43	1.10	17.65	0.85					43	0.51	17.65	---
646	16.49	334.54	16.04	517	11.66	245.85	---	1163	13.92	580.39	---
				43	0.97	NB	---	43	0.51	---	---
				43	0.97	20.24	---	43	0.51	20.24	---
86	2.19	52.96	2.54	215	4.85	115.82	---	301	3.60	168.78	---
3918		2086.06		4434		---		8352		---	
18.92		---		21.41		---		40.33		---	

TRANSECT TOTAL

#	%	mg	%
12701	61.34	4215.61	---
86	0.42	610.96	---
129	0:62	22.38	---
1851	8.94	359.08	---
559	2.70	1456.45	---
2410	11.64		
43	0.21	21.96	---
4306	20.79	---	---
86	0.42	49.22	---
4521	21.83	---	---
86	0.42	---	---
258	1.25	55.97	---
516	2.49	---	---
20707		---	

TRANSECT: South Control
SAMPLING DATE: December 12, 1972
SEASON: Winter

Organisms Collected	1				1R				Total 1 and 1R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea Oligochaeta Polychaeta	1765	67.21	342.72	-	2454	82.63	651.43	-	4219	75.39	994.15	-
Arthropoda: Arachnidia												
Crustacea: Amphipoda												
Isopoda: Chiridotea					129	4.34	232.07	-	129	2.31	232.07	-
Cyathura					129	4.34	232.07	-	129	2.31	232.07	-
Total Crustacea												
Insecta: Coleoptera												
Collembola	861	32.79	NB	-	387	13.03	NB	-	1248	22.30	-	-
Diptera												
Trichoptera	861	32.79	-	-	387	13.03	-	-	1248	22.30	-	-
Total Insecta												
Mollusca: Gastropoda												
Pelecypoda												
Platyhelminthes: Turbellaria												
Sample Total	2626		-		2970		-		5596		-	
% of Transect Total	13.74		-		15.54		-		29.28		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1636	64.41	780.60	-	2497	73.42	754.34	-	4133	69.57	1534.94	-
43	1.69	7.32	-					43	0.72	7.32	-
				43	1.26	4.74	-	43	0.72	4.74	-
				43	1.26	4.74	-	43	0.72	4.74	-
646	25.43	NB	-	775	22.79	NB	-	1421	23.92	-	-
646	25.43	-	-	775	22.79	-	-	1421	23.92	-	-
43	1.69	4.30	-					43	0.72	4.30	-
172	6.77	73.62	-	86	2.53	NB	-	258	4.34	-	-
2540		-		3401		-		5941		-	
13.29		-		17.80		-		31.09		-	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1292	33.72	182.13	-	2454	65.54	722.05	-	3746	49.45	904.18	-
				129	3.45	19.37	-	129	1.70	19.37	-
904	23.60	1331.72	-	258	6.89	112.38	-	1162	15.34	1444.1	-
				43	1.15	322.92	-	43	0.57	322.92	-
258	6.73	871.89	-	301	8.04	621.73	-	559	7.38	1493.62	-
1162	30.33	2203.61	-	602	16.08	1057.03	-	1764	23.29	3260.64	-
301	7.86	NB	-	215	5.74	NB	-	516	6.81	-	-
301	7.86	-	-	215	5.74	-	-	516	6.81	-	-
				43	1.15	NB	-	43	0.57	-	-
1076	28.09	304.40	-	301	8.04	52.96	-	1377	18.18	357.36	-
3831		-		3744		-		7575		-	
20.04		-		19.59		-		39.63		-	

Transect Total			
#	%	mg	%
12098	63.30	3433.27	-
172	0.90	26.69	-
1205	6.30	1448.84	-
43	0.22	322.92	-
688	3.60	1725.69	-
1936	10.13	3497.45	-
3185	16.66	-	-
3185	16.66	-	-
86	0.45	-	-
1635	8.55	-	-
19112		-	

TRANSECT: 75ΔT
SAMPLING DATE: December 12, 1972
SEASON: Winter

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		775	58.05	NB	-	1378	94.13	700.95	-	2153	76.92	-	-
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda					43	2.94	47.79	-	43	1.54	47.79	-
		Isopoda: Chiridotea												
		Cyathura	43	3.22	NB	-					43	1.54	-	-
		Total Crustacea	43	3.22	NB	-	43	2.94	47.79	-	86	3.07	-	-
	Insecta:	Coleoptera												
		Collembola												
		Diptera	517	38.73	NB	-	43	2.94	NB	-	560	20.01	-	-
		Trichoptera												
		Total Insecta	517	38.73	NB	-	43	2.94	NB	-	560	20.01	-	-
Mollusca:	Gastropoda Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		1335		-		1464		-		2799		-	
	% of Transect Total		9.15		-		10.03		-		19.18		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1593	66.07	569.20	-	1378	74.45	415.49	-	2971	69.71	984.69	-
				43	2.32	48.65	-	43	1.01	48.65	-
				43	2.32	48.65	-	43	1.01	48.65	-
732	30.36	NB	-	172	9.29	NB	-	904	21.21	-	-
732	30.36	NB	-	172	9.29	NB	-	904	21.21	-	-
86	3.57	79.65	-	258	13.94	59.85	-	344	8.07	139.5	-
2411		-		1851		-		4262		-	
16.52		-		12.68		-		29.20		-	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1464	64.15	668.23	-	3057	58.20	1783.81	-	4521	60.00	2452.04	-
				43	0.82	6.89	-	43	0.57	6.89	-
603	26.42	NB	-	1464	27.87	NB	-	2067	27.43	-	-
603	26.42	NB	-	1464	27.87	NB	-	2067	27.43	-	-
215	9.42	121.85	-	646	12.30	379.75	-	861	11.43	501.6	-
				43	0.82	15.93	-	43	0.57	15.93	-
2282 15.63		- -		5253 35.99		- -		7535 51.62		- -	

Transect Total

#	%	mg	%
9645	66.08	-	-
43	0.3	6.89	-
86	0.6	96.44	-
43	0.29	-	-
129	0.08	-	-
3531	24.19	-	-
3531	24.19	-	-
861	5.90	501.6	-
387	2.65	155.43	-
14596		-	

TRANSECT: North Control
SAMPLING DATE: December 12, 1972
SEASON: Winter

Organisms Collected	1				1R				Total 1 and 1R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea	43	2.00	309.14	-					43	00.63	309.14	-
Oligochaeta	1163	54.02	374.16	-	2497	53.71	1179.30	-	3660	53.81	1553.46	-
Polychaeta												
Arthropoda: Arachnidia	43	2.00	7.32	-	43	0.92	11.63	-	86	1.26	18.95	-
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera												
Collembola												
Diptera	689	32.00	NB	-	990	21.29	NB	-	1679	24.68	-	-
Trichoptera												
Total Insecta	689	32.00	-	-	990	21.29	-	-	1679	24.68	-	-
Mollusca: Gastropoda												
Pelecypoda	86	4.00	81.81	-	86	1.15	7.75	-	172	2.53	89.56	-
Platyhelminthes: Turbellaria	129		33.58	-	1033	2222	232.50	-	1162	17.08	266.08	-
Sample Total	2153		-		4649		-		6802		-	
% of Transect Total	11.24		-		24.26		-		31.74		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				43	1.15	223.89	-	43	0.76	223.89	-
1076	56.81	759.08	-	799	74.72	882.22	-	3875	68.71	1641.30	
43	2.27	8.18	-					43	0.76	8.18	-
43	2.27	44.35	-	344	9.18	NB	-	387	6.86	-	-
43	2.27	44.35	-	344	9.18	-	-	387	6.86	-	-
646	34.11	NB	-	388	10.36	NB	-	1034	18.33	-	-
646	34.11	-	-	388	10.36	-	-	1034	18.33	-	-
86	4.54	15.93	-	86	2.30	37.89	-	172	3.05	53.82	-
				86	2.30	7.32	-	86	1.52	7.32	
1894		-		3746		-		5640		-	
9.89		-		19.55		-		29.44		-	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	1.20	96.01	-					43	0.64	96.01	-
2583	72.27	442.62	-	1938	61.64	658.76	-	4521	67.30	1101.38	-
43	1.20	NB	-	129	4.10	318.18	-	172	2.56	-	-
43	1.20	-	-	129	4.10	318.18	-	172	2.56	-	-
517	14.47	NB	-	431	13.71	NB	-	948	14.11	-	-
517	14.47	-	-	431	13.71	-	-	948	14.11	-	-
388	10.86	155.86	-	474	15.08	205.81	-	862	12.83	361.67	-
				172	5.47	47.79	-	172	2.56	47.79	-
3574		-		3144		-		6718		-	
18.65		-		16.41		-		35.06		-	

Transect Total

#	%	mg	%
129	0.67	629.04	-
12056	62.92	4296.14	-
129	0.67	27.13	-
559	2.92	-	-
559	2.92	-	-
3661	19.11	-	-
3661	19.11	-	-
1206	6.29	505.05	-
1420	7.41	321.19	-
19160		-	

Transect: Maximum ΔT
Sampling Date: December 12, 1972
Season: Winter

Organisms Collected			1				1^R				Total 1 and 1^R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea													
	Oligochaeta		1163	27.56	1061.76	---	1765	63.08	57.70	---	2928	41.72	1119.46	---
	Polychaeta		86	2.04	9.47	---					86	1.23	9.47	---
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea					86	3.07	NB	---	86	1.23	---	---
	Insecta:	Coleoptera												
		Collembola												
		Diptera	2067	48.98	NB	---	861	30.77	NB	---	2928	41.72	---	---
		Trichoptera												
		Total Insecta	2067	48.98	---	---	861	30.77	---	---	29.28	41.72	---	---
Mollusca:	Gastropoda													
	Pelecypoda		43	1.02	5.17	---	43	1.54	4.31	---	86	1.23	9.48	---
Platyhelminthes:	Turbellaria		861	20.46	294.50	---	43.1	1.54	82.67	---	904	12.88	377.17	---
	Sample Total		4220		---		2798		---		7018		---	
	% of Transect Total		9.41		---		6.24		---		15.64		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3358	66.68	566.19	---	1981	70.80	371.14	---	5339	68.15	937.33	---
86	1.71	49.08	---					86	1.10	49.08	---
43	0.85	14.64	---					43	0.65	14.64	---
43	0.85	283.74	---					43	0.65	283.74	---
86	1.70	298.38	---					86	1.30	298.38	---
344	6.83	NB	---	344	12.29	NB	---	688	8.78	---	---
344	6.83	---	---	344	12.29	---	---	688	8.78	---	---
904	17.95	154.57	---	344	12.29	407.74	---	1248	15.93	562.31	---
258	5.12	58.56	---	129	4.61	24.11	---	387	4.94	82.67	---
5086		---		2798		---		7834		---	
11.23		---		6.24		---		17.46		---	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
12615	83.71	2892.93	---	10333	69.17	2803.81	---	22948	76.47	5696.74	---
43	0.29	99.46	---	86	0.56	196.34	---	129	0.43	295.80	---
				43	0.29	353.49	---	43	0.14	353.49	---
172	1.14	987.27	---	215	1.44	189.02	---	387	1.29	1176.29	---
215	1.43	1086.73	---	344	2.29	738.85	---	559	1.86	1825.58	---
1292	8.57	NB	---	2971	19.89	NB	---	4263	14.21	---	---
1292	8.57	---	---	2971	19.89	---	---	4263	14.21	---	---
732	4.86	117.97	---	215	1.44	116.25	---	947	3.16	234.22	---
215	1.43	97.74	---	1076	7.20	317.32	---	1291	4.30	415.06	---
15069		---		14939		---		30008		---	
33.59		---		33.30		---		66.89		---	

TRANSECT TOTAL

#	%	mg	%
31215	69.58	7753.53	---
86	0.19	9.47	---
86	0.19	49.08	---
172	0.38	310.44	---
86	0.19	637.23	---
387	0.86	1176.29	---
731	1.62	2123.96	---
7879	17.56	---	---
7879	17.56	---	---
2281	5.08	806.01	---
2582	5.76	874.90	---
44860		----	

Transect: North Control
Sampling Date: June 7, 1973
Season: Spring

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea, Oligochaeta, Polychaeta	129	25.00	10.76	1.28	2411.	98.25	1201.26	96.74	2540	8552	1212.02	58.26
Arthropoda: Arachnidia												
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera, Collembola, Diptera, Trichoptera	258	50.00	87.83	10.47	43	1.75	40.47	3.26	301	10.13	128.30	6.17
Total Insecta	258	50.00	87.83	10.47	43	1.75	40.47	3.26	301	10.13	128.30	6.17
Mollusca: Gastropoda, Pelecypoda	129	25.00	740.13	88.25					129	4.34	740.13	35.58
Platyhelminthes: Turbellaria												
Sample Total	516		838.72		2454		1241.73		2970		2080.45	
% of Transect Total	3.11		7.44		14.77		11.01		17.87		18.45	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of 1 m^2

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1636	70.37	1801.03	80.80	1550	90.01	613.12	81.79	3186	78.72	2414.15	81.05
215	9.25	55.54	2.49	86	4.99	11.19	1.49	301	7.44	66.73	2.24
215	9.25	55.54	2.49	86	4.99	11.19	1.49	301	7.44	66.73	2.24
474	20.39	372.43	16.71	86	4.99	125.29	16.71	560	13.84	497.72	16.71
474	20.39	372.43	16.71	86	4.99	125.29	16.71	560	13.84	497.72	16.71
2325 13.99		2229.00 19.76		1722 10.36		749.60 6.65		4047 24.35		2978.60 26.41	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3660	76.59	2994.54	86.84	4306	89.30	2354.30	84.95	7966	82.97	5348.84	86.00
301	6.30	92.14	2.67	172	3.57	146.82	5.30	473	4.93	238.96	3.84
301	6.30	92.14	2.67	172	3.57	146.82	5.30	473	4.93	238.96	3.84
				43	0.89	38.32	1.38	43	0.45	38.32	0.62
				86	1.78	73.19	2.64	86	0.90	73.19	1.18
732	15.32	251.88	7.30	129	2.68	129.59	4.68	861	8.97	381.47	6.13
732	15.32	251.88	7.30	258	5.35	241.10	8.70	990	10.32	492.98	7.93
86	1.80	109.79	3.18	86	178	29.28	1.06	172	1.79	139.07	2.24
4779		3448.35		4822		2771.50		9601		6219.85	
28.76		30.57		29.02		24.57		57.77		55.15	

TRANSECT TOTAL

#	%	mg	%
13692	82.39	8975.01	
774	4.66	305.69	
774	4.66	305.69	
43	0.26	38.32	
86	0.52	73.19	
1722	10.36	1007.49	
1851	11.14	1119.00	
301	1.81	879.20	
16618		11278.90	

Transect: Maximum ΔT
Sampling Date: June 7, 1973
Season: Spring

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		6372	91.35	522.69	78.06	8913	88.09	1239.58	87.88	15285	89.42	1762.27	84.63
Arthropoda:	Arachnidia						86	0.85	36.17	2.55	86	0.50	36.17	1.73
	Crustacea:	Amphipoda	43	0.62	9.90	1.49					43	0.25	9.90	0.48
		Isopoda: Chiridotea	43	0.62	3.44	0.45	43	0.42	24.97	1.77	86	0.50	28.41	1.35
		Cyathura												
		Total Crustacea	43	1.24	13.34	1.94	43	0.42	24.97	1.77	129	0.75	38.31	1.83
	Insecta:	Coleoptera												
		Collembola												
		Diptera	474	6.80	111.94	16.72	818	8.08	79.65	5.67	1292	7.56	191.59	9.22
		Trichoptera												
		Total Insecta	474	6.80	111.94	16.72	818	8.08	79.65	5.67	1292	7.56	191.59	9.22
Mollusca:	Gastropoda Pelecypoda		43	0.62	22.39	3.28	43	0.42	2.15	0.14	86	0.50	24.54	1.20
Platyhelminthes:	Turbellaria						215	2.12	28.85	2.06	215	1.26	28.85	1.39
	Sample Total		6975		670.36		10118		1411.37		17093		2081.73	
	% of Transect Total		25.36		8.41		36.78		17.70		62.14		26.11	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2_R				Total $_2$ and $_2R$			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1162	42.88	560.59	41.52	301	33.29	497.29	52.05	1463	40.48	1057.88	45.88
301	11.11	39.61	2.93					301	8.33	39.61	1.72
301	11.11	39.61	2.93					301	8.33	39.61	1.72
559	20.63	316.03	23.40	474	52.43	382.34	40.01	1033	28.58	698.37	30.28
559	20.63	316.03	23.40	474	52.43	382.34	40.01	1033	28.58	698.37	30.28
688	25.39	434.00	32.14	129	14.27	75.78	7.93	817	22.61	509.78	22.11
2710 9.85		1350.23 16.93		904 3.29		955.41 11.98		3614 13.14		2305.64 28.91	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
2238	52.52	647.99	29.28	1335	52.58	1006.22	73.26	3573	52.54	1654.21	46.12
430	10.09	135.63	6.13	301	11.86	120.56	8.78	731	10.75	256.19	7.14
43	1.01	6.89	0.31					43	0.63	6.89	0.19
473	11.10	142.52	6.44	301	11.86	120.56	8.78	774	11.38	263.08	7.33
				43	1.69	2.58	0.19	43	0.63	2.58	0.08
603	14.15	222.17	10.04	559	22.02	211.40	15.39	1162	17.09	433.57	12.09
603	14.15	222.17	10.04	602	13.71	213.98	15.58	1205	17.72	436.15	12.17
947	22.22	1200.40	54.24	86	3.39	12.49	0.91	1033	15.19	1212.89	33.82
				215	8.46	20.24	1.47	215	3.16	20.24	0.56
4261		2213.08		2539		1373.49		6800		3586.51	
15.49		27.75		9.23		17.22		24.72		44.98	

TRANSECT TOTAL			
#	%	mg	%
20321	73.88	4474.36	56.11
86	0.31	36.17	0.45
1075	3.91	305.70	3.83
129	0.47	35.30	0.44
1204	4.38	340.00	4.27
43	0.16	2.58	0.03
3487	12.68	1323.53	16.59
3530	12.84	1325.11	16.62
1936	7.03	1747.21	21.91
430	1.56	49.09	0.62
27507		7973.94	

Transect: South Control
Sampling Date: June 7, 1973
Season: Spring

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		3186	72.57	69.32	20.08	689	20.78	107.64	17.77	3875	50.29	176.96	18.61
Arthropoda:	Arachnidia		129	2.94	73.62	21.32					129	1.67	73.62	7.74
	Crustacea:	Amphipoda	301	6.86	41.33	11.97	904	27.27	309.57	51.10	1205	15.64	350.90	36.89
		Isopoda: Chiridotea	129	2.94	21.09	6.11					129	1.67	21.09	2.22
		Cyathura												
		Total Crustacea	430	9.79	62.42	18.08	904	27.27	309.57	51.10	1334	17.31	371.99	39.11
	Insecta:	Coleoptera					86	2.59	9.47	1.56	86	1.12	9.47	1.00
		Collembola	387	8.82	27.99	8.11	1378	41.57	109.79	18.12	1765	22.91	137.78	14.49
		Diptera												
		Trichoptera												
		Total Insecta	387	8.82	27.99	8.11	1464	44.16	119.26	1969	1851	24.02	147.25	15.48
Mollusca:	Gastropoda Pelecypoda		86	1.96	52.09	15.09	258	7.78	69.32	11.44	344	4.46	121.41	12.77
Platyhelminthes:	Turbellaria		172	3.92	59.85	17.33					172	2.22	59.85	6.29
	Sample Total		4390		345.29		3315		605.79		7705		951.08	
	% of Transect Total		29.06		12.73		21.94		22.34		51.00		35.07	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				$_2R$				Total 2 and $_2R$			
#	%	mg	%	#	%	mg	%	#	%	mg	%
215	26.28	32.72	31.28	689	50.04	204.52	37.46	904	41.18	237.24	36.47
86	10.51	18.08	17.28					86	3.92	18.08	2.78
86	10.51	26.26	25.10	43	3.12	2.15	0.39	129	5.88	28.41	4.37
86	10.51	26.26	25.10	43	3.12	2.15	0.39	129	5.88	28.41	4.37
431	52.70	27.55	26.34	559	40.60	68.03	12.46	990	45.10	95.58	14.69
431	52.69	27.55	26.34	559	40.60	68.03	12.46	990	45.10	95.58	14.69
				86	6.25	271.25	49.68	86	3.92	271.25	41.69
818		104.61		1377		545.95		2195		650.56	
5.41		3.86		9.11		20.13		14.53		23.99	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1205	54.90	24.97	2.98	1205	40.00	8.18	3.01	2410	46.27	33.15	2.99
129	5.88	9.04	1.08					129	2.48	9.04	0.81
86	3.92	23.25	2.77	1119	37.14	132.18	48.65	1205	23.14	155.43	14.00
129	5.88	671.24	80.07	129	4.28	41.76	15.37	258	4.95	713.00	64.24
215	9.79	694.49	82.85	1248	41.42	173.98	64.03	1463	28.09	868.43	78.24
646	29.43	109.79	13.10	517	17.16	86.11	31.70	1163	22.33	195.90	17.65
646	29.43	109.79	13.10	517	17.16	86.11	31.70	1163	22.33	195.90	17.65
				43	1.43	3.44	1.27	43	0.83	3.44	0.31
2195		838.29		3013		271.67		5208		1109.96	
14.53		30.91		19.94		10.02		34.47		40.93	

TRANSECT TOTAL			
#	%	mg	%
7189	47.58	447.35	16.50
344	2.28	100.74	3.72
2539	16.81	534.74	19.72
387	2.56	734.09	27.07
2926	19.37	1268.83	46.79
86	0.57	9.47	0.35
3918	25.93	429.26	15.83
4004	26.50	438.73	16.18
86	0.57	271.25	10.00
344	2.28	121.41	4.48
215	1.42	63.29	2.33
15108		2711.60	

TRANSECT: 75 ΔT
SAMPLING DATE: June 7, 1973
SEASON: Spring

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea, Oligochaeta, Polychaeta	3832	72.95	987.70	46.38	3918	83.49	1639.57	81.66	7750	77.92	2627.27	63.50
Arthropoda: Arachnidia	129	2.46	63.72	2.99	43	0.92	41.33	2.06	172	1.73	105.05	2.54
Crustacea: Amphipoda	86	1.64	19.37	0.91	86	1.83	36.17	1.80	172	1.73	55.54	1.34
Isopoda: Chiridotea, Cyathura												
Total Crustacea	86	1.64	19.37	0.91	86	1.83	36.17	1.80	172	1.73	55.54	1.34
Insecta: Coleoptera	215	4.09	41.33	1.94	43	0.92	6.89	0.34	258	2.59	48.22	1.17
Collembola	388	7.39	84.82	3.98	474	10.10	222.59	11.09	862	8.67	307.41	7.43
Diptera, Trichoptera												
Total Insecta	603	11.48	126.15	5.92	517	11.02	229.48	11.43	1120	11.26	355.63	8.60
Mollusca: Gastropoda, Pelecypoda	129	2.46	70.61	3.32	86	1.83	53.39	2.66	215	2.16	124.00	3.00
Platyhelminthes: Turbellaria	474	9.02	861.98	40.48	43	0.92	7.75	0.39	517	5.20	869.73	21.02
Sample Total	5253		2129.53		4693		2007.69		9946		4137.22	
% of Transect Total	26.93		26.57		24.06		25.05		50.99		51.63	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
689	51.61	604.94	69.69	1119	40.6	217.86	23.95	1808	44.19	822.80	46.28
215	16.10	75.78	8.73	474	17.20	123.14	13.54	68.9	16.84	198.92	11.19
215	16.10	75.78	8.73	474	17.20	123.14	13.54	68.9	16.84	198.92	11.19
43	3.22	16.36	1.88					43	1.05	16.36	0.92
388	29.06	170.93	19.69	646	23.44	380.18	41.79	1034	25.27	551.11	31.00
431	32.28	187.29	21.57	646	23.44	380.18	41.79	1077	26.32	567.47	31.92
				431	15.69	157.58	17.32	431	10.54	157.58	8.86
				86	3.12	31.00	3.41	86	2.10	31.00	1.74
1335		868.01		2756		909.76		4091		1777.77	
6.84		10.83		14.13		11.35		20.97		22.18	

3				3_R				Total 3 and 3_R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
2799	7647	988.99	72.12	904	50.00	326.79	44.94	3703	67.72	1315.78	62.70
43	1.17	7.75	0.57	215	11.89	43.05	5.92	258	4.72	50.80	2.42
43	1.17	7.75	0.57	215	11.89	43.05	5.92	258	4.72	50.80	2.42
43	1.17	19.80	1.44					43	0.79	19.80	0.94
560	15.30	306.56	22.36	603	33.35	209.25	28.77	1163	21.27	515.81	24.58
603	16.47	326.36	23.80	603	33.35	209.25	28.77	1206	22.06	535.61	25.52
215	5.87	48.22	3.52	86	4.76	148.11	20.37	301	5.50	196.33	9.36
3660		1371.32		1808		727.20		5468		2098.52	
18.76		17.11		9.27		9.07		28.03		26.19	

Transect Total

#	%	mg	%
13261	67.99	4765.85	59.47
172	0.88	105.05	1.31
1119	5.74	305.26	3.81
1119	5.74	305.26	3.81
43	0.22	19.80	0.25
301	1.54	64.58	0.81
3059	15.68	1374.33	17.15
3403	17.44	1458.71	18.21
947	4.85	477.91	5.96
603	3.09	900.73	11.24
19505		8013.51	

TRANSECT: Maximum ΔT
SAMPLING DATE: August 3, 1973
SEASON: Summer

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		947	56.40	720.76	85.98	2411	58.33	1147.01	-	3358	57.78	1867.77	-
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	43	2.56	2.15	0.26	43	1.04	NB	-	86	1.48	-	-
		Isopoda: Chiridotea Cyathura												
		Total Crustacea	43	2.56	2.15	0.26	43	1.04			86	1.48	2.15	-
	Insecta:	Coleoptera												
		Collembola												
		Diptera	689	41.04	115.39	13.76	1679	40.62	595.89	-	2368	40.74	711.28	-
		Trichoptera												
		Total Insecta	689	41.04	115.39	13.76	1679	40.62	595.89	-	2368	40.74	711.28	-
Mollusca:	Gastropoda Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		1679		838.30		4133		-		5812		-	
	% of Transect Total		4.59		-		11.29		-		15.88		-	

Sampling Depths

Numbers of Organisms and Weight in mg are Values calculated for Sample Areas of $1m^2$.

2				2_R				Total 2 and 2_R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1765	5256	1369.61	-	3143	57.95	1678.32	69.33	4908	55.89	3047.93	-
172	5.12	107.64	-	129	2.37	25.40	1.05	301	3.43	133.04	-
				43	0.8	21.53	.89	43	0.49	21.53	-
172	5.12	107.64	-	172	3.17	46.93	1.94	344	3.92	154.57	-
1249	37.19	348.75	-	818	15.08	516.67	21.34	2067	23.53	865.42	-
				43	.08	33.58	1.39	43	49	33.58	-
1249	37.19	348.75	-	861	15.88	550.25	22.73	2110	24.02	899.00	-
43	1.28	NB	-	1033	19.04	112.81	4.66	1076	12.25	-	-
129	3.84	8.61	-	215	3.96	32.29	1.33	344	3.92	40.90	
3358		-		5424				8782		-	
9.18		-		14.82		2420.60		24.00		-	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3659	39.91	973.49	28.01	990	7.72	450.36	5.74	4649	21.13	1423.85	12.58
172	1.87	279.00	8.03	2109	16.44	670.38	8.55	2281	10.37	949.38	8.39
				215	1.67	203.22	2.59	215	0.98	203.22	1.79
43	0.47	9.90	0.28	646	5.03	472.32	6.02	689	3.13	482.22	4.26
215	2.34	288.90	8.31	2970	23.14	1345.92		3185	14.48	1634.82	14.44
4219	46.01	1883.26	54.18	8654	67.46	6036.88	77.00	12873	58.52	7920.14	69.99
4219	46.01	1883.26	54.18	8654	67.46	6036.88	77.00	12873	58.52	7920.14	69.99
947	10.33	308.28	8.87	215	1.67	7.32	0.09	1162	5.28	315.60	2.79
129	1.41	21.96	0.63					129	0.59	21.96	0.19
9169 25.06		3475.89 -		12829 35.06		7840.48 -		21998 60.17		11316.37 -	

Transect Total

#	%	mg	%
12915	35.29	6339.55	-
2668	7.29	-	-
215	0.59	203.22	-
732	2.00	503.75	-
3615	9.88	1791.54	-
17308	47.30	9496.84	-
43	0.12	33.58	-
17351	47.42	-	-
2238	6.12	-	-
473	1.29	62.86	-
36592		-	

Transect: South Control
Sampling Date: August 3, 1973
Season: Summer

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		4392	55.75	2243.21	46.63	732	68.02	39.18	49.73	5124	57.22	2282.40	46.68
Arthropoda:	Arachnidia		43	0.54	4.30	0.09					43	0.48	4.30	0.09
	Crustacea:	Amphipoda	172	2.18	233.36	4.85	43	3.99	1.72	2.18	215	2.40	235.08	4.81
		Isopoda: Chiridotea												
		Cyathura	43	0.54	2.58	0.05					43	0.48	2.58	0.05
		Total Crustacea	115	2.72	235.94	4.90	43	3.99	1.72	2.18	258	2.88	237.66	4.86
	Insecta:	Coleoptera												
		Collembola												
		Diptera	2626	33.33	1203.84	25.02	172	15.98	12.05	15.29	2798	31.25	1215.89	24.87
		Trichoptera												
		Total Insecta	2626	33.33	1203.84	25.02	172	15.98	12.05	15.29	2798	31.25	1215.89	24.87
Mollusca:	Gastropoda Pelecypoda		430	5.46	1121.18	23.31	129	11.98	25.83	32.78	559	6.24	1147.01	23.46
Platyhelminthes:	Turbellaria		172	2.18	1.72	0.04					172	1.92	1.72	0.04
	Sample Total		7878		4810.20		1076		78.78		8954		4888.98	
	% of Transect Total		26.79		---		3.66		---		30.45		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1292	85.73	189.01	82.83					1292	57.70	189.01	-
86	5.71	18.51	8.11	474	64.75	22.82	-	560	25.01	41.33	-
86	5.71	18.51	8.11	474	64.75	22.82	-	560	25.01	41.33	-
129	8.56	20.67	9.06	129	17.62	21.96	-	258	11.52	42.63	-
129	8.56	20.67	9.06	129	17.62	21.96	-	258	11.52	42.63	-
				129	17.62	NB	-	129	5.76	NB	-
1507		228.19		732		-		2239		-	
5.13		---		2.49		-		7.61		-	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
6286	64.32	4846.38	54.56	4219	50.00	2899.39	45.51	10505	57.68	7745.77	50.78
86	0.88	162.75	1.83	474	5.62	40.90	0.64	560	3.07	203.65	1.34
				43	0.51	2862.36	44.92	43	0.24	2862.36	18.76
86	0.88	162.75	1.83	517	6.13	2903.26	45.56	603	3.31	3066.01	20.10
3272	33.48	980.38	11.04	2928	34.70	485.67	7.62	6200	34.04	1466.05	9.61
3272	33.48	980.38	11.04	2928	34.70	485.67	7.62	6200	34.04	1466.05	9.61
				344	4.07	63.29	0.99	344	1.89	63.29	0.41
129	1.32	2892.50	32.51	430	5.09	19.80	0.3	559	3.06	2912.30	19.09
9773 33.24		8882.01 ---		8438 28.70		6371.41 ---		18211 61.93		15253.42 ---	

TRANSECT TOTAL

#	%	mg	%
16921	57.55	10217.18	-
43	0,14	4.30	-
1335	4.54	480.06	-
86	0.29	2864.94	-
1421	4.83	3345.00	-
9256	31.48	2724.57	-
9256	31.48	2724.57	-
129	0.44	-	-
903	3.07	1210.30	-
731	2.49	2914.02	-
29404		---	

Transect: North Central
Sampling Date: August 3, 1973
Season: Summer

Organisms Collected			1 #	1 %	1 mg	1 %	1_R #	1_R %	1_R mg	1_R %	Total 1 and 1_R #	Total 1 and 1_R %	Total 1 and 1_R mg	Total 1 and 1_R %
Annelida:	Hirudinea						43	0.69	246.71	7.74	43	0.47	246.71	6.58
	Oligochaeta		1851	66.15	306.98	54.47	4607	73.79	2194.56	68.89	6458	71.43	2501.54	66.73
	Polychaeta													
Arthropoda:	Arachnidia						43	0.69	2.15	0.07	43	0.47	2.15	0.06
	Crustacea:	Amphipoda												
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea												
	Insecta:	Coleoptera												
		Collembola												
		Diptera	474	16.94	192.03	34.07	861	13.79	289.34	9.08	1335	14.76	481.37	12.84
		Trichoptera	86	3.07	17.65	3.13					86	0.95	17.65	0.05
		Total Insecta	560	20.01	209.68	37.20	861	13.79	289.34	9.08	1421	15.71	499.02	12.89
Mollusca:	Gastropoda						86	1.38	116.69	3.66	86	0.95	116.69	3.11
	Pelecypoda		344	12.29	46.07	8.17	517	8.28	299.67	9.41	861	9.52	345.74	9.22
Platyhelminthes:	Turbellaria		43	1.54	0.86	0.15	86	1.38	36.17	1.13	129	1.43	37.03	0.99
	Sample Total		2798		563.59		6243		3185.29		9041		3748.88	
	% of Transect Total		9.88		3.43		22.04		19.38		31.92		22.81	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas $1m^2$

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				86	1.22	440.03	11.15	86	0.83	440.03	6.81
2669	80.51	2405.97	95.72	5037	71.78	3179.68	80.60	7706	74.58	5585.65	86.48
				43	0.61	6.89	0.17	43	0.42	6.89	0.11
				129	1.84	65.44	1.66	129	1.25	65.44	1.01
				129	1.84	65.44	1.66	129	1.25	65.44	1.01
603	18.19	99.03	3.94	1249	17.80	99.03	2.51	1852	17.92	198.06	3.07
603	18.19	99.03	3.94	1249	17.80	99.03	2.51	1852	17.92	198.06	3.07
				43	0.61	31.43	0.80	43	0.42	31.43	0.49
				258	3.68	102.90	2.61	258	2.50	102.90	1.59
43	1.29	8.61	0.34	172	2.45	19.80	0.50	215	2.08	28.41	0.44
3315		2513.61		7017		3949.29		10332		6858.81	
11.70		15.29		24.77		24.00		36.47		39.21	

3				3R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	1.69	236.81	14.12					43	0.48	236.81	3.80
1335	52.58	961.44	57.31	4004	62.42	3907.33	85.86	5339	59.63	4868.44	78.17
				43	0.67	23.25	0.51	43	0.48	23.25	0.37
43	1.69	55.97	3.34					43	0.48	55.97	0.90
43	1.69	55.97	3.34	43	0.67	23.25	0.51	86	0.96	79.22	1.27
559	22.02	293.21	17.48	1550	24.16	457.25	10.05	2109	23.55	750.46	12.05
559	22.02	293.21	17.48	1550	24.16	457.25	10.05	2109	23.55	750.46	12.05
430	16.93	109.36	6.52	517	8.05	148.97	3.27	947	10.58	258.33	4.15
129	5.08	20.67	1.23	301	4.69	13.78	0.30	430	4.80	34.45	0.55
2539		1677.46		6415		4550.58		8954		6227.71	
8.96		10.21		22.65		27.69		31.61		37.89	

TRANSECT TOTAL

#	%	mg	%
172	0.61	923.55	5.62
19503	68.85	12955.63	78.83
86	0.30	9.04	0.06
172	0.61	88.69	0.54
43	0.15	55.97	0.34
215	0.76	144.66	0.88
5382	19.00	1447.54	8.81
5382	19.00	1447.54	8.81
129	0.46	148.12	0.90
2066	7.29	706.97	4.30
774	2.73	99.89	0.61
28327		16435.40	

Transect: 75 ΔT
Sampling Date: August 3, 1973
Season: Summer

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea Oligochaeta Polychaeta		430	38.46	383.19	64.68	1765	64.06	858.54	65.61	2195	56.67	1241.73	65.32
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	129	11.54	98.16	16.57					129	3.33	98.16	5.16
		Isopoda: Chiridotea Cyathura												
		Total Crustacea	129	11.54	98.16	16.57					129	3.33	98.16	5.16
	Insecta:	Coleoptera												
		Collembola												
		Diptera	559	50.00	111.08	18.75	990	35.93	449.93	34.38	1549	40.00	561.01	29.51
		Trichoptera												
		Total Insecta	559	50.00	111.08	18.75	990	35.93	449.93	34.38	1549	40.00	561.01	29.51
Mollusca:	Gastropoda Pelecypoda													
Platyhelminthes:	Turbellaria													
	Sample Total		1118		592.43		2755		1308.47		3873		1900.90	
	% of Transect Total		4.19		6.90		10.32		15.24		14.51		22.14	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
775	60.03	628.19	81.46	947	16.41	5.91	0.53	1722	24.99	634.10	33.63
129	9.99	9.47	1.23	517	8.96	92.57	8.30	646	9.15	102.04	5.41
129	9.99	9.47	1.23	517	8.96	92.57	8.30	646	9.15	102.04	5.41
301	23.31	110.65	14.35	4306	74.63	1016.12	91.16	4607	65.24	1126.77	59.75
301	23.31	110.65	14.35	4306	74.63	1016.12	91.16	4607	65.24	1126.77	59.75
43	3.33	21,09	2.73					43	0.61	21.09	1.12
43	3.33	1.72	0.22					43	0.61	1.72	0.09
1291 4.84		771.12 8.98		5770 21.62		1114.60 12.98		7061 26.46		1885.72 21.97	

3				3 R				Total 3 and R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
732	17.17	557.57	41.75	947	8.24	781.89	22.59	1679	10.66	1339.46	27.92
2583	60.60	393.53	29.46	4951	43.07	675.98	1953	7534	47.82	1069.51	22.29
				43	0.37	22.39	0.65	43	0.27	22.39	0.47
2583	60.60	393.53	29.46	4994	43.44	698.37	20.18	7577	48.09	1091.90	22.76
646	15.16	368.99	27.63	4047	35.21	1487.15	42.96	4693	29.78	1856.14	38.69
				43	0.37	54.68	1.58	43	0.27	54.68	1.14
646	15.16	368.99	27.63	4090	35.58	1541.83	44.54	4736	30.05	1910.82	39.83
				43	0.37	82.23	2.37	43	0.27	82.23	1.71
43	1.01	6.03	0.45	301	2.62	288.04	8.32	344	2.18	294.07	6.13
258	6.05	9.47	0.71	1119	9.73	69.32	2.00	1377	8.74	78.79	1.64
4262		1335.59		11494		3461.68		15756		4797.27	
15.97		15.56		43.06		40.33		59.03		55.89	

		mg	
5596	20.97	3215.29	37.46
8309	31.13	1269.71	14.79
43	0.16	22.39	0.26
8352	31.29	1292.10	15.05
10849	40.65	3543.92	41.29
43	0.16	54.68	0.64
10892	40.81	3598.60	41.93
43	0.16	82.23	0.96
387	1.45	315.16	3.67
1420	5.32	80.51	0.94
26690		8583.89	

TRANSECT: South Control
SAMPLING DATE: October 4, 1973
SEASON: Fall

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		1507	47.32	559.30	-	1335	10.71	324.21	42.37	2842	50.79	883.51	-
Arthropoda:	Arachnidia		43	1.35	3.01	-					43	0.77	3.01	-
	Crustacea:	Amphipoda	215	6.75	37.89	-	258	10.71	7.32	0.95	473	8.45	45.21	-
		Isopoda: Chiridotea	43	1.35	21.09	-	172	7.14	393.96	51.49	215	3.84	415.05	-
		Cyathura												
		Total Crustacea	258	8.10	58.98	-	430	17.84	401.28	52.45	688	12.29	460.26	-
	Insecta:	Coleoptera												
		Collembola												
		Diptera	344	10.80	23.68	-	258	10.71	7.75	1.01	602	10.76	31.43	-
		Trichoptera	172	5.40	83.52	-	86	3.57	14.64	1.91	258	4.61	98.16	-
		Total Insecta	516	16.20	107.21	-	344	14.27	22.37	2.92	860	15.37	129.58	-
Mollusca:	Gastropoda Pelecypoda		258	8.10	20.67	-	215	8.92	8.61	1.12	474	8.47	29.28	-
Platyhelminthes:	Turbellaria		603	18.93	NB	-	86	3.57	8.61	1.12	689	12.31	-	-
	Sample Total		3185		-		2410		765.10		5596		-	
	% of Transect Total		25.78		-		19.51		-		45.29		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
258	24.98	117.11	-	1593	66.07	163.61	36.93	1851	53.75	280.72	-
43	4.16	286.75	-					43	1.25	286.75	-
86	8.66	1.29	-					86	2.50	1.29	-
43	4.16	26.69	-					43	1.25	26.69	
43	4.16	53.82	-	43	1.78	115.82	26.14	86	2.50	169.64	-
172	16.65	81.80	-	43	1.78	115.82	26.14	215	6.25	197.62	-
			-								-
388	37.56	101.18	-	646	26.79	43.49	9.82	1034		144.67	-
				43	1.78	26.26	5.93	43	1.25	26.26	-
388	37.56	101.18	-	689	28.58	69.75	15.74	1077	30.02	170.93	-
129	12.48	37.03	-	86	3.57	93.86	21.19	215	6.24	130.89	-
			-								
43	4.16	NB	-					43	1.25	-	-
1033		-		2411		443.04		3444		-	
8.36		-		19.51		-		27.88		-	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
215	19.21	21.96	11.02	1292	58.83	123.57	17.78	1507	45.46	145.53	16.27
43	3.84	1.29	0.65					43	1.30	1.29	0.14
172	15.37	20.24	10.15					172	5.19	20.24	2.26
86	7.69	43.06	21.60					86	2.59	43.06	4.82
258	23.06	53.30	31.75					301	7.78	64.59	7.22
474	42.36	95.58	47.95	689	31.38	522.27	75.16	1163	35.08	617.85	69.09
86	7.69	13.78	6.91	43	1.96	6.03	0.87	129	3.89	19.81	2.21
560	50.04	109.36	54.86	732	33.33	528.30	76.02	1292	38.97	637.66	71.31
43	3.84	3.44	1.73	86	3.92	34.87	5.02	129	3.89	38.31	4.28
				86	3.92	8.18	1.18	86	2.59	8.18	0.91
1119		199.35		2196		694.92		3315		894.27	
9.06		-		17.77		-		26.83		-	

Transect Total			
		mg	
6200	50.18	1309.75	-
43	0.35	286.75	-
86	0.70	4.3	-
731	5.92	66.74	-
43	0.35	26.69	-
387	3.13	627.75	-
1161	9.39	725.48	-
2799	22.65	793.95	-
430	3.48	144.24	-
3229	26.14	938.19	-
818	6.62	198.48	-
818	6.62	-	-
12355		-	

TRANSECT: 75ΔT
SAMPLING DATE: October 4, 1973
SEASON: Fall

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		1593	72.54	1109.12	86.16	732	51.55	347.03	66.34	2325	64.30	1456.15	80.40
Arthropoda:	Arachnidia		86	3.92	17.22	1.32					86	2.38	17.22	0.94
	Crustacea:	Amphipoda	43	1.96	9.47	0.69	129	9.08	31.43	5.92	172	4.76	40.90	2.26
		Isopoda: Chiridotea Cyathura												
		Total Crustacea	43	1.96	9.47	0.69	129	9.08	31.43	5.92	172	4.76	40.90	2.26
	Insecta:	Coleoptera					43	3.02	1.29	0.19	43	1.19	1.29	0.05
		Collembola												
		Diptera	388	17.67	129.17	10.02	301	21.19	126.58	24.09	689	19.05	255.75	14.14
		Trichoptera	86	3.92	22.82	1.70	86	6.05	8.61	1.52	172	4.76	31.43	1.71
		Total Insecta	474	21.58	151.99	11.72	430	30.26	136.48	25.80	904	25.00	288.47	15.90
Mollusca:	Gastropoda Pelecypoda													
Platyhelminthes:	Turbellaria						129	9.08	8.61	1.52	129	3.57	8.61	0.50
		Sample Total	2196		1287.80		1420		523.55		3613		1811.35	
		% of Transect Total	12.59		9.92		8.14		4.04		20.73		13.95	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1206	46.50	211.40	43.69	1076	53.19	579.10	67.80	2282	49.44	790.50	59.21
129	4.97	19.37	1.86					129	2.79	19.37	1.42
431	16.62	23.68	4.97					431	9.34	23.68	1.80
431	16.62	23.68	4.97					431	9.34	23.68	1.80
517	19.94	41.33	8.49	646	31.93	155.00	18.15	1163	25.19	196.33	14.67
9	0.34	39.61	8.28	86	4.10	102.47	11.96	95	2.06	142.08	10.63
526	20.28	80.94	16.77	732	36.03	257.47	30.11	1258	27.25	338.41	25.30
43	1.66	98.17	20.29					43	0.93	98.17	7.34
86	3.32	14.21	2.90	129	6.38	9.90	1.17	215	4.66	24.11	1.80
172	663	34.87	7.25	86	4.10	7.32	0.82	258	5.59	42.19	3.14
2593		482.64		2023		853.79		4616		1336.43	
14.86		3.72		11.60		6.58		26.46		10.29	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3574	69.76	7462.03	96.05	1421	34.74	620.87	30.06	4995	54.22	8082.90	82.18
732	14.29	80.51	1.04	732	17.90	54.25	2.61	1464	15.89	134.76	1.37
732	14.29	80.51	1.04	732	17.90	54.25	2.61	1464	15.89	134.76	1.37
344	6.71	208.39	2.68	1076	26.31	666.51	3228	1420	15.41	874.90	8.90
344	6.71	208.39	2.68	1076	26.31	666.51	3228	1420	15.41	874.90	8.90
43	0.84	0.86	0.01					43	0.47	.86	0.00
86	1.68	2.15	0.02	517	12.64	709.13	34.32	603	6.55	711.28	7.23
344	6.71	15.50	0.07	344	8.41	15.50	0.77	688	7.47	31.00	0.32
5123		7769.44		4090		2066.26		9213		9835.70	
29.37		59.84		23.45		15.91		52.81		75.76	

9602	55.04	10329.55	79.57
215	1.23	36.59	0.28
2067	11.85	199.34	1.53
2067	11.85	199.34	1.53
43	0.25	1.29	0.00
3272	18.76	132.98	10.22
267	1.53	173.51	1.34
3582	20.54	1501.78	11.56
86	0.50	99.03	0.76
818	4.69	735.39	5.66
1075	6.16	81.80	0.63
17445		12983.48	

Transect: Maximum ΔT
Sampling Date: October 4, 1973
Season: Fall

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea Oligochaeta Polychaeta		1593	58.74	232.93	26.40	1292	57.70	632.49	53.89	2885	58.27	865.42	42.09
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	86	3.17	25.83	2.93	86	3.84	32.29	2.75	172	3.47	58.12	2.83
		Isopoda: Chiridotea	86	3.17	110.65	12.54					86	1.74	110.65	5.38
		Cyathura	172	6.34	136.48	15.47	86	3.84	32.29	2.75	258	5.21	168.77	8.21
		Total Crustacea												
	Insecta:	Coleoptera												
		Collembola	603	22.23	457.25	51.83	732	32.70	448.64	38.25	1335	26.96	905.89	4406
		Diptera	86	3.17	34.01	3.86					86	1.74	34.01	1.65
		Trichoptera												
		Total Insecta	689	25.41	491.26	55.69	732	32.70	448.64	38.25	1421	28.70	939.90	45.72
Mollusca:	Gastropoda													
	Pelecypoda		43	1.59	0.86	0.09	43	1.92	55.97	4.77	86	1.74	56.83	2.76
Platyhelminthes:	Turbellaria		215	7.93	20.67	2.34	86	3.84	4.30	0.37	301	6.08	24.97	1.21
	Sample Total		2712		882.20		2239		1173.69		4951		2055.89	
	% of Transect Total		18.64		18.31		15.39		24.37		34.03		42.68	

SAMPLING DEPTHS

Numbers of organisms and weigh- in mg are values calculated for sample areas of $1m^2$.

$_2$				$_2R$				Total $_2$ and $_2R$			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	1.43	11.62	0.86					43	0.81	11.62	0.58
1464	48.57	995.45	73.40	1033	45.29	303.97	48.03	2497	47.16	1299.42	65.33
388	12.87	63.29	4.67	47.4	20.78	140.36	22.18	862	16.28	203.65	10.24
43	1.43	37.88	2.79					43	0.81	37.88	1.90
431	14.30	101.17	7.46	474	20.78	140.36	22.18	905	17.09	241.53	12.14
86	2.85	14.64	1.08	215	9.43	44.35	7.01	301	5.68	58.99	2.97
43	1.43	689	0.51	43	1.89	50.81	8.03	86	1.62	57.70	2.90
129	4.28	21.53	1.59	258	11.31	95.16	15.04	387	7.31	116.69	5.87
43	1.43	9.90	0.73					43	0.81	9.90	0.50
861	28.57	215.28	15.87	301	13.20	36.17	5.71	1162	21.95	251.45	12.64
43	1.43	1.29	0.09	215	9.43	57.26	9.05	258	4.87	58.55	2.94
3014		1356.24		2281		632.92		5295		1989.16	
20.71		28.16		15.68		13.14		36.39		41.29	

3				3.R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	1.61	214.42	50.92					43	0.99	214.42	27.77
2067	77.44	139.07	33.03	818	50.03	145.09	41.35	2885	67.03	284.16	36.81
172	6.44	6.03		301	18.41	20.67	5.89	473	10.99	26.70	3.46
				86	5.26	99.03	28.22	86	1.20	99.03	12.83
172	6.44	6.03	1.43	387	23.67	119.70	34.11	559	12.99	125.73	16.29
43	1.61	14.21	3.37	86	5.26	6.03	1.72	129	2.99	20.24	2.62
43	1.61	14.21	3.37	86	5.26	6.03	1.72	129	2.99	20.24	2.62
172	6.44	40.47	9.61	258	15.78	78.79	22.45	430	9.99	119.26	15.45
172	6.44	6.89	1.64	86	5.26	1.29	0.37	258	5.99	8.18	1.06
2669		421.09		1635		350.90		4304		771.99	
18.34		8.74		11.24		7.28		29.58		16.03	

TRANSECT TOTAL

#	%	mg	%
86	0.59	226.04	4.69
8267	56.82	2449.00	50.84
1507	10.36	288.47	5.99
86	0.59	99.03	2.05
129	0.89	148.53	3.08
1722	11.84	536.03	11.13
1765	12.13	985.12	20.45
172	1.18	91.71	1.90
1937	13.31	1076.83	22.35
43	0.30	9.90	0.21
1678	11.53	427.54	8.88
817	5.62	91.70	1.90
14550		4817.04	

TRANSECT: North Control
SAMPLING DATE: October 4, 1973
SEASON: Fall

Organisms Collected			1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida:	Hirudinea Oligochaeta Polychaeta		431	50.05	55.97	30.11	1076	42.36	187.29	25.94	1507	44.31	243.26	26.79
Arthropoda:	Arachnidia						43	2.79	14.21	1.94	43	1.26	14.21	1.54
	Crustacea:	Amphipoda	172	19.98	96.44	51.61	43	2.79	0.43	5.96	215	6.32	96.87	10.69
		Isopoda: Chiridotea	43	4.99	6.46	3.23					43	1.26	6.46	0.66
		Cyathura												
		Total Crustacea	215	24.97	102.90	54.84	43	2.79	43	5.96	258	7.58	103.33	11.35
	Insecta:	Coleoptera												
		Collembola												
		Diptera	172	19.98	17.22	9.14	775	30.51	291.49	40.36	947	27.84	308.71	34.07
		Trichoptera					43	2.79	52.96	7.35	43	1.26	52.96	5.84
		Total Insecta	172	19.98	17.22	9.14	818	33.30	344.45	47.71	990	29.10	361.67	39.91
Mollusca:	Gastropoda Pelecypoda		43	4.99	9.47	4.84	560	22.05	17481	24.27	603	17.73	184.28	20.29
Platyhelminthes:	Turbellaria													
	Sample Total		861		185.56		2540		721.19		3401		906.75	
	% of Transect Total		5.73		2.72		16.91		10.56		22.64		13.28	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculate for Sample Areas of $1m^2$.

2				2R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
43	2.63	199.78	14.64					43	1.05	199.78	9.30
904	55.29	947.23	69.33	1808	73.71	663.49	84.46	2712	66.34	1610.72	74.90
172	10.52	17.65	1.32	129	5.26	8.18	1.02	301	7.36	25.83	1.21
172	10.52	17.65	1.32	129	5.26	8.18	1.02	301	7.36	25.83	1.21
258	15.78	86.54	6.37	258	10.52	97.74	12.48	516	12.62	184.28	8.55
258	15.78	86.54	6.37	258	10.52	97.74	12.48	516	12.62	184.28	8.55
172	10.52	109.36	7.98	172	7.01	15.50	2.04	344	8.41	124.86	5.81
86	5.26	5.59	0.44	86	3.51	0.43	0.05	172	4.21	6.02	0.28
1635		1366.15		2453		785.34		4088		2151.49	
10.88		20.01		16.33		11.50		27.21		31.51	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
				172	4.39	731.95	32.15	172	2.30	731.95	19.42
2583	71.43	1244.75	83.39	2928	74.75	1440.22	63.24	5511	73.16	2684.97	71.22
517	14.30	50.37	3.35	301	7.68	1.72	0.08	818	10.86	52.09	1.38
517	14.30	50.37	3.35	301	7.68	1.72	0.08	818	10.86	52.09	1.38
301	8.32	176.96	11.86	258	6.59	78.36	3.43	559	7.42	255.32	6.76
301	8.32	176.96	11.86	258	6.59	78.36	3.43	559	7.42	255.32	6.76
43	1.19	19.37	1.27	43	1.10	5.17	0.22	86	1.14	24.54	0.66
172	4.76	1.29	0.07	215	5.49	19.80	0.88	387	5.14	21.09	0.56
3616		1492.74		3917		2277.22		7533		3769.96	
24.07		21.86		26.08		33.35		50.15		55.21	

Transect Total

#	%	mg	%
215	1.43	931.73	13.65
9730	64.77	4538.95	66.48
43	0.29	14.21	0.21
1334	8.88	174.79	2.56
43	0.29	6.46	0.09
1377	9.17	181.25	2.65
2022	13.46	748:31	10.95
43	0.29	52.96	0.78
2065	13.75	801.27	11.73
1033	6.88	333.68	4.89
559	3.72	27.11	0.40
15022		6828.20	

TRANSECT: Maximum ΔT

SAMPLING DATE: December 3, 1973

SEASON: WINTER

Organisms Collected			1				1R				Total 1 and 1R			
			#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida:	Hirudinea		43	2.56	16.36	1.94					43	0.97	16.36	0.54
	Oligochaeta		818	48.75	117.54	13.94	1550	56.26	607.09	28.05	2368	53.42	724.63	24.09
	Polychaeta													
Arthropoda:	Arachnidia		43	2.56	5.59	0.66					43	0.97	5.59	.19
	Crustacea:	Amphipoda	215	12.81	144.67	17.15	129	4.68	40.90	1.89	344	7.76	185.57	6.17
		Isopoda: Chiridotea												
		Cyathura	86	5.13	207.09	24.55	172	6.24	901.59	41.67	258	5.82	1108.68	36.86
		Total Crustacea	301	17.94	351.76	41.70	301	10.93	942.49	43.54	602	13.58	1294.25	43.03
	Insecta:	Coleoptera												
		Collembola												
		Diptera	301	17.94	197.19	23.38	689	25.01	612.26	28.29	990	22.33	809.45	26.91
		Trichoptera	43	2.56	70.18	8.32					43	0.97	70.18	2.33
		Total Insecta	344	20.50	267.37	31.70	689	25.01	612.26	28.29	1033	23.30	879.63	29.24
Mollusca:	Gastropoda													
	Pelecypoda		43	2.56	41.76	4.95					43	0.97	41.76	1.39
Platyhelminthes:	Turbellaria		86	5.13	43.06	5.11	215	7.80	2.58	0.11	301	6.79	45.64	1.52
	Sample Total		1678		843.44		2755		2164.42		4433		3007.86	
	% of Transect Total		9.53		-		15.65		-		25.18		-	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1163	50.99	767.26	56.93	1593	62.72	1065.64	79.38	2756	57.17	1832.90	68.13
38.7	6.97	166.63	12.41	431	16.97	179.97	13.41	818	16.97	346.60	12.88
38.7	6.97	166.63	12.41	431	16.97	179.97	13.41	818	16.97	346.60	12.88
258	11.31	240.25	17.82	215	8.46	56.83	4.24	473	9.81	297.08	11.04
258	11.31	240.25	17.82	215	8.46	56.83	4.24	473	9.81	297.08	11.04
301	13.20	91.71	6.80	172	6.77	15.06	1.12	473	9.81	106.77	3.97
172	7.54	81.81	6.07	129	5.08	24.97	1.86	301	6.24	106.78	3.97
2281 12.96		1347.66 -		2540 14.43		1342.47 -		4821 27.38		2690.13 -	

3				3_R				Total 3 and 3_R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
775	22.79	424.10	-	689	13.92	359.08	-	1464	17.53	783.18	-
43	1.26	NB	-					43	0.51	-	-
1894	55.71	1170.69	-	3746	75.66	2487.34	-	5640	67.54	3658.03	-
43	1.26	299.24	-					43	0.51	299.24	-
				86	1.74	310.00	-	86	1.03	310.00	-
1937	56.97	1469.93	-	3832	77.40	2797.34	-	57.69	69.08	4267.27	-
301	8.8	410.75	-	172	3.47	153.27	-	473	5.66	564.02	-
43	1.26	NB	-	129	2.61	NB	-	172	2.06	-	-
344	10.12	-	-	301	6.08	-	-	645	7.72	-	-
215	6.32	30.56	-	86	1.74	NB	-	301	3.60	-	-
86	2.52	18.08	-	43	0.87	21.53	-	129	1.54	39.61	-
3400		-		4951		-		8351		-	
19.31		-		28.12		-		47.44		-	

Transect Total			
#	%	mg	%
43	0.24	16.36	-
6588	37.42	3340.71	-
43	0.24	-	-
43	0.24	5.59	-
6802	38.63	4190.2	-
43	0.24	299.24	-
344	1.95	1418.68	-
7189	40.83	5908.12	-
1936	10.99	1607.55	-
215	1.22	-	-
2151	12.21	-	-
817	4.64	-	-
731	4.15	192.03	-
17605		-	

Transect: South Control
Sampling Date: December 3, 1973
Season: Winter

Organisms Collected	1 #	1 %	1 mg	1 %	1R #	1R %	1R mg	1R %	Total 1 and 1R #	Total 1 and 1R %	Total 1 and 1R mg	Total 1 and 1R %
Annelida: Hirudinea, Oligochaeta, Polychaeta	1636	79.15	189.45	71.78	2239	43.70	893.41	31.94	3875	53.89	1082.86	35.37
Arthropoda: Arachnidia												
Crustacea: Amphipoda												
Isopoda: Chiridotea Cyathura					86	1.68	895.99	32.03	86	1.19	895.99	29.27
Total Crustacea					86	1.68	895.99	32.03	86	1.19	895.99	29.27
Insecta: Coleoptera												
Collembola												
Diptera	388	18.77	73.19	27.73	2282	4454	570.06	20.38	2670	37.13	643.25	21.01
Trichoptera					172	3.36	156.29	5.59	172	2.39	156.29	5.10
Total Insecta	388		73.19		2454	4790	626.35	25.97	28.42	39.52	799.54	26.11
Mollusca: Gastropoda, Pelecypoda	43	2.08	1.29	0.49	129	2.52	94.72	3.39	172	2.39	96.01	3.14
Platyhelminthes: Turbellaria					215	4.19	186.86	6.68	215	2.99	186.86	6.10
Sample Total	2067		263.93		5123		2797.33		7190		3061.26	
% of Transect Total	10.89		---		26.98		---		37.87		---	

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1464	45.95	289.34	8.33	861	42.56	229.92	---	2325	44.63	519.26	---
603	18.93	1015.26	29.25	43	2.12	NB	---	646	12.40	---	---
301	9.45	1977.99	56.98	86	4.25	396.98	---	387	7.43	2374.97	---
904	28.37	2993.25	86.23	129	6.38	396.98	---	1033	19.83	3390.23	---
388	12.18	69.75	2.01	904	44.68	316.89	---	1292	24.80	386.64	---
388	12.18	69.75	2.01	904	44.68	316.89	---	1292	24.80	386.64	---
129	4.05	1.72	0.04	86	4.25	3.87	---	215	4.13	5.59	---
301	9.45	91.28	2.63	43	2.12	19.37	---	344	6.60	110.65	---
3186		3471.08		2023		---		5209		---	
16.78		---		10.66		---		27.44		---	

3				3.R				Total 3 and 3.R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
344	15.37	35.74	1.69	344	7.91	25.83	0.93	688	10.45	61.57	1.26
1421	63.49	1426.01	67.34	2928	67.34	1643.45	5926	4349	66.03	3069.46	62.76
				43	0.98	244.13	8.80	43	0.65	244.13	4.99
215	9.61	601.06	28.38	258	5.93	781.47	28.18	473	7.18	1382.53	28.27
1636	73.10	2027.07	95.73	3229	74.26	2669.05	96.24	4865	73.86	4696.12	96.02
129	5.76	43.05	2.03	732	16.83	77.93	2.81	861	13.07	120.98	2.47
				43	0.98	0.43	0.01	43	0.65	0.43	0.00
129	5.76	43.05	2.03	775	17.81	78.36	2.82	904	13.72	121.41	2.47
129	5.76	11.62	0.55					129	1.96	11.62	0.24
2238		2117.48		4348		2773.24		6586		4890.72	
11,79		---		22.90		---		34.69		---	

TRANSECT TOTAL

#	%	mg	%
6888	36.28	1663.69	---
4995	26.31	---	---
43	0.23	244.13	---
946	4.98	4653.49	---
5984	31.52	---	---
4823	25.40	1150.87	---
215	1.13	156.72	---
5038	26.53	1307.59	---
387	2.04	101.60	---
688	3.62	309.13	---
18985		---	

Transect: North Control
Sampling Date: December 3, 1973
Season: Winter

Organisms Collected	1				1 R				Total 1 and 1 R			
	#	%	mg	%	#	%	mg	%	#	%	mg	%
Annelida: Hirudinea Oligochaeta Polychaeta	344	100	31.86	100	172	100	10.33	100	516	100	42.19	100
Arthropoda: Arachnidia												
Crustacea: Amphipoda												
Isopoda: Chiridotea												
Cyathura												
Total Crustacea												
Insecta: Coleoptera												
Collembola												
Diptera												
Trichoptera												
Total Insecta												
Mollusca: Gastropoda												
Pelecypoda												
Platyhelminthes: Turbellaria												
Sample Total	344		31.86		172		10.33		516		42.19	
% of Transect Total	3.41				1.71				5.12			

SAMPLING DEPTHS

Numbers of organisms and weight in mg are values calculated for sample areas of $1m^2$.

2				2 R				Total 2 and 2R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1249	70.72	700.52	57.39	1765	59.43	992.87	---	3014	63.64	1693.39	---
				43	1.45	NB	---	43	1.0	---	---
				172	5.79	83.53	---	172	3.63	83.53	---
				172	5.79	83.53	---	172	3.63	83.53	---
431	24.40	493.42	40.42	904	30.44	1115.15	---	1335	28.19	1608.57	---
86	4.87	26.69	2.19					86	1.82	26.69	---
517	29.27	520.11	42.60	904	30.44	1115.15	---	1421	30.00	1635.26	---
				43	1.45	27.99	---	43	1.0	27.99	---
				43	1.45	NB	---	43	1.0	---	---
1766		1220.63		2970		---		4736		---	
17.53				29.48		---		47.01		---	

3				3 R				Total 3 and 3R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
3703	81.13	3677.84	80.21	215	83.33	68.03	98.14	3918	81.25	3745.87	80.47
689	15.09	888.24	19.37	0	0			689	14.28	888.24	19.08
689	15.09	888.24	19.37	0	0			689	14.28	888.24	19.08
172	3.77	19.37	0.42	43	16.66	1.29	1.86	215	4.46	20.66	0.44
4564 45.30		4585.45 ---		258 2.56		69.32 ---		4822 47.87		4654.77 ---	

TRANSECT TOTAL			
#	%	mg	%
7448	73.93	5481.45	---
43	0.43	---	---
172	1.70	83.53	---
172	1.70	83.53	---
2024	20.09	2496.81	---
86	0.85	26.69	---
2110	20.95	2523.50	---
43	0.43	27.99	---
258	2.56	---	---
10074		---	

TRANSECT: 75 ΔT
SAMPLING DATE: December 3, 1973
SEASON: Winter

Organisms Collected			1 #	1 %	1 mg	1 %	1 R #	1 R %	1 R mg	1 R %	Total 1 and 1 R #	Total 1 and 1 R %	Total 1 and 1 R mg	Total 1 and 1 R %
Annelida:	Hirudinea		43	1.61	12.49	0.91					43	1.04	12.49	0.42
	Oligochaeta		1981	73.0	823.66	60.24	861	48.82	738.41	50.41	2842	63.51	1562.07	55.10
	Polychaeta													
Arthropoda:	Arachnidia													
	Crustacea:	Amphipoda	129	4.70	99.89	7.31					129	2.90	99.89	3.52
		Isopoda: Chiridotea												
		Cyathura												
		Total Crustacea	129	4.70	99.89	7.31					129	2.90	99.89	3.52
	Insecta:	Coleoptera												
		Collembola												
		Diptera	431	15.92	382.34	28.03	861	48.82	703.52	48.0	1292	28.81	1085.87	38.34
		Trichoptera												
		Total Insecta	431	15.92	382.34	20.03	861	48.82	703.52	48.0	1292	28.81	1085.87	38.34
Mollusca:	Gastropoda													
	Pelecypoda		43	1.61	21.53	1.61					43	1.02	21.53	0.73
Platyhelminthes:	Turbellaria		86	3.17	27.55	2.03	43	2.41	23.25	1.63	129	2.80	50.80	1.81
	Sample Total		2713		1367.46		1765		1465.19		4478		2832.65	
	% of Transect Total		16.12		10.91		10.53		11.73		26.61		22.51	

Sampling Depths

Numbers of Organisms and Weight in mg are values calculated for sample of $1m^2$.

$_2$				$_2R$				Total $_2$ and $_2R$			
#	%	mg	%	#	%	mg	%	#	%	mg	%
1378	72.80	1532.36	84.01	1894	73.31	2008.56	65.51	3272	73.12	3540.92	72.44
301	15.91	233.36	12.83	258	10.01	167.06	5.42	559	12.51	400.42	8.21
301	15.91	233.36	12.83	258	10.01	167.06	5.42	559	12.51	400.42	8.21
129	6.83	41.76	2.30	387	15.03	877.48	28.61	516	11.52	919.24	18.84
129	6.83	41.76	2.30	387	15.03	877.48	28.61	516	11.52	919.24	18.84
86	4.52	17.22	0.93	43	1.62	11.62	0.32	129	2.94	28.84	0.52
1894 11.34		1824.70 14.52		2582 15.34		3064.72 24.47		4476 26.59		4889.42 38.90	

3				3 R				Total 3 and 3 R			
#	%	mg	%	#	%	mg	%	#	%	mg	%
86	1.93	491.27	15.08					86	1.12	491.27	10.14
2885	65.76	1814.81	55.52	1679	48.12	827.10	52.39	4564	57.92	2641.91	54.19
689	15.69	271.68	8.34	775	22.20	326.36	20.67	1464	18.66	598.04	12.21
				43	1.21	3.20	0.20	43	0.51	3.2	0.10
689	15.69	271.68	8.34	818	23.41	329.56	20.88	1507	19.17	601.24	12.31
517	11.77	651.44	19.91	517	14.89	263.50	16.69	1034	13.11	914.94	18.74
517	11.77	651.44	19.91	517	14.89	263.50	16.69	1034	13.11	914.94	18.74
43	0.98	28.85	0.83	129	3.64	79.65	5.05	172	2.26	108.50	2.29
172	3.91	11.19	0.30	344	9.91	78.79	4.99	516	6.50	89.98	1.88
4392		3269.24		3487		1578.60		7879		4847.84	
26.09		26.01		20.72		12.55		46.80		38.57	

Transect Total			
#	%	mg	%
129	0.77	503.76	4.01
10678	63.43	7744.90	61.61
2152	12.78	1098.35	8.76
43	0.26	3.2	0.02
2195	13.04	1101.55	8.78
2842	16.88	2920.05	23.23
2842	16.88	2920.05	23.23
215	1.27	130.03	1.03
774	4.59	169.62	1.35
16833		12569.91	

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

1973

HUDSON RIVER AQUATIC ECOLOGY STUDIES AT ROSETON AND DANSKAMMER POINT

VOLUME IV

HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

CHAPTER VII

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TABLE OF CONTENTS

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME IV

TABLE OF CONTENTS

CHAPTER VII

VII. HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

A. Introduction... ... ...VII-1
1. General Description of the River Basin... 1
2. Hydrodynamics of the Estuary... 2
(a) Tidal Characteristics 2
(b) Salinity Intrusion... 4
(c) Channel Geometry 5
(d) Freshwater Flow. 6
3. Previous Studies of Hudson River Water Quality 7
4. Environmental Significance of Water Quality Parameters.. 12
(a) General 12
(b) Relevant Water Quality Parameters... 12
(c) Hudson River Classification and Water Quality Standards.. 14

B. Methods and Procedures... 15
1. General 15
2. Field Collection Procedures 16
3. Laboratory Analytical Procedures 17

C. Results and Discussion... 18
1. Flow and Salinity 19
2. Temperature Distribution.. 22
3. Dissolved Oxygen 22
4. Chemical Parameters.. 22
(a) General 22
(b) Selected Data Presentations 23
(i) Station Averaged Values.. 23
(ii) Depth Averaged Values 26
(c) Statistics and Correlations 27
(d) Analysis of Variance. 35
5. Sediment Characteristics.. 38

D. Conclusions 42

References Cited 48

LIST OF FIGURES

VOLUME IV

LIST OF FIGURES

Figure No.		Preceding Page No.
	CHAPTER VII	
VII-1	The Hudson River - An Estuary	VII-1
VII-2	Hudson River Tidal Characteristics	VII-3
VII-3	Hudson River Tidal Flow and Velocity	VII-3
VII-4	Hudson River Effect of Freshwater Flow on Equilibrium Length of Mean Salinity Intrusion	VII-4
VII-5	Hudson River Generalized Mean Salinity Profiles Steady-State Conditions	VII-4
VII-6	Hudson River Channel Physical Characteristics	VII-5
VII-7	Lower Hudson River Long Term Monthly Average Fresh Water Flows	VII-6
VII-8	Hudson River Flow at Green Island	VII-7
VII-9	Hudson River Water Quality-USEPA 1973 Sodium and Magnesium Data	VII-10
VII-10	Hudson River Water Quality-USEPA 1973 Sulfate and Chloride Data	VII-10
VII-11	Hudson River Water Quality-USEPA 1973 Calcium and Potassium Data	VII-10
VII-12	Hudson River Water Quality-USEPA 1973 Fluoride and MBAS Data	VII-11
VII-13	Hudson River Water Quality-USEPA 1973 Orthophosphate and Total Phosphate Data	VII-11
VII-14	Hudson River Water Quality-USEPA 1973 Ammonia, Nitrate and Total Kjeldahl Nitrogen Data	VII-11
VII-15	Hudson River Water Quality-NYSDEC 1968-1970 and USEPA 1973 COD and DO Data	VII-11
VII-16	Hudson River Water Quality-NYSDEC 1971-72 USEPA 1970-72 Copper, Lead and Mercury Data	VII-11

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER VII (Continued)	Preceding Page No
VII-17	Hudson River Water Quality-NYSDEC, 1967-70, 1971-72 and USEPA 1970-72, 1973 Total Suspended Solids Data	VII-12
VII-18	Hudson River Water Quality USEPA 1970-72, 1973 Silica Data	VII-12
VII-19	Water Quality and Sediment Sampling Stations	VII-16
VII-20	Hudson River Flow at Green Island - 1973	VII-19
VII-21	Hudson River Weekly Average Flow - 1973	VII-19
VII-22	Hudson River Weekly Location of Salt Front - 1973	VII-19
VII-23	Hudson River Generalized Mean Salinity Profiles Steady-State Conditions	VII-20
VII-24	Central Hudson Gas & Electric Chloride Concentration at Danskammer - 1973	VII-21
VII-25	Hudson River Temperature - 1973	VII-22
VII-26	Hudson River Dissolved Oxygen - 1973	VII-22
VII-27	Huson River Water Quality M.P. 62.7 to 68.2 Chloride, Sulfate, and Total Dissolved Solids	VII-23
VII-28	Hudson River Water Quality M.P. 62.7 to 68.2 Total Solids, Total Volatiles, and Total Suspended Solids	VII-23
VII-29	Hudson River Water Quality M.P. 62.7 to 68.2 BOD and COD	VII-23
VII-30	Hudson River Water Quality M.P. 62.7 to 68.2 Ammonia and Total Kjeldahl Nitrogen	VII-23
VII-31	Hudson River Water Quality M.P. 62.7 to 68.2 Total Phosphorus and Nitrate-N	VII-23
VII-32	Hudson River Water Quality M.P. 62.7 to 68.2 Zinc, Chromium, and Phenol	VII-23

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER VII (Continued)	Preceding Page No
VII-33	Hudson River Water Quality M.P. 62.7 to 68.2 pH and Alkalinity	VII-23
VII-34	Central Hudson Gas & Electric Corporation Ammonia and Silica at Danskammer Point Intake 1973	VII-23
VII-35	Central Hudson Gas & Electric Corporation Total Hardness at Danskammer Point Intake - 1973	VII-23
VII-36	Central Hudson Gas & Electric Corporation Turbidity and Alkalinity at Danskammer Point Intake - 1973	VII-23
VII-37	Hudson River Water Quality M.P. 62.7 to 68.2 Ammonia Nitrogen at Various Depths	VII-26
VII-38	Hudson River Water Quality M.P. 62.7 to 68.2 Total Suspended Solids at Various Depths	VII-26
VII-39	Hudson River Water Quality M.P. 62.7 to 68.2 Chromium at Various Depths	VII-26
VII-40	Hudson River Water Quality M.P. 62.7 to 68.2 Zinc at Various Depths	VII-26
VII-41	Sediment Chemical Characteristics COD and TVS	VII-41
VII-42	Sediment Chemical Characteristics TKN and TP	VII-41
VII-43	Sediment Chemical Characteristics Cu and Cd	VII-41
VII-44	Sediment Chemical Characteristics Zn and Pb	VII-41

LIST OF TABLES

LIST OF TABLES

Table No.	CHAPTER VII	Preceding Page No
VII-1	Selected Water Quality Concentrations Representative of the Freshwater Portion of the Hudson River Estuary	VII-12
VII-2	Guidelines and Regulations for Effluent Parameters from Steam Electric Power Plants	VII-13
VII-3	Mean Composition of River Waters in North America	VII-13
VII-4	Summary of Trace Elements in Waters of the United States	VII-13
VII-5	Elements Present in Solution in Sea Water Excluding Dissolved Gases	VII-13
VII-6	Proposed EPA Water Quality Criteria Relevant to Steam Electric Power Plants	VII-13
VII-7	New York State Water Quality Criteria, Class A and Class B Waters	VII-15
VII-8	Water Quality Sampling Stations: 1973 Roseton/Danskammer Point Vicinity	VII-15
VII-9	Water Quality Analyses	VII-15
VII-10	Categories of Water Quality Statistical Analyses	VII-27
VII-11	Comparison of Water Quality Results with Background Values	VII-27
VII-12	Comparison of Water Quality Results by Depth	VII-27
VII-13	Comparison of North and South Control Stations	VII-27
VII-14	Comparison of 1973 Hudson River Water Quality By Mile Point	VII-27
VII-15	Correlation Coefficients During Salt Intrusion	VII-33

LIST OF TABLES
(Continued)

Table No.	CHAPTER VII (Continued)	Preceding Page No
VII-16	Correlation Coefficients Category 3 (Table VII-10)	VII-33
VII-17	Correlation Coefficients Category 2 (Table VII-10)	VII-33
VII-18	Analysis of Variance 1973 Roseton/Danskammer Point Water Quality Investigations	VII-35
VII-19	Results of ANOVA Set 1	VII-35
VII-20	Results of ANOVA Set 2	VII-35
VII-21	Results of ANOVA Set 1: Homogeneous Subsets for Depth Difference	VII-37
VII-22	Results of ANOVA Set 2: Homogeneous Subsets for Station Differences	VII-37
VII-23	Sediment Characterization Transect: North Control	VII-38
VII-24	Sediment Characterization Transect: Wappinger Creek	VII-38
VII-25	Sediment Characterization Transect: Danskammer Cove	VII-38
VII-26	Sediment Characterization Transect: Danskammer Discharge	VII-38
VII-27	Sediment Characterization Transect: Maximum ΔT	VII-38
VII-28	Sediment Characterization Transect: 75 ΔT	VII-38
VII-29	Sediment Characterization Transect: Intermediate	VII-38
VII-30	Sediment Characterization Transect: South Control	VII-40
VII-31	Sediment Characterization Summary: All Depths	VII-40

LIST OF TABLES
(Continued)

Table No.	CHAPTER VII (Continued)	Preceding Page No.
VII-32	Sediment Characterization Summary: All Stations	VII-40
VII-33	Hudson River Sediment Characterization	VII-41
VII-34	Sediment Chemical Analysis	VII-41

CHAPTER VII

VII. HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

A. INTRODUCTION

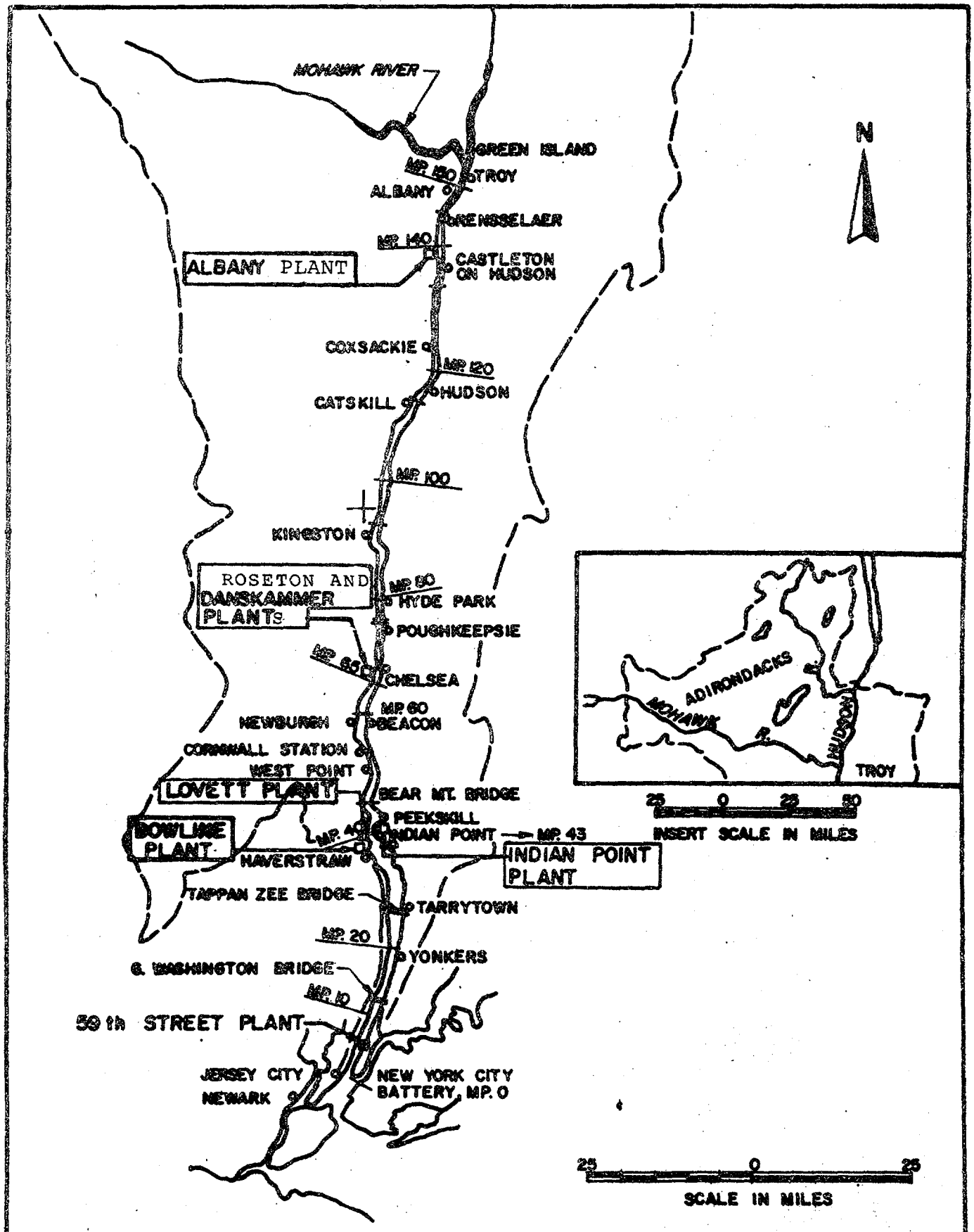
1. General Description of the River Basin

The Hudson River basin is located in the eastern part of New York State, with a drainage area of about 12,700 square miles (Figure VII-1). The Hudson River has Henderson Lake as its source in the Adirondack Mountains in Northern New York State and flows generally south for 315 river miles to the Battery, discharging into Upper New York Bay. The major physiographic features of the Hudson River basin are a mountainous terrain covering 48% of the basin, cultivated lands covering 42%, lakes and waterbodies covering 2%, and urban developments covering 8% of the basin.

The Lower Hudson River, from the Troy Dam to the New York Bight is more properly termed the Hudson River estuary. Technically speaking, an estuary has been defined by Pritchard (1967) as a "semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage." This definition is often expanded to establish the upper limit of an estuary as the area in which tidal movements of the waterbody, due to the connected sea, are no longer measurable.

Thus, the Hudson River estuary extends from the Battery (mile point 0.0)

FIGURE XII-1



THE HUDSON RIVER – AN ESTUARY

in a generally northern direction for some 154 river miles (see Figure VII-1). The Federal Dam in Troy (mile point 153.7) represents a barrier against the tidal effects advancing further upstream in the river and thus creates a man-made head for the estuary.

The Roseton and Danskammer Point Generating Stations, the subject of the studies described herein, are located approximately at mile points 66 and 67, respectively, on the upstream portion of Newburgh Bay, on the west shore of the Hudson River. Other power plants are located at mile points 140 (Albany), 37 (Bowline), 42 (Lovett) and 43 (Indian Point).

2. Hydrodynamics of the Estuary

The definition of an estuary implies the non-steady state nature of the system. Hydrodynamics of estuaries are determined primarily by the interaction of regular, periodic tides from the ocean, channel morphometry the periodic and random influx of fresh water.

(a) Tidal Characteristics. The tidal behavior of the estuary is classified as that of a dampened, reflected tidal wave regimen. Dampening occurs by dissipation of tidal energy via channel friction as the oceanic tidal wave progresses upstream. Reflection includes secondary wave propagations caused by channel obstructions. Complete reflection occurs at the Federal Dam at Troy. Additional wave reflections occur due to significant changes in channel width.

As width increases, wave amplitude tends to decrease, whereas a decrease in channel width causes an increase in wave amplitudes. Tidal

behavior at any section is the composite effect of ocean tide, channel friction, and wave reflection. The primary ocean tides are also variable, with maximum amplitudes occurring during spring tide and minimum amplitudes during neap tide. Variations in freshwater discharge and barometric conditions also contribute to changes in amplitude.

Figure VII-2 illustrates the principal tidal characteristics along the stretch of river between the ocean entrance and Troy. Mean high and low water (referenced to mean low water at Sandy Hook New Jersey) are also shown. The half-tide level indicates the average slope in the river. The total drop from Troy to the sea is about 2 feet.

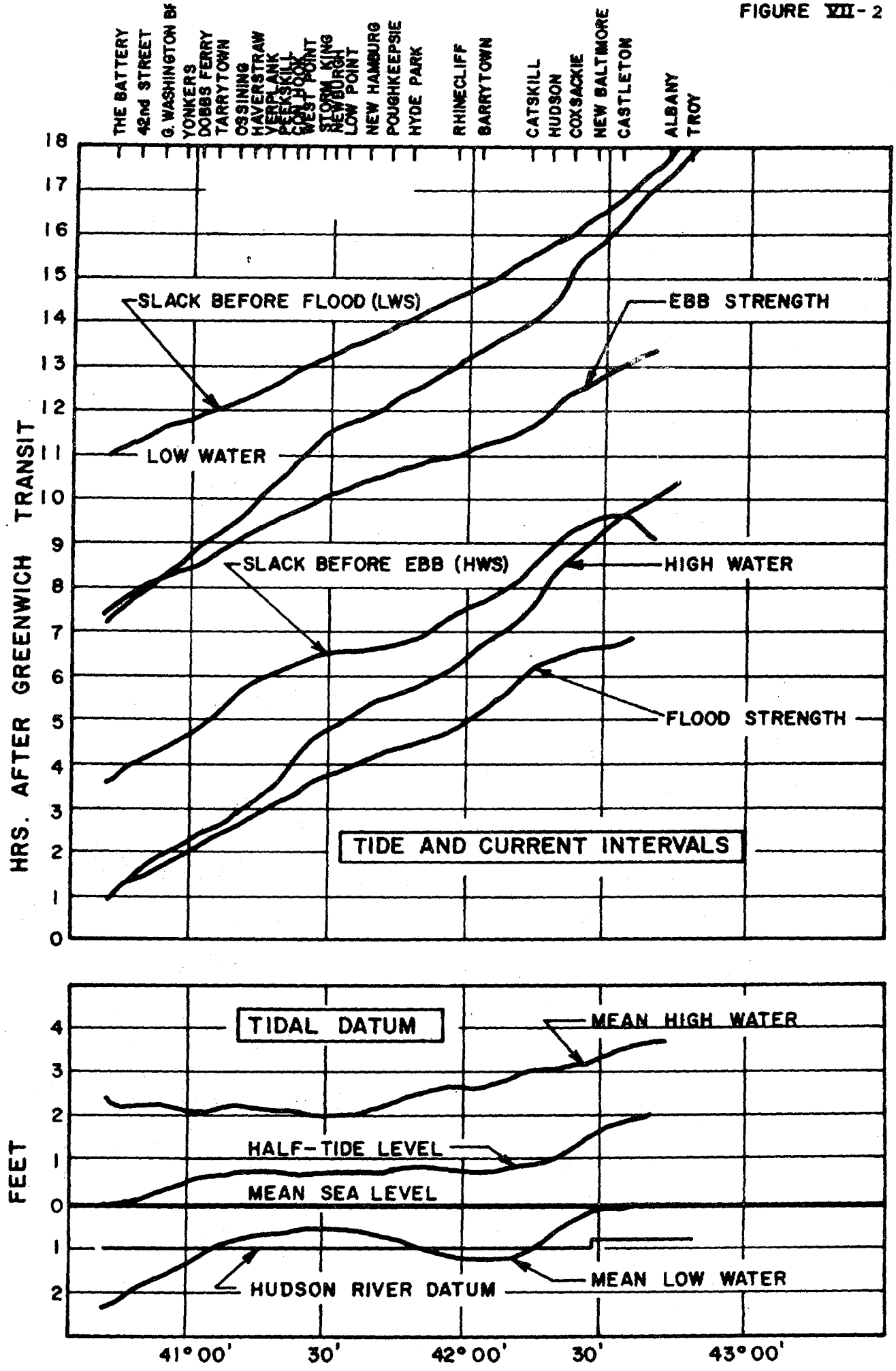
In moving upstream the range of tide diminishes from about 4.4 feet at the Battery to a minimum of about 2.6 feet at a point near Storm King (mile point 56). The tidal range reaches 4.1 feet near Catskill and then increases to 4.8 feet at Troy.

The spring tide is characterized by a higher range of high and low water elevations. The spring tide range is about 5.3 feet at the Battery, 3.1 feet at West Point, and 5.1 feet at Troy.

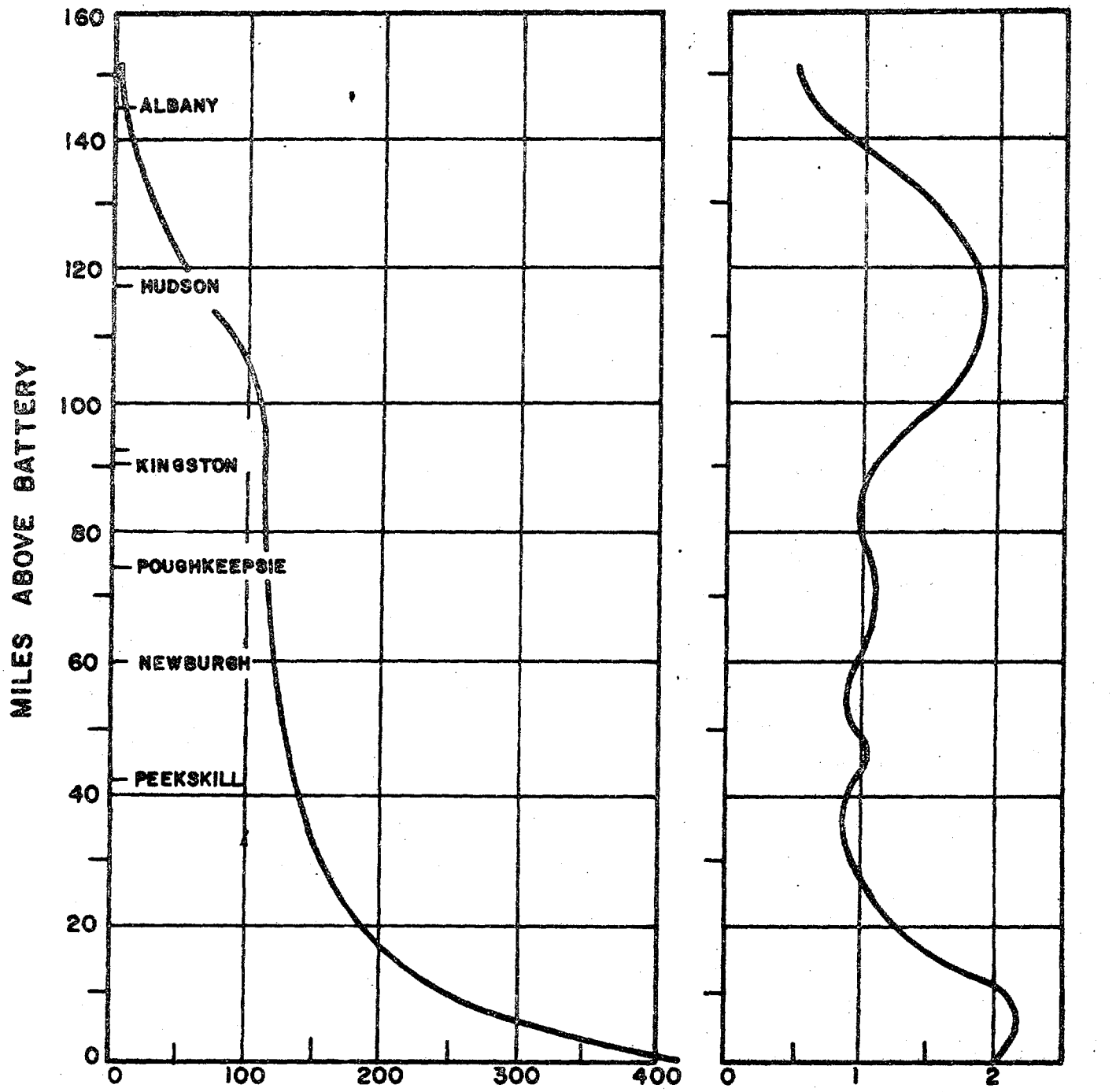
Figure VII-3 shows the variation of mean sectional tidal velocity and tidal flow along the length of the river. Ebb and flood strengths were each averaged across the river cross-section. Mean absolute velocity over a tidal cycle was then obtained by averaging section-averaged ebb and flood strengths. The Hudson River ebb strength (maximum ebb current) is generally greater than the flood strength in the entire estuary. This is mainly due to the fact that the freshwater flow and the ebb flow are proceeding in the same direction.

FIGURE VII-2

HUDSON RIVER TIDAL CHARACTERISTICS



HUDSON RIVER TIDAL FLOW AND VELOCITY



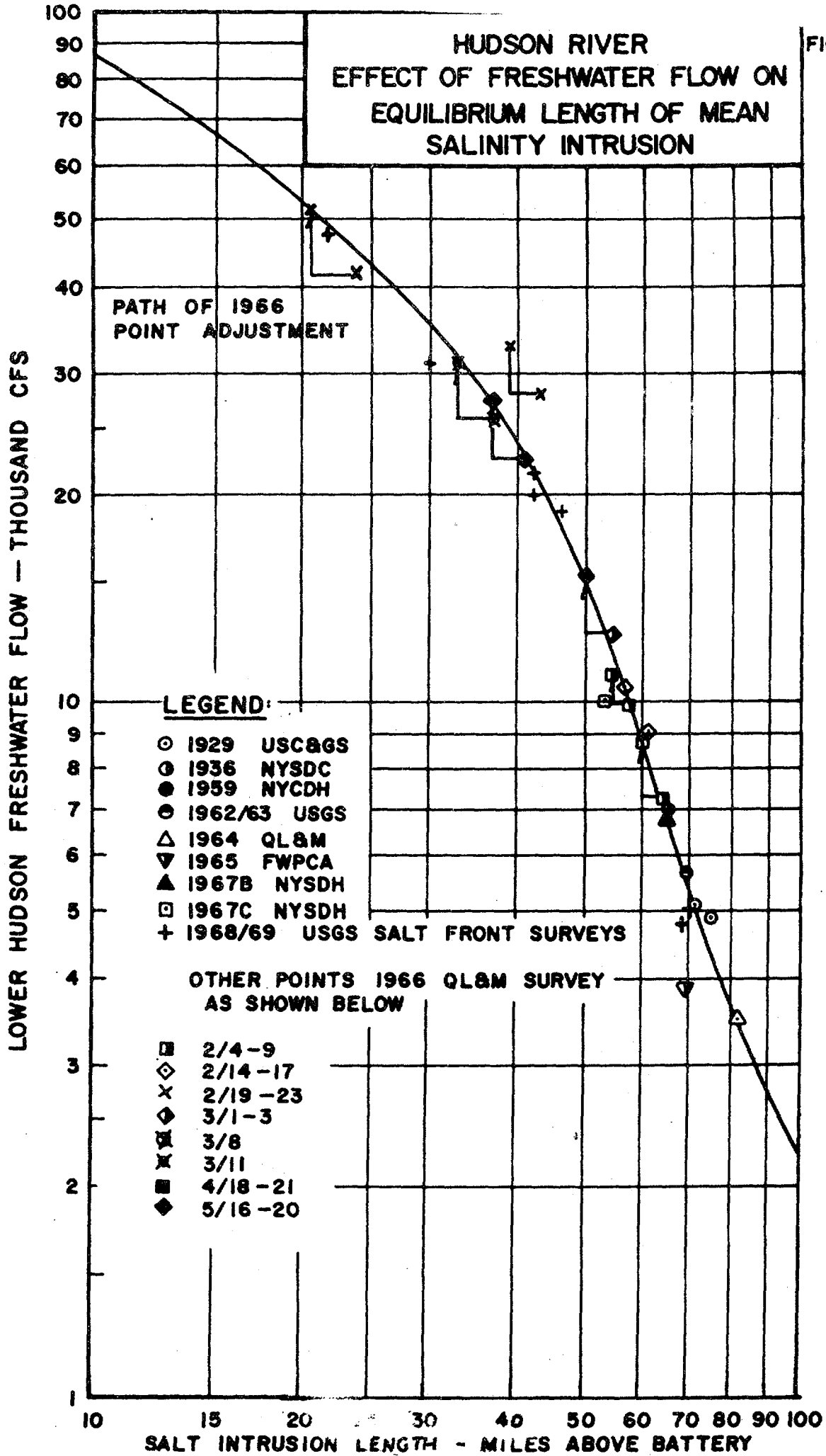
The mean tidal flow decreases from a maximum of 425,000 cfs at the Battery to zero at the Federal Dam at Troy. The values of the mean tidal flow are affected by the freshwater flow, particularly in the upstream reaches of the estuary. The mean tidal flows shown in Figure VII-3 correspond to a low summer freshwater flow of approximately 6,000 cfs.

(b) Salinity Intrusion. The ocean-derived salt intrusion into the Hudson River estuary is affected by the freshwater inflow. Several other factors, such as variations in tidal ranges and extremely strong winds, usually have an effect on the degree of salt intrusion. The effects of these variables are generally not comparable in magnitude to the effect of the freshwater flow.

Quirk, Lawler & Matusky Engineers (1971) investigated the impact of freshwater flow on Hudson River salinity, in particular its effect on salt intrusion (location of 100 ppm salinity). The analysis incorporated results of a number of salinity measurements conducted on the Hudson River since 1929. The results of this study are summarized in Figures VII-4 and VII-5.

The data shown in Figure VII-4 show reasonable correlation between the the steady state length of mean salinity intrusion and freshwater flow in the Lower Hudson. The generalized relationship between mean salt intrusion and freshwater flow in the lower Hudson River under approximate steady state conditions is shown in Figure VII-4.

FIGURE VII-4


HUDSON RIVER
EFFECT OF FRESHWATER FLOW ON
EQUILIBRIUM LENGTH OF MEAN
SALINITY INTRUSION
PATH OF 1966
POINT ADJUSTMENT
LEGEND:
1929 USC&GS
1936 NYSDC
1959 NYCDH
1962/63 USGS
1964 QL&M
1965 FWPCA
1967B NYSDH
1967C NYSDH
1968/69 USGS SALT FRONT SURVEYS
OTHER POINTS 1966 QL&M SURVEY
AS SHOWN BELOW
2/4-9
2/14-17
2/19-23
3/1-3
3/8
3/11
4/18-21
5/16-20
LOWER HUDSON FRESHWATER FLOW — THOUSAND CFS
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
10
15
20
30
40
50
60
70
80
90
100
SALT INTRUSION LENGTH - MILES ABOVE BATTERY

HUDSON RIVER
GENERALIZED MEAN SALINITY PROFILES
STEADY-STATE CONDITIONS

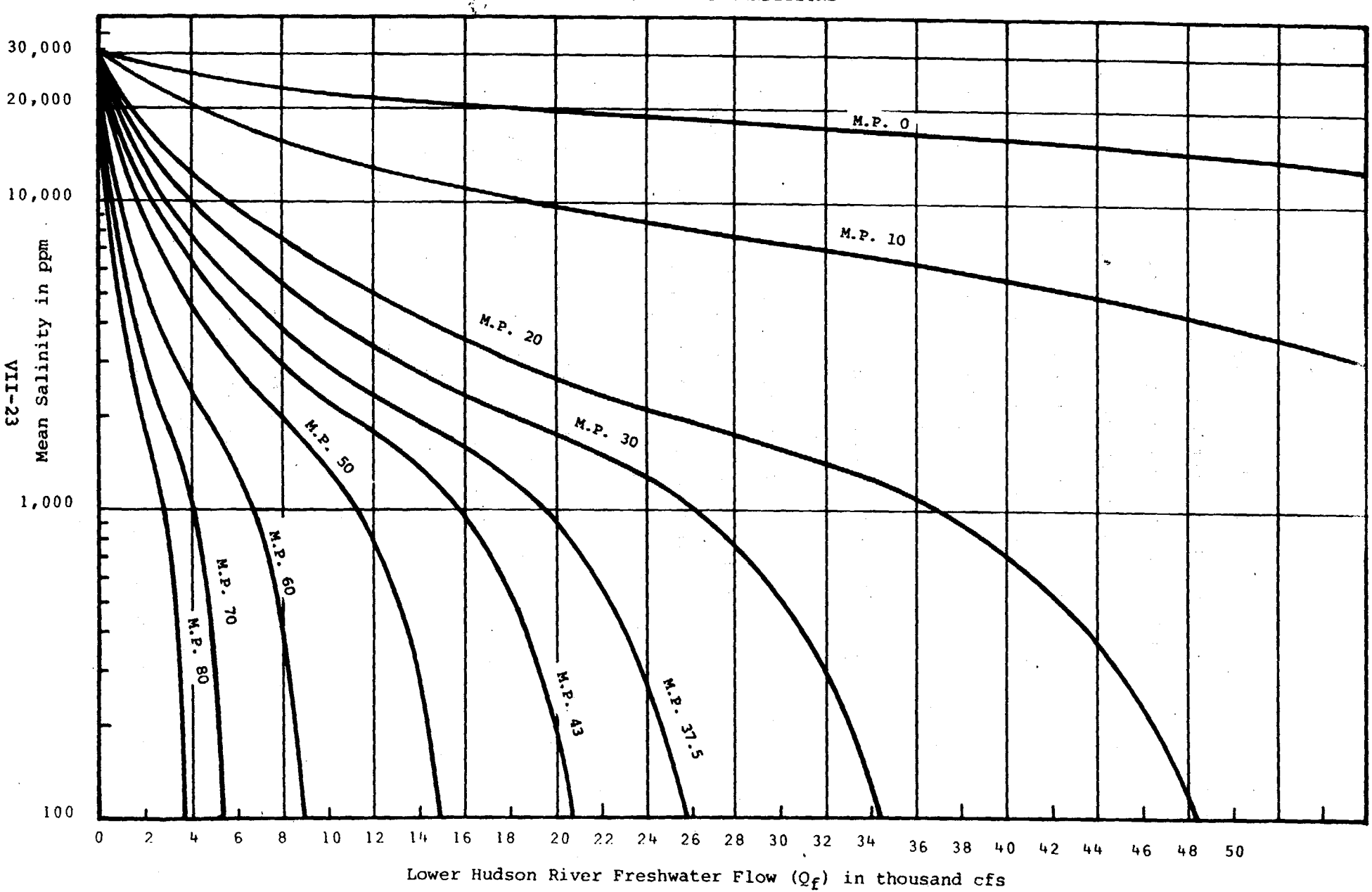


FIGURE VII - 5

The profiles in Figures VII-4 and VII-5 indicate that Hyde Park, some 80 miles upstream of the Battery, may be the northern most upstream point intruded by ocean salt. When freshwater flow is greater than about 7,000 cfs, the salt intrusion may not reach the Roseton/Danskammer Point area (i.e. mile point 65). The occurrence of flows less than 7,000cfs is usually confined to the summer and early fall seasons. During other seasons, the river section near Roseton/Danskammer Point would be essentially freshwater. A more detailed discussion of salt intrusion is presented in a later section.

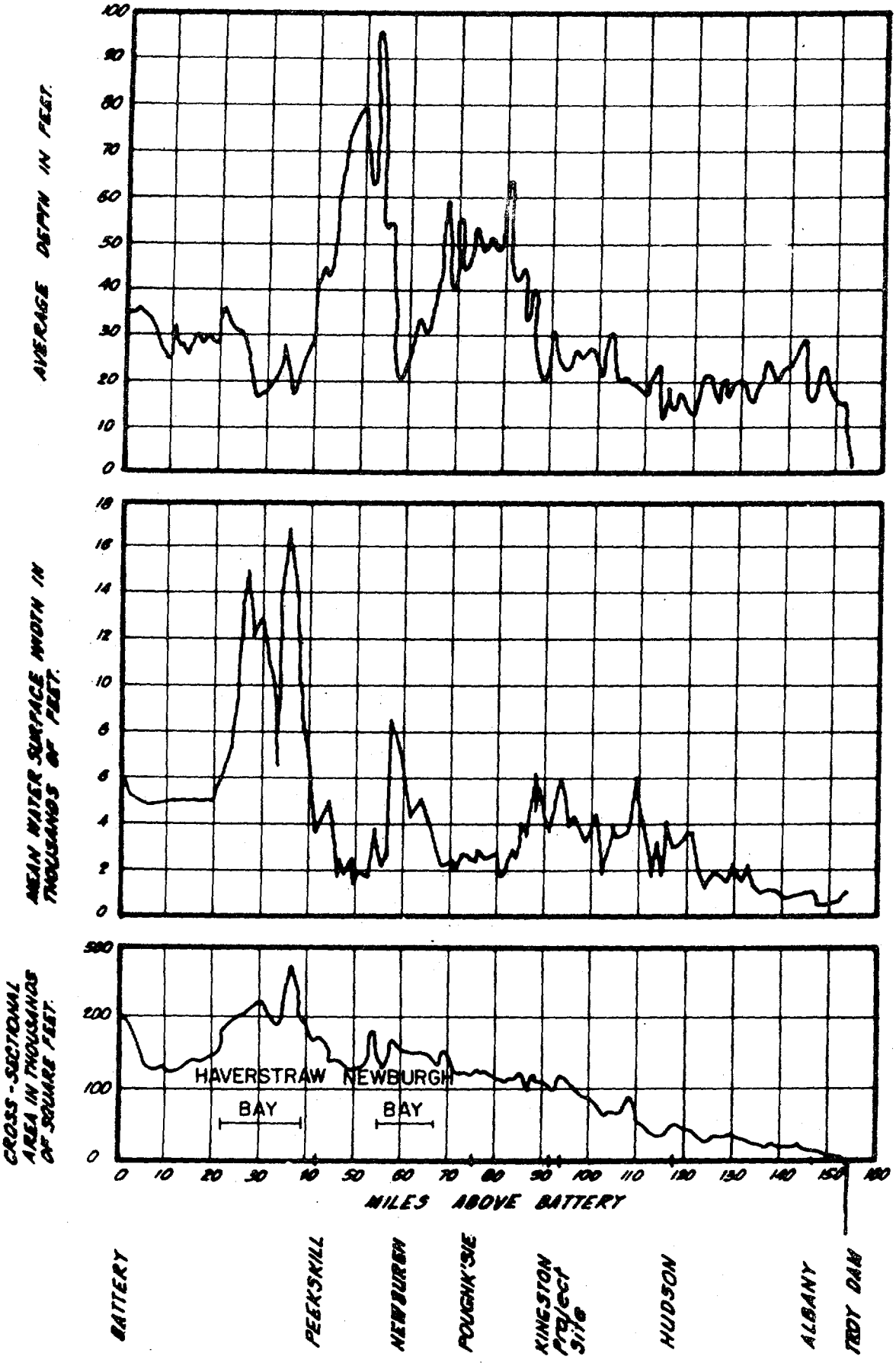
(c) Channel Geometry. The Hudson River estuary is a relatively deep and straight channel. The variations in the major channel characteristics, i.e., the cross-sectional area, surface width, and mean depth, are shown in Figure VII-6. The cross-sectional area of the channel ranges from about 250,000 square feet in Haverstraw Bay to less than 50,000 square feet in the upstream reach of the estuary.

The surface width varies significantly and somewhat erratically along the longitudinal axis of the estuary. This is due to the presence of several bays and shoals in the Lower Hudson. Locations of the two major bays, Haverstraw Bay and Newburgh Bay, are shown in Figure VII-6. The widest section of the river is located at Haverstraw Bay, where the surface width reaches approximately three miles.

The mean depth of the estuary is defined as the cross-sectional area divided by the surface width. From the Battery to the head of Haverstraw Bay, the mean depth generally decreases from about 33 feet to 16 feet. Upstream of Haverstraw Bay, the mean depth abruptly increases, reaching a maximum of approximately 90 feet in the vicinity of West Point, after

FIGURE VII - 6

HUDSON RIVER CHANNEL PHYSICAL CHARACTERISTICS



which it decrease to a 20 to 50 foot range in Newburgh Bay. Upstream of Newburgh Bay the mean depth increases to the 40 to 60 foot range until mile point 80, after which it generally decreases such that north of mile point 100, up to the Troy Dam, the mean depth is generally 20 to 25 feet or less.

(d) Freshwater Flow. The major portion (about 80% under normal summer conditions) of freshwater flow enters the estuary at Troy. The remaining portion of freshwater flow consists largely of tributaries flowing into the upper reach of the estuary. Measurement of the freshwater flow in the estuary is not possible because of tidal oscillation. Flow histograms in the tidal portion of the river are usually constructed by measuring Hudson River flows at Green Island (the most downstream U.S.G.S. gaging station above tidewater) and relating this to empirically developed flow and time relationships between the tributaries and Green Island.

Based on observations of Hudson River flows at Green Island over a period of 53 years (1918 - 1970), the long-term monthly average freshwater flow in the lower portions of the Hudson River estuary is estimated at about 18,200 cfs. Freshwater flow varies over the period of one year, with maximum flows occurring predominantly during the spring months (March, April, and May). The period of low freshwater flows usually begins in June and continues until November. Figure VII-7 depicts the variation of long-term monthly average flows in the Lower Hudson.

LOWER HUDSON RIVER LONG TERM

MONTHLY AVERAGE FRESH WATER FLOWS

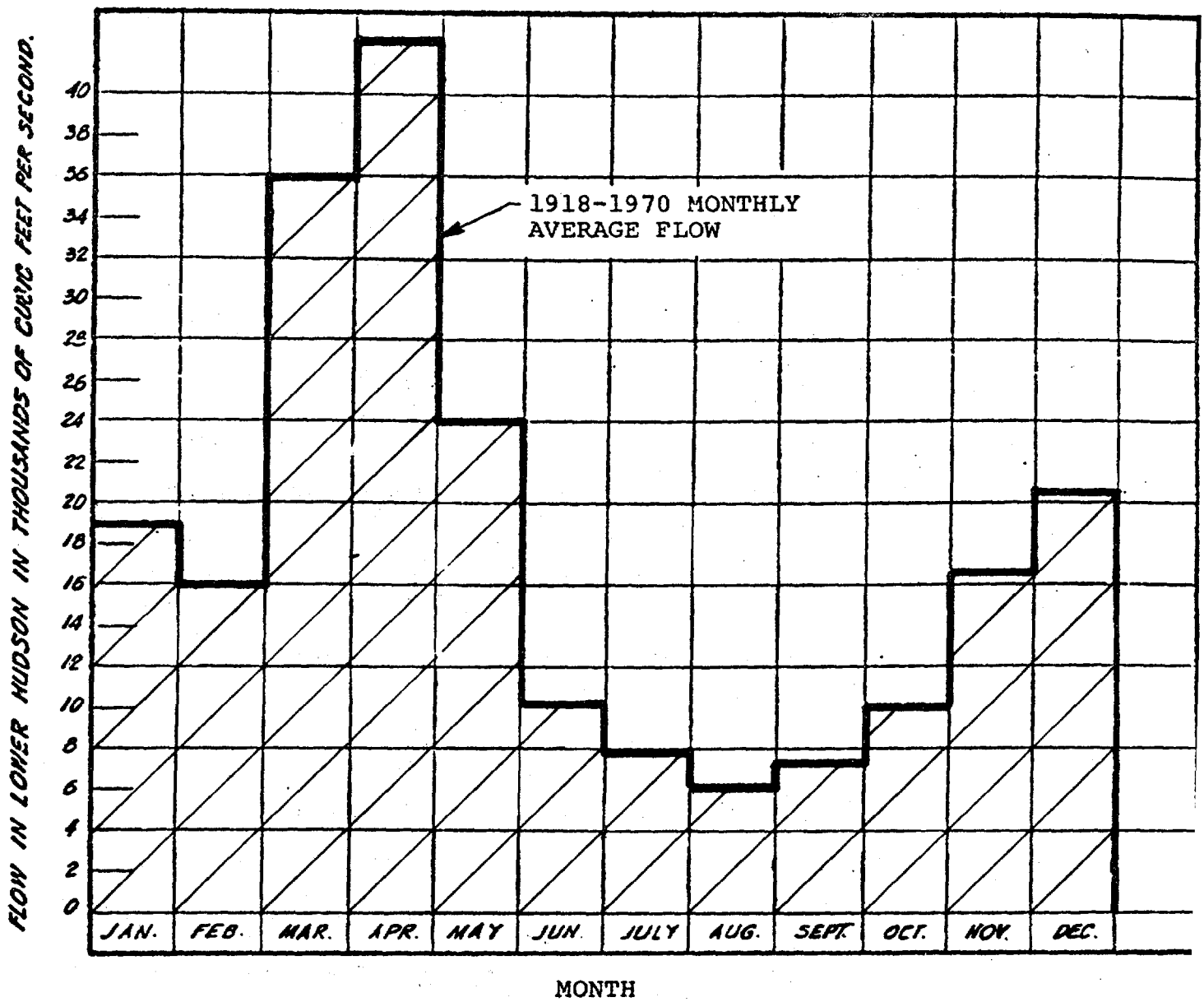


Figure VII-8 shows the monthly average freshwater flows of the Hudson River at Green Island for the years of 1971 and 1972. The patterns of flow distributions through these years are similar to the long term average patterns.

Approximate Lower Hudson River flows can be obtained by multiplying the Green Island flows by the Lower Hudson long term yield factor of 1.225. During the spring months, however, this factor may be as high as 1.5 or more due to high runoffs from the Lower Hudson tributaries.

3. Previous Studies of Hudson River Water Quality

The Hudson River has played a very important role in the industrial and economic development of New York State. As part of the New York State Canal System connecting New York City to the Great Lake region, the system provides a convenient transportation route for ship and barge traffic. It is also used for liquid waste disposal. Protection of uses requiring higher degrees of water quality has evolved gradually and has become a focal point of environmental concern in recent years.

Prior to 1960, few studies that were made of the Hudson River provided reasonably extensive physical, chemical, and bacteriological data. Studies were confined generally to isolated areas and to parameters specific to intended uses. Exceptions were surveys conducted in 1949, 1951, and 1952 by New York State Department of Health wherein measurements of approximately ten common physical, chemical and bacteriological parameters were made.

HUDSON RIVER FLOW AT GREEN ISLAND

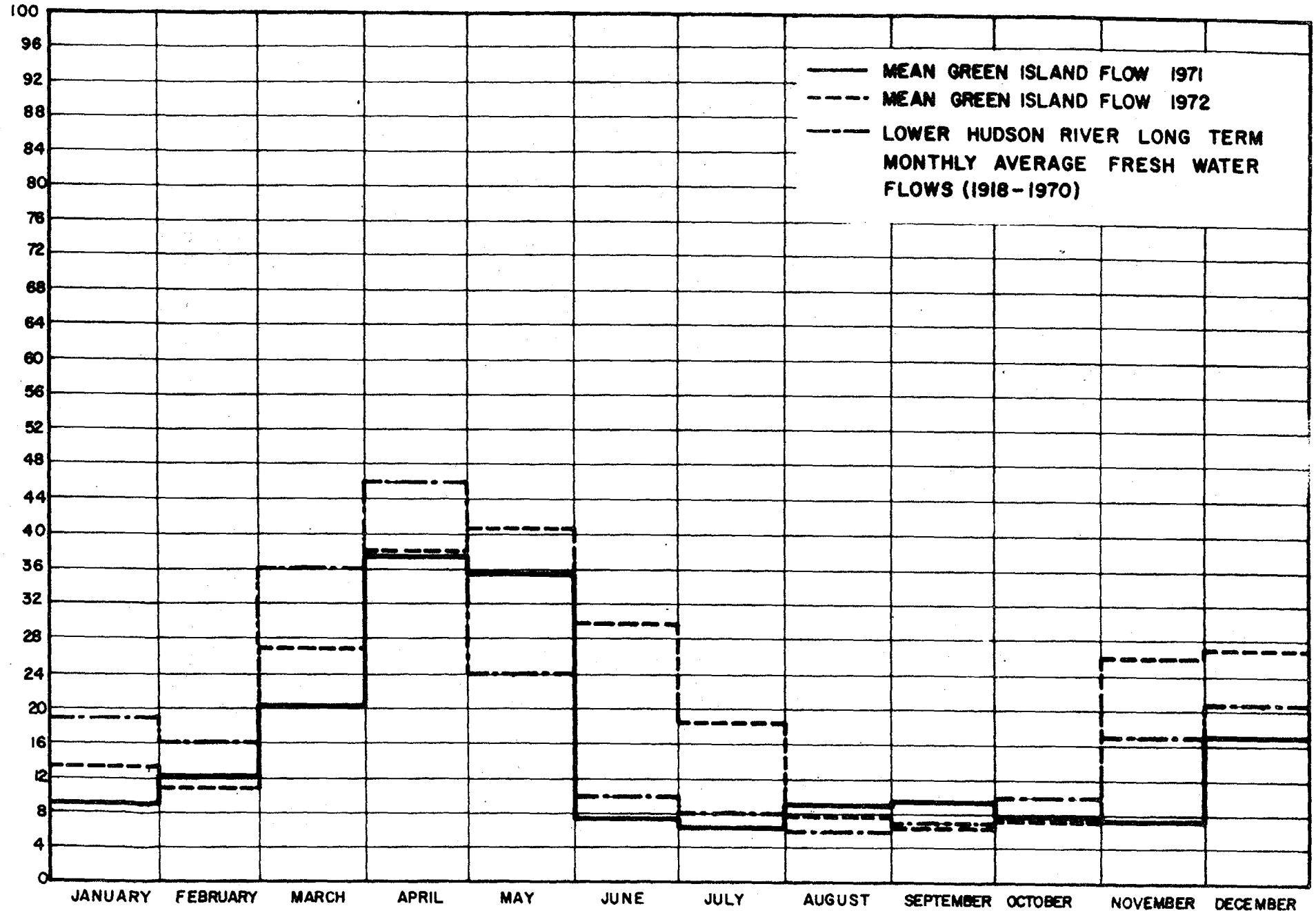


FIGURE VII - 8

In the 1960's, and on a continuing basis thereafter, a number of comprehensive, as well as specialized, water quality surveys were undertaken. The comprehensive surveys have been associated with ecoligical investigations supported by electric power utilities on the Hudson River (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974; Texas Instruments, Inc., 1972) and with state and federal agency surveillance programs. In addition, independent studies have been conducted by a variety of public and private institutions. Water quality information readily available from published sources is summarized in Appendix VII-A.

Data compiled by the New York State Department of Environmental Conservation and the United States Environmental Protection Agency are normally quite extensive, covering up to thirty-five or forty individual parameters for a number of mile points. These data are available as raw data listings, percentile summaries and/or means and ranges. Data from these two agencies are valuable in estimating the water quality condition of the Hudson River as a function of mile point during several periods of time.

Data from these two agencies were grouped into the time periods:

1968-1970	(10/67 to 9/70)
1971-1972	(10/70 to 9/72)
1973	(10/72 to 9/73)

The yearly mean values for selected water quality parameters were plotted as functions of the mile point. The parameters selected reflect the applicability of the parameters to the present study and those for which adequate data were available.

The longitudinal concentration distributions from Yonkers to Albany were analyzed for apparent patterns. Such analysis can often be only qualitative and subjective, and not quantitative, because of the spacing between data points in time (average of 3 to 4 weeks) and because of insufficient spatial data points (typically at 10 mile intervals but sometimes restricted to four to six points over 130 miles or restricted to mile points below 80 or 110). Compounding these difficulties were cases where analytical procedures were apparently changed or where inherent analytical difficulties obscured any possible patterns.

Nevertheless, the concentration distributions could generally be classified into several distinct patterns:

1. concentration apparently not affected by mile point;
2. concentration increases with proximity to New York Metropolitan area;
3. concentration increases with proximity to Albany and/or New York Metropolitan area;
4. concentration reaches a maximum or minimum at a point between Albany and New York, apparently independent of metropolitan areas

Abbreviations for chemical and physical analyses used in the following discussion are:

TDS - Total Dissolved Solids

MBAS - Methylene Blue Active Substances

OP - Orthophosphate

TP - Total Phosphate

TKN - Total Kjeldhal Nitrogen

COD - Chemical Oxygen Demand

TSS - Total Suspended Solids

TVS - Total Volatile Solids

TS - Total Solids

Concentrations of NO_3, Fe, Mn and Hg were generally included in the category of no obvious pattern. While NO_3 was relatively uniform in each time period, Fe demonstrated patterns that were irregular or inconsistent over time. Mn possibly increases in the proximity of New York, but the patterns were not definitive. Hg was uniformly below detection limits in the 1971-1972 period; the patterns were irregular in 1973.

Parameters following pattern 2 would be expected to be those characteristic of ocean water; Ca, K, Na, Mg, Cl, SO_4 and TDS all fall within this category. Figures VII-9 through VII-11 present results for the 1973 samples, which are typical for the other time periods analyzed. These data indicate that on an average basis, little effect of ocean water parameters is exerted above mile point 40, and almost no effect is exerted above mile point 60.

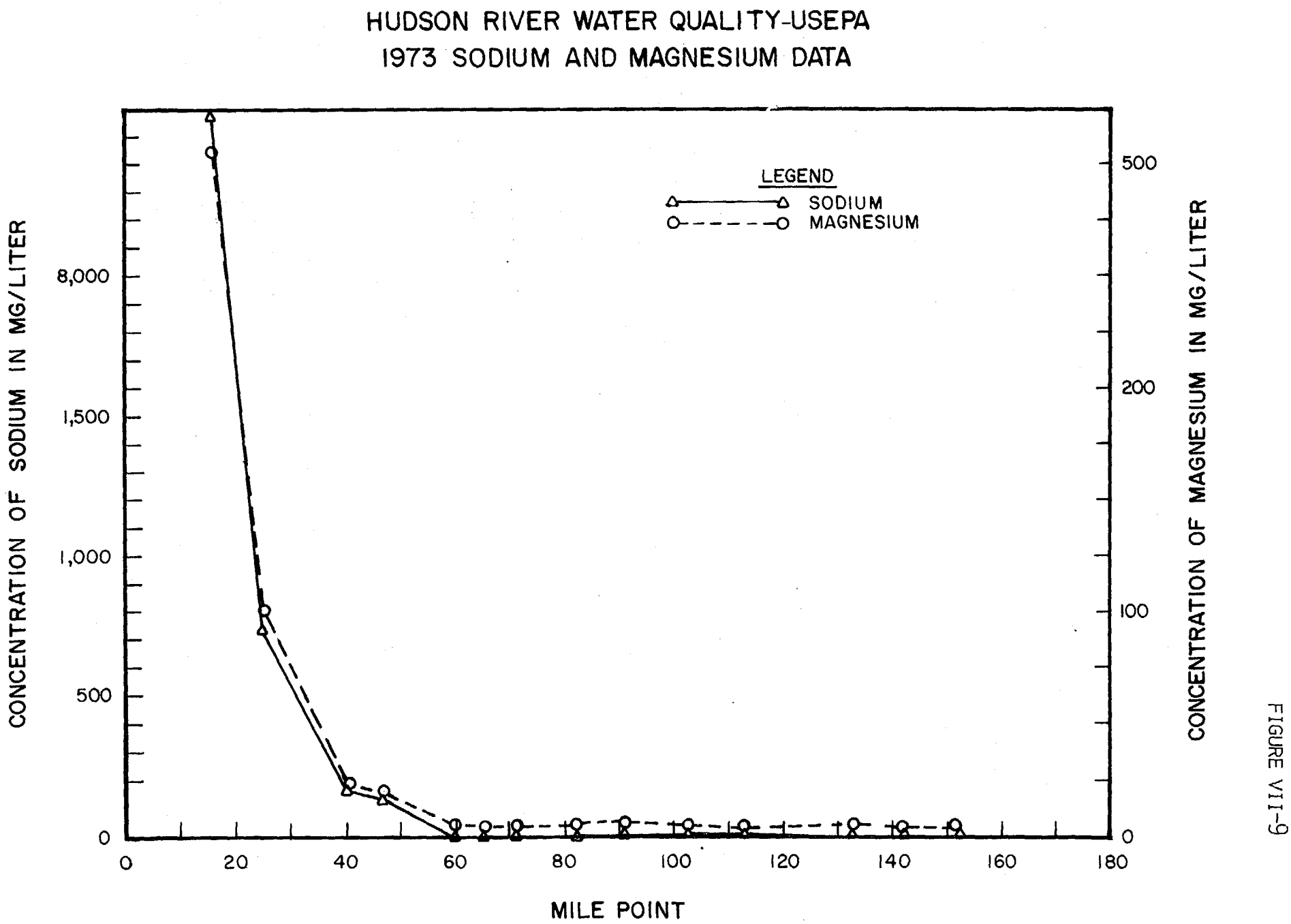

HUDSON RIVER WATER QUALITY-USEPA
1973 SODIUM AND MAGNESIUM DATA
LEGEND
SODIUM
MAGNESIUM
CONCENTRATION OF SODIUM IN MG/LITER
CONCENTRATION OF MAGNESIUM IN MG/LITER
MILE POINT
0
500
1,000
1,500
8,000
0
100
200
500
0
20
40
60
80
100
120
140
160
180

FIGURE VII-9

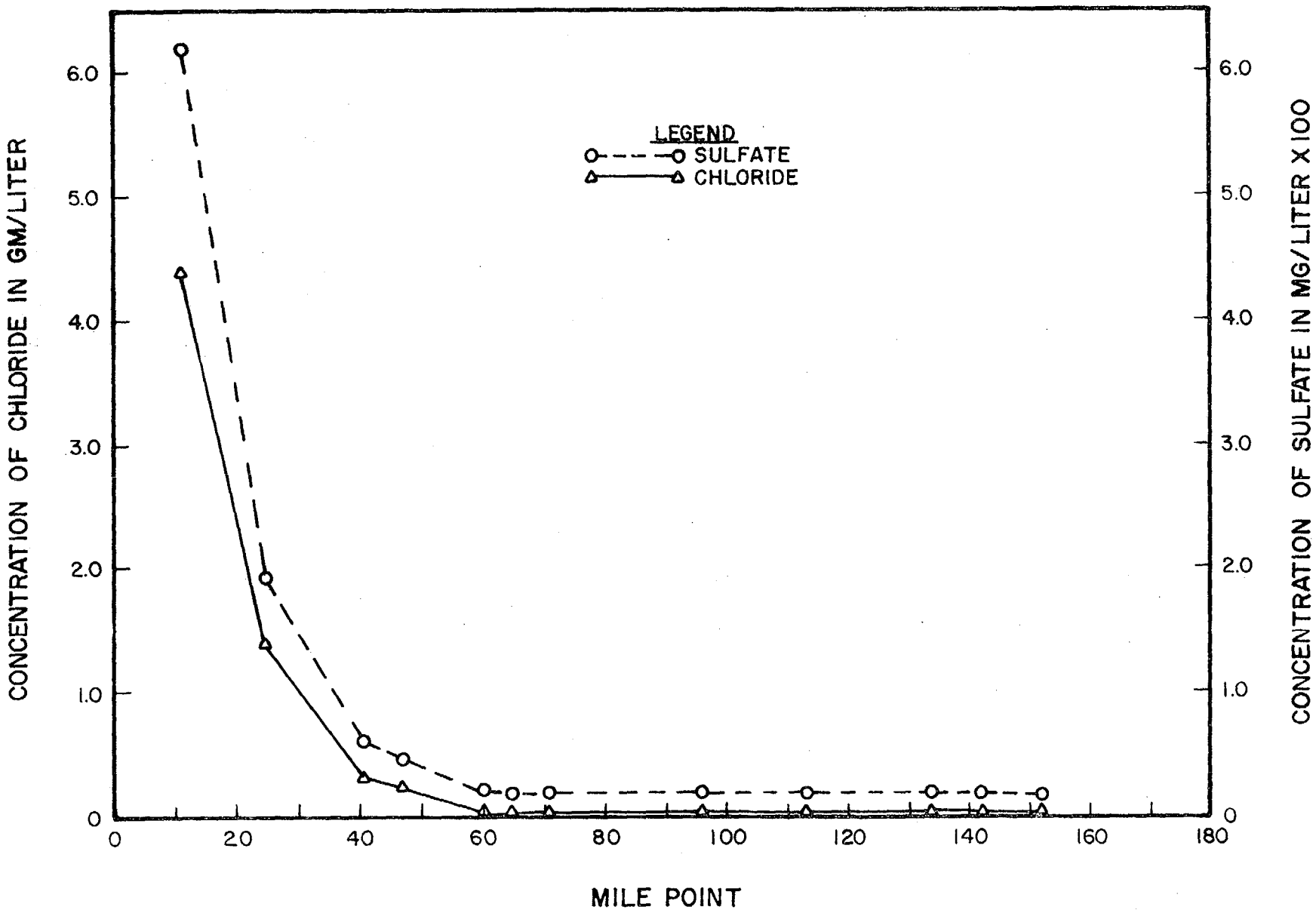


FIGURE VII-10

HUDSON RIVER WATER QUALITY-USEPA
1973 CALCIUM AND POTASSIUM DATA

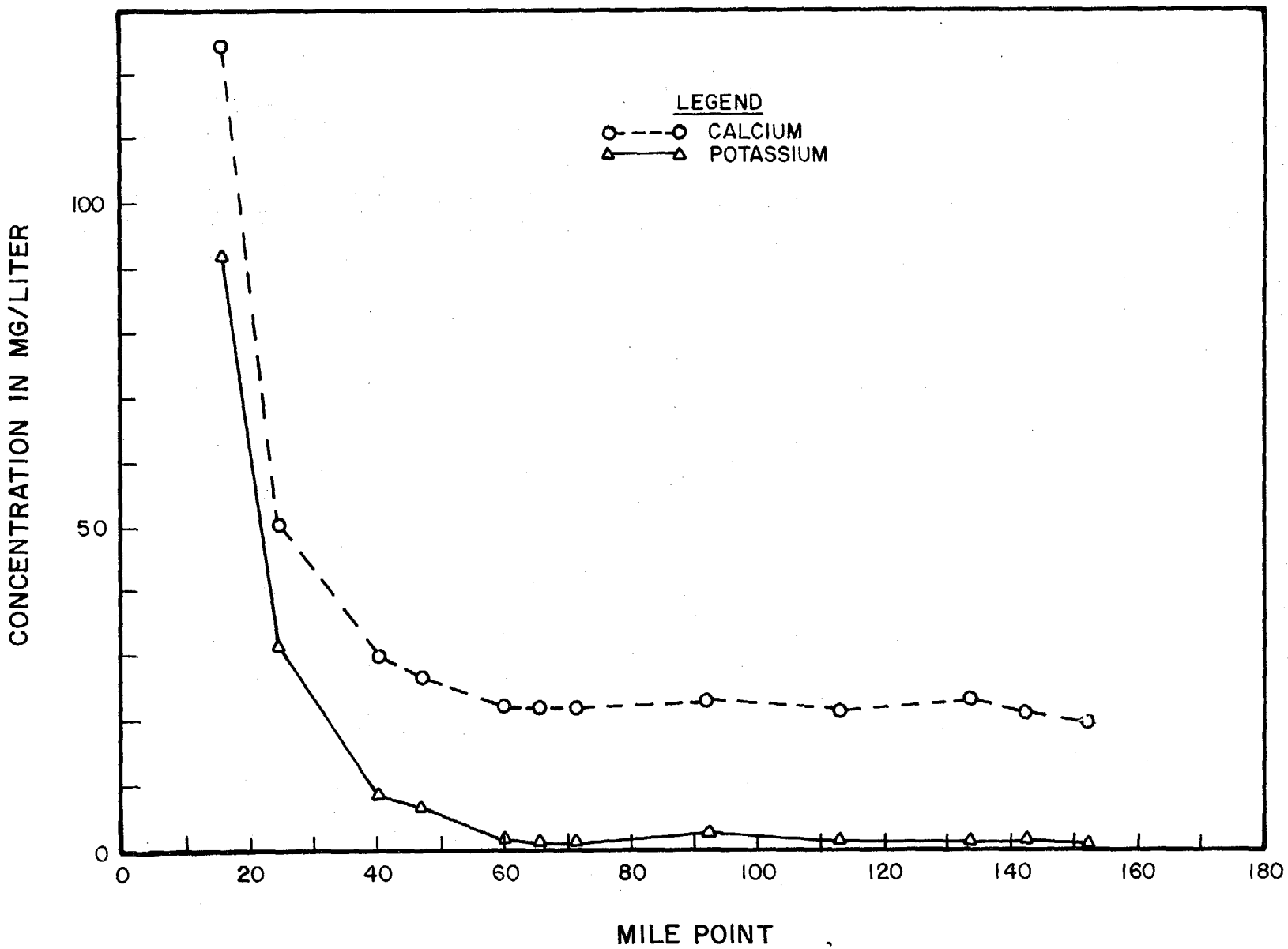


FIGURE VII-11

Parameters following pattern 3 would be expected to be those characteristic of municipal sewage. Several parameters fit in either pattern 2 or 3, but because of their known presence in sewage they have been placed in pattern 3. Thus, CO_2, F, MBAS, OP, TP, NH_3, NO_2, TKN, and COD are placed in this category. The F and MBAS data for 1973 are presented in Figure VII-12. The patterns are generally consistent with previous time periods. OP and TP data for 1973 are presented in Figure VII-13 and are also consistent with data for previous time periods.

The several forms of nitrogen concentrations measured in 1973 are presented in Figure VII-14. The pattern for TKN is not evident, but is evident for the New York Metropolitan Area in the 1971-72 data. As indicated previously, no obvious pattern exists for NO_3-N. Finally, COD data are presented in Figure VII-15 for 1973 and for the earlier 1968-1970 time period.

As for the parameters described under pattern category 2, significant effects for parameters in pattern 3 are generally observable south of mile point 40 to 60. The upper extent of influence is less clear because parameters may slowly decay in concentration, but the upper limit may be estimated to be located near mile points 100 to 120.

No immediate explanation can be given for parameters following pattern 4. Both Cu and Pb had a peak concentration near mile point 25 in the 1971-72 time period (see Figure VII-16). Data in 1973 were too few to substantiate this pattern and in 1968-70 were not available to any significant degree.

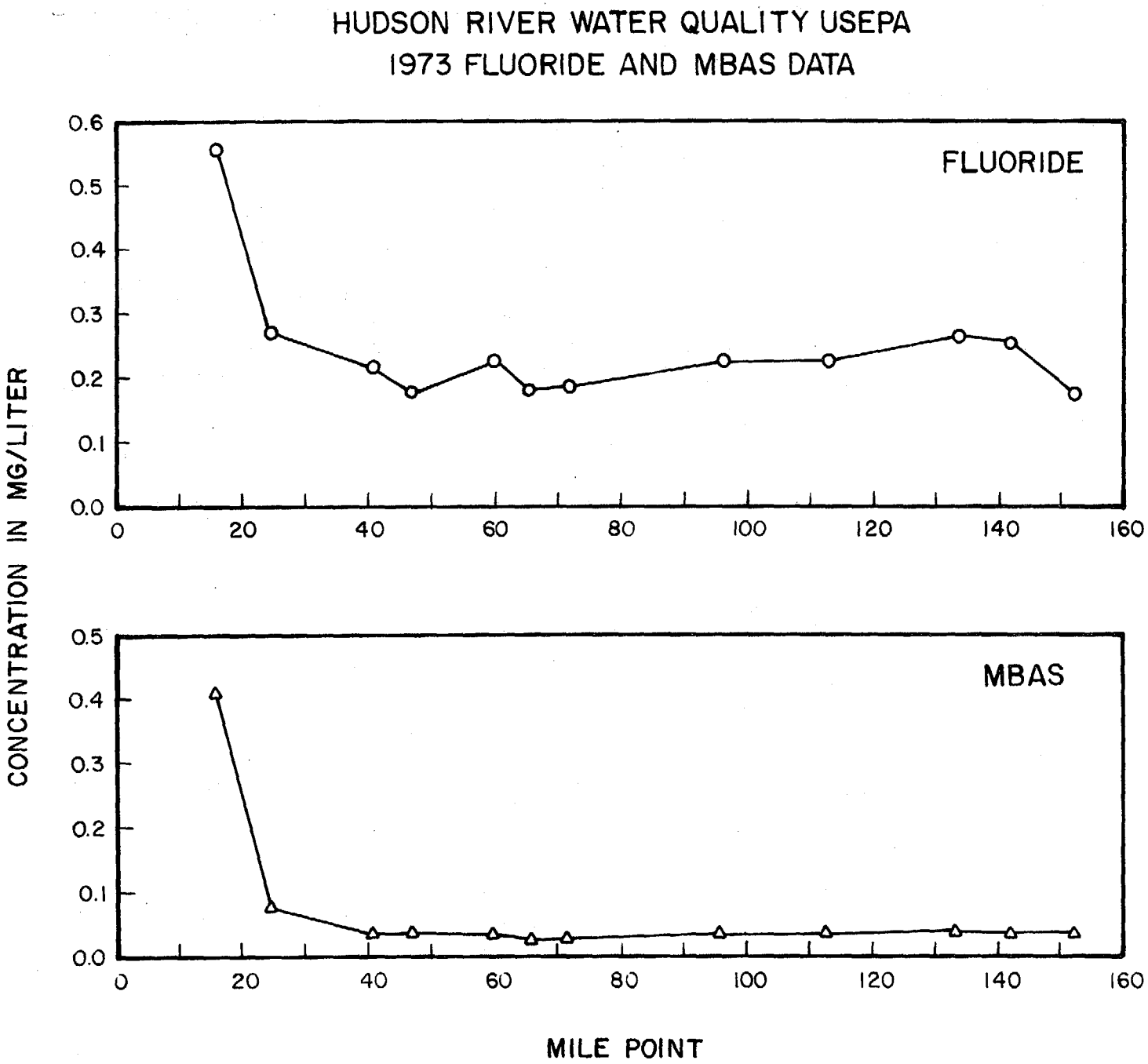


FIGURE VII-12

HUDSON RIVER WATER QUALITY-USEPA
1973 ORTHOPHOSPHATE AND TOTAL PHOSPHATE DATA

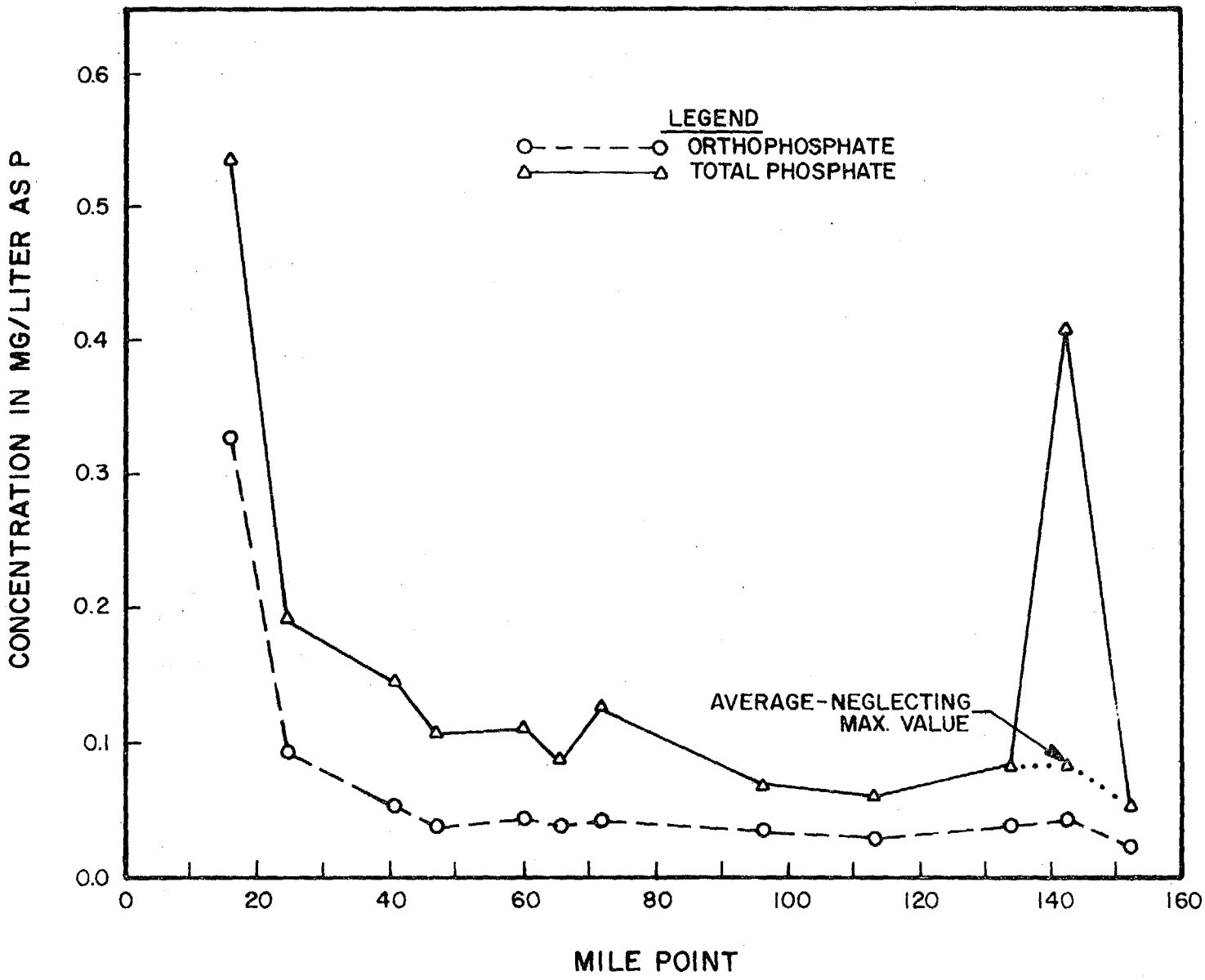


FIGURE VII-13

HUDSON RIVER WATER QUALITY-USEPA 1973 AMMONIA, NITRATE, AND TOTAL KJELDAHL NITROGEN DATA

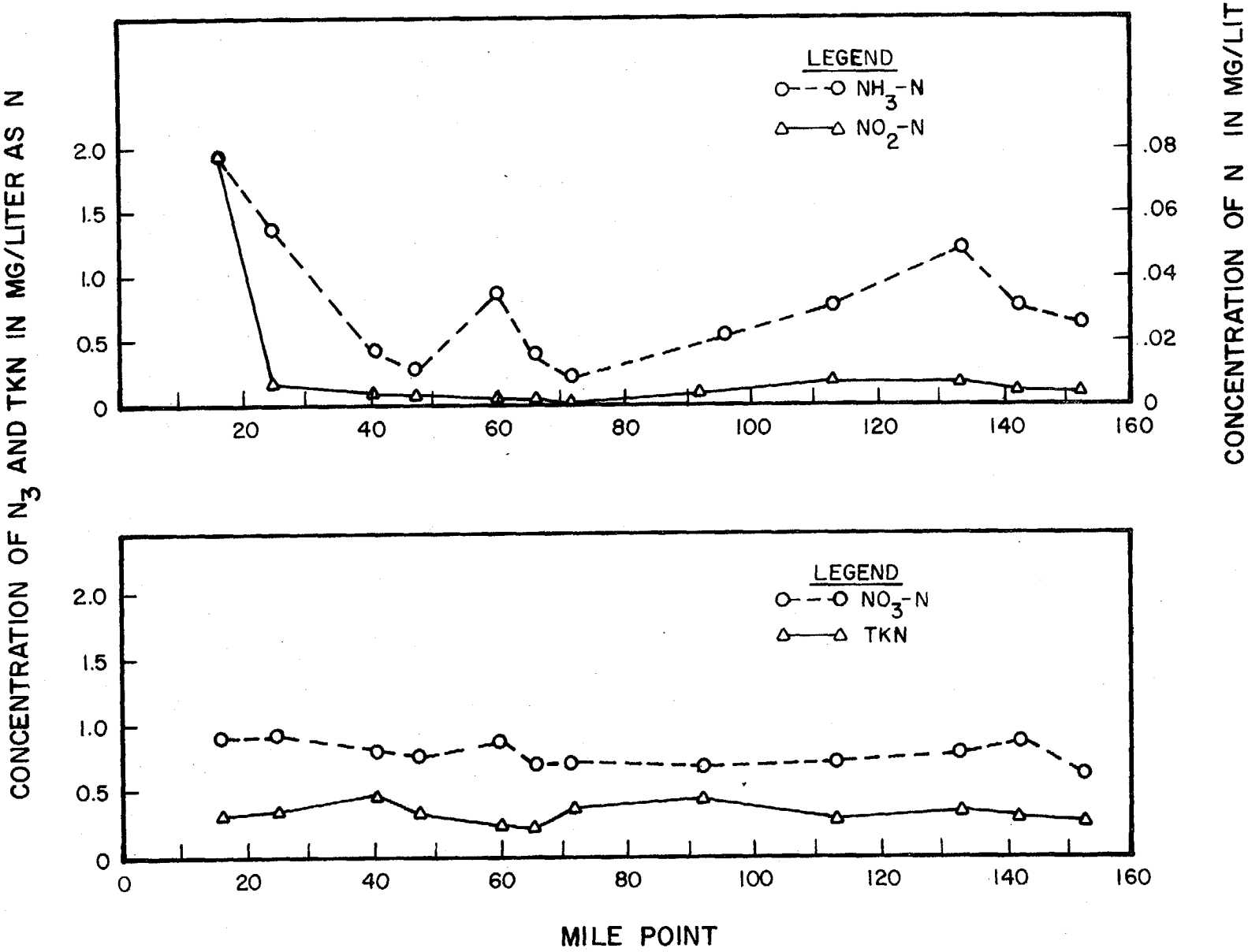


FIGURE VII-14

HUDSON RIVER WATER QUALITY–NYSDEC 1968-70
AND USEPA 1973 COD AND DO DATA

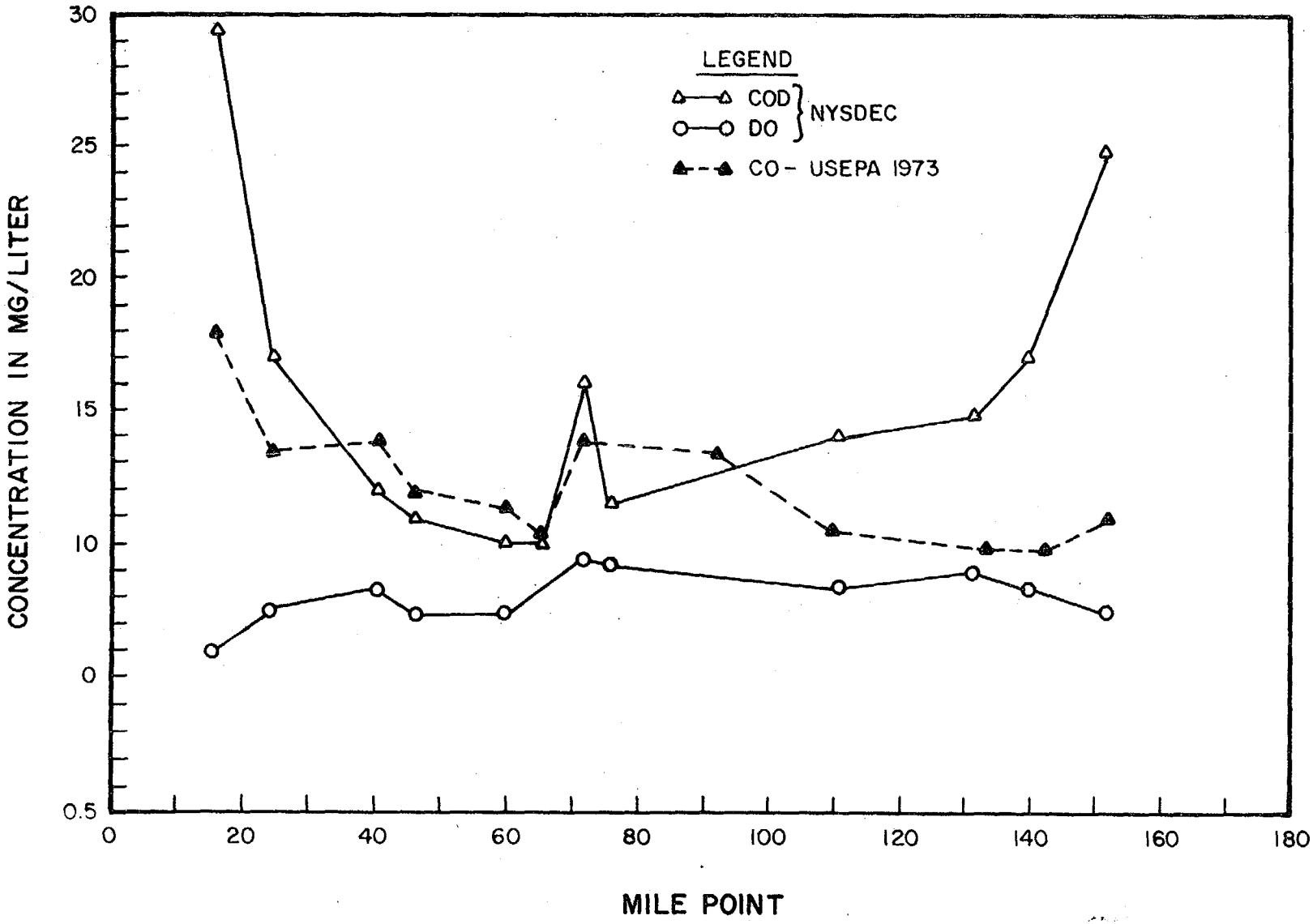


FIGURE VII-15

HUDSON RIVER WATER QUALITY-NYSDEC 1971-72
USEPA 1970-72 COPPER, LEAD, AND MERCURY DATA

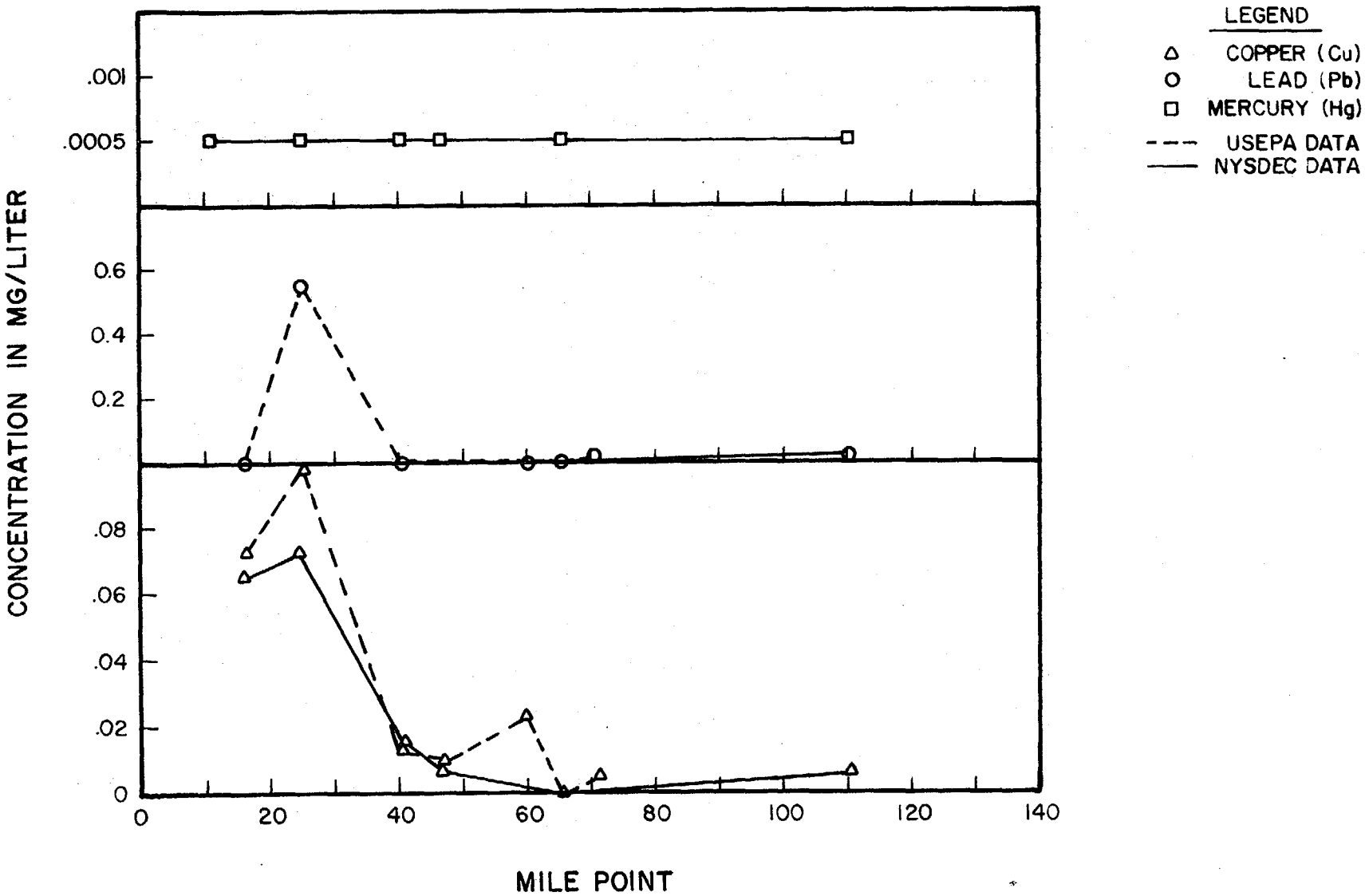


FIGURE VII-16

TSS had a consistent peak between mile points 70 and 80, as illustrated in Figure VII-17. The consistency between time periods is apparently meaningful. Finally, silica apparently has a minimum concentration between mile points 70 and 100 (see Figure VII-18). The pattern could be representative of those described under pattern 3, except that the southern extent of relatively high values extends north of mile point 60.

Based on the above patterns, the average water quality parameter values for the reach between mile points 40 and 120 are generally indicative of the quality of the freshwater portion of the Hudson River estuary, if data during obvious stratification in this reach are omitted. Table VII-1 presents concentrations of various parameters indicative of the freshwater portion. The values shown are not strict averages of available data, but rather are rounded values felt to be representative of freshwater values.

4. Environmental Significance of Water Quality Parameters

(a) General. The disposal of human wastes and other organic refuse without creating a nuisance has always created problems. These problems have been compounded over the years in areas where the population base has expanded and the resultant industrialization and/or agricultural uses have added more chemicals to the natural streams than their capacity for self-purification can handle. When the pollution situation became more pronounced, a great deal of public concern was generated about finding ways of restoring and maintaining the chemical, physical and biological integrity of the waters.

(b) Relevant Water Quality Parameters. The U. S. Government, through the Federal Water Pollution Control Act Amendments of 1972, set as a national goal (Sec. 101 (a) (1)) the elimination of the discharge of pollutants into navigable waters by 1985. An interim goal (Sec. 101 (a) (2)) provides for the

HUDSON RIVER WATER QUALITY- NYSDEC 1967-70, 1971-72
AND USEPA 1970-72, 1973 TOTAL SUSPENDED SOLIDS DATA

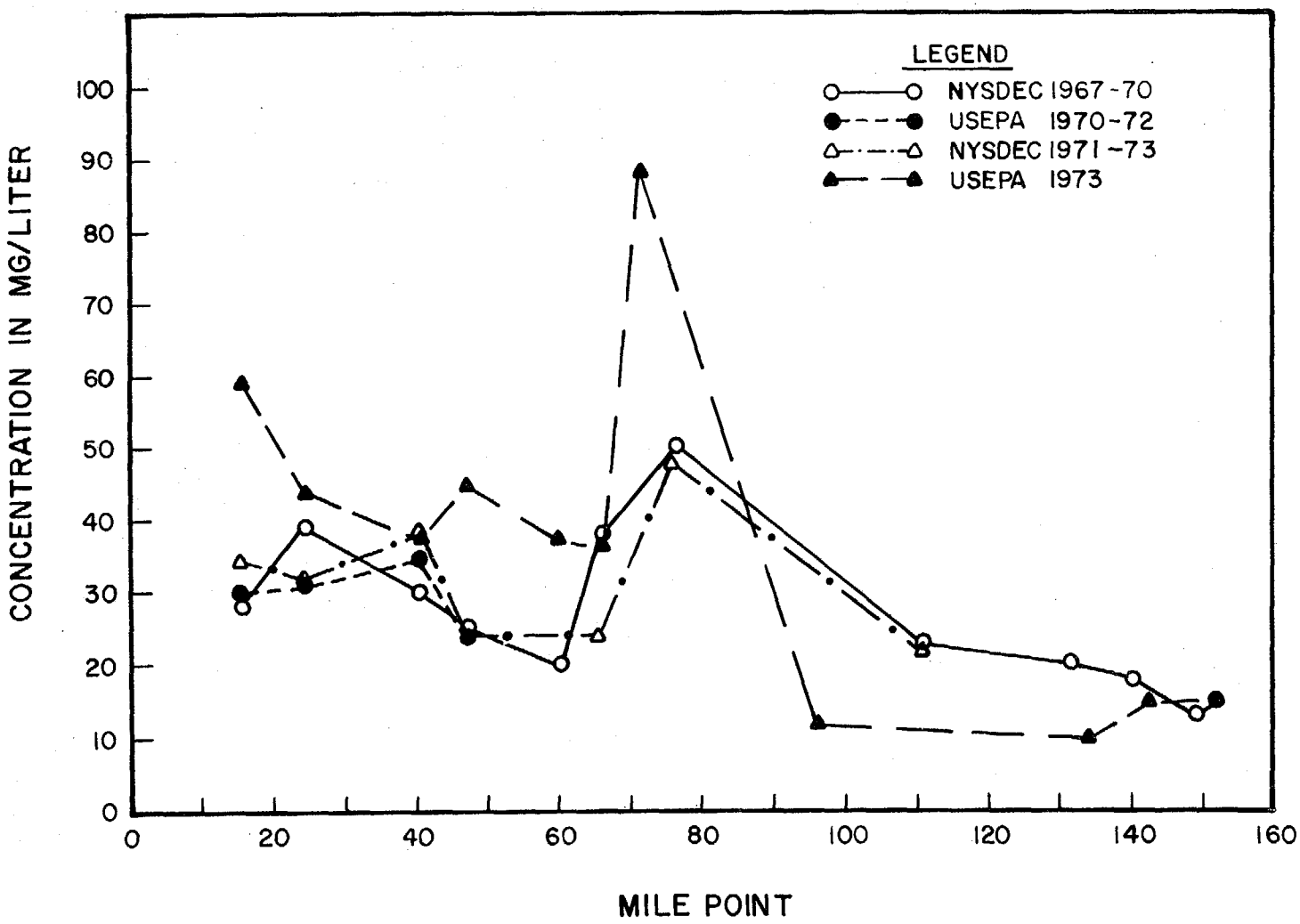


FIGURE VII-17

HUDSON RIVER WATER QUALITY
USEPA 1970-72,1973 SILICA DATA

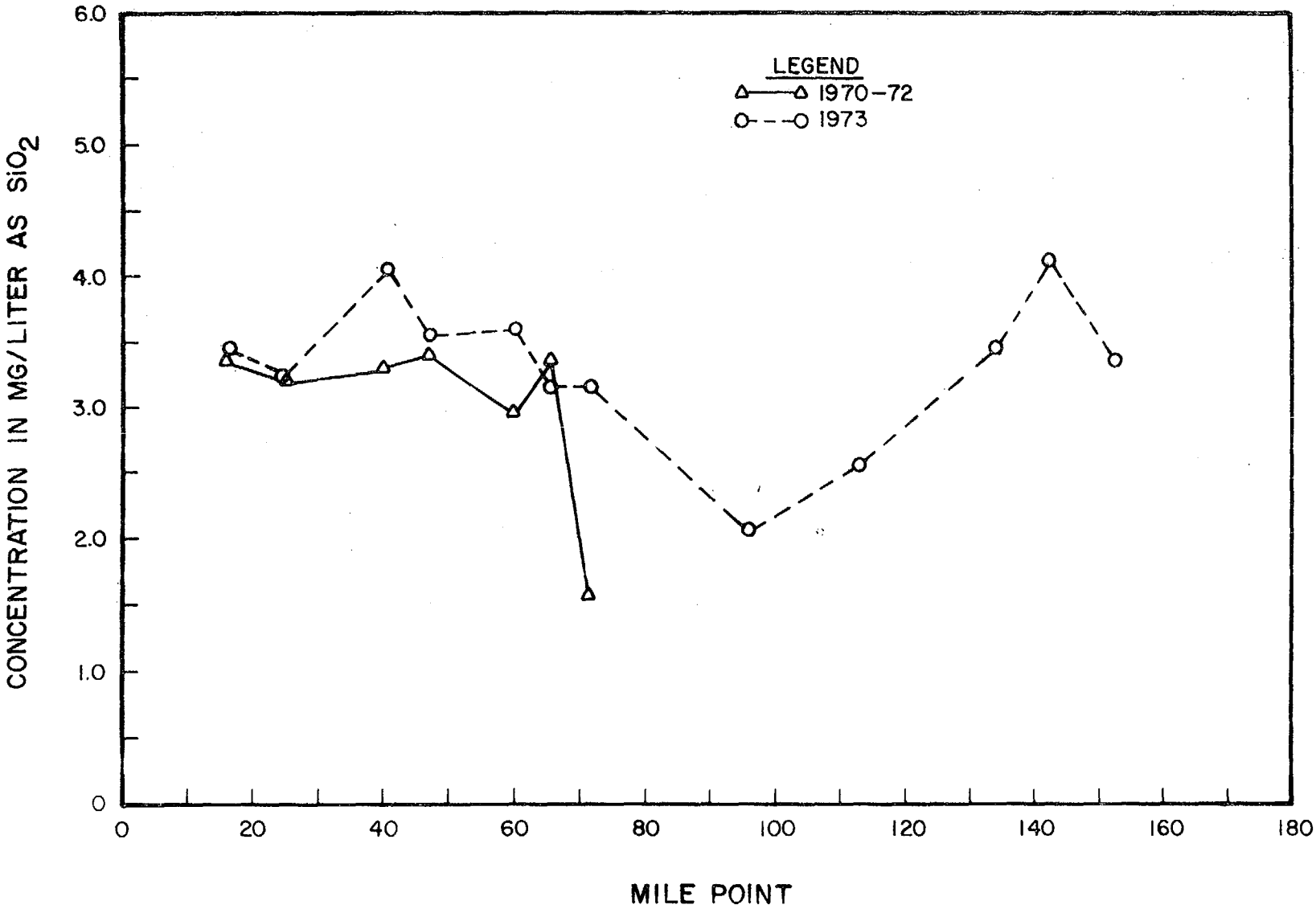


FIGURE VII-18

TABLE VII-1

Selected Water Quality Concentrations Representative of the Freshwater Portion of the Hudson River Estuary

Mile Points 40 to 120

Parameter	Average Concentration (mg/l)	Parameter	Average Concentration (mg/l)
COD	12	Fe	.2
BOD	2	Mn	.03
Phenols	.01	Cu	.01
MBAS	.05	Pb	.01
CO_2	5	Hg	.001
OP	.04	Cl	10
TP	.1	SO_4	20
NH_3-N	.2	TDS	150
NO_2-N	.02	Na	15
NO_3-N	.7	Mg	5
TKN	.3	Ca	25
Si	3.0	K	2
F	.2	SpC (µmhos/cm)	180
TSS	30		

protection and propagation of fish, shellfish, and wildlife, and for recreation in and on the nation's waters by July, 1983.

The Environmental Protection Agency (EPA) has issued effluent limitation guidelines and standards for the steam electric power generating point source category to bring the industry into compliance with the 1972 Act mentioned above. These rules were published in draft form in the Federal Register (39 (43), 8294) on March 4, 1974. Other industries are bound by similar rules issued under Title 40 of the Code of Federal Regulations, Parts 401 to 435. Municipalities must also comply with the law and increase the effectiveness of municipal wastewater treatment.

Table VII-2 indicates those parameters that may be included in the effluent limitations and guidelines. It is important to note that besides the substances contributed by municipal and industrial sources, chemicals may also enter the water from natural processes, agricultural practices, urban runoff, or from accidental chemical spills. Because of the lack of intensive study on most of the parameters, it is often quite difficult to determine accurately the percentage of constituent contributed by each potential source.

As a means of providing perspective for specific values of water quality parameters, Tables VII-3 through VII-5 indicates the approximate concentration ranges in North American rivers and in sea water for several of these parameters.

The EPA has established proposed water quality criteria for many of the parameters listed in Table VII-2. These criteria are listed in Table VII-6. Brief discussions are provided in Appendix VII-B for certain environmental

TABLE VII-2

GUIDELINES AND REGULATIONS FOR EFFLUENT PARAMETERS FROM STEAM ELECTRIC POWER PLANTS

PARAMETER	GUIDELINE AND REGULATION CODE (see Key below)
Acidity	1
Alkalinity	1, 4(A)
Aluminum	1(WS), 2(US), 3
Boron	1(P), 2(P), 3
Bromide	1, 3
Cadmium	1(P), 2(P)
Chloride	1, 3 4(B)
Chlorine	1(WS), 2(US), 3(LS)
Chromium	1(WS), 2(US), 3(LS), 4(B)
Coliform, Fecal	1, 3, 5
Copper	1(WS) 2(US), 3(LS)
Fluoride	1, 3
Hardness	1, 3
Iron	1(WS), 2(US), 3(LS)
Lead	1(P), 2(P), 3
Magnesium	1, 3
Manganese	1, 3
Mercury	1(WS), 2(US), 3
Nickel	1(P), 2(P)
Nitrogen - ammonia	1(WS), 2(US), 3, 4(A), 5
- nitrate	1, 3, 4(A), 5
- organic	5
- TKN	4(A), 5
Oil and Grease	1(WS), 2(US), 3(LS)
Oxygen - dissolved	5
- BOD	1(WS), 2(US), 3, 4(A), 5
- COD	1(WS), 2(US), 3, 4(A)
Phenols	1(WS), 2(US), 3, 4(B)
pH	1(C), 2(M), 3(LS), 5
Phosphorus - ortho	5
- total	1(WS), 2(US), 3(LS), 4(A), 5
Salinity	5
Salenium	1(P), 2(P), 3
Solids - TDS	1(C), 2(M), 3, 4(A), 5
- TSS	1(C), 2(M), 3(LS), 4(A), 5
- TS	3, 4(A)
- TVS	4(A)
Sulfur - Sulfate	1(WS), 2(US), 3, 4(B)
- Sulfite	1(WS), 2(US), 3
Surfactants	1, 3
Turbidity	1, 3
Vanadium	1(WS), 2(US), 3
Zinc	1(WS), 2(US), 3(LS), 4(B)

CODE KEY
NUMERALS

1. Burns and Roe Contractors Report for EPA Guidelines (Section VI0

2. EPA Action Memorandum - Review of B&R Report (Tab C p44)

3. Federal Register, 39, 8292 (1974, Monday, March 4).
   40 CFR 423 (b) (2) (ii)

4. U.S. Army Corp of Engineers Permit Applications - Section A & B

5. Article VIII of the Public Service Commission - Section 80.2
   (b) (2) (ii)

LETTERS

US - variable significance

P - potentially significant

WS - low volume waste streams

C - large volume composite stream

M - major significance

LS - limits set

A - Part A

B - Part B

No letter - mentioned, no source or significance attached

TABLE VII-3

MEAN COMPOSITION OF RIVER WATERS

IN NORTH AMERICA*

PARAMETER	CONCENTRATION (mg/l)
Bicarbonate	68
Sulfate	20
Chloride	8
Nitrate	1
Calcium	21
Magnesium	5
Sodium	9
Potassium	1.4
Iron	0.16
Silica	9

*D.A. Livingstone, "Chemical Composition of Rivers and Lakes", Geol. Survey Prof. Paper 440-G, 1963.

TABLE VII-4

SUMMARY OF TRACE ELEMENTS IN

WATERS OF THE UNITED STATES*

Element	Frequency of Detection %	Observed Concentration (mg/l) Minimum	Mean	Maximum
Silver	6.6	0.0001	0.0026	0.038
Aluminum	31.2	0.001	0.074	2.760
Arsenic	5.5	0.005	0.064	0.336
Boron	98.0	0.001	0.101	5.000
Barium	99.4	0.002	0.043	0.340
Beryllium	5.4	0.00001	0.00019	0.00122
Cadmium	2.5	0.001	0.0095	0.120
Cobalt	2.8	0.001	0.017	0.048
Chromium	24.5	0.001	0.0097	0.112
Copper	74.4	0.001	0.015	0.280
Iron	75.6	0.001	0.052	4.600
Manganese	51.4	0.0003	0.058	3.230
Molybdenum	32.7	0.002	0.068	1.500
Nickel	16.2	0.001	0.019	0.130
Phosphorus	47.4	0.002	0.120	5.040
Lead	19.3	0.002	0.023	0.140
Strontium	99.6	0.003	0.217	5.000
Vanadium	3.4	0.002	0.040	0.300
Zinc	76.5	01002	0.064	1.183

Total of 1,577 samples

* J.F. Kopp and R.C. Kroner, Trace Metals in Waters of the United States, U.S. Dept. of Interior, FWPCA, Cincinatti, Ohio, 1967.

TABLE VII-5

ELEMENTS PRESENT IN SOLUTION

IN SEA WATER EXCLUDING DISSOLVED GASES*

ELEMENT	CONCENTRATION, ppm
Cl	18.980
Na	10.561
Mg	1,272
S	884
Ca	400
K	380
Br	65
C (Inorganic)	28
Sr	13
Si	0.02-4.0
B	4.6
C (Organic)	1.2-3.0
Al	0.16-1.9
F	1.4
N (as NO_3)	0.001-0.7
N (as organic N)	0.03-0.2
Li	0.1
P (as phosphate)	0.001-0.1
Ba	0.006-0.090
I	0.05
N (as nitrite)	0.0001-0.05
N (as ammonia)	0.005-0.05
As (as arsenite)	0.003-0.024
Fe	0.002-0.060
P (as organic P)	0-0.016
Zn	0.005-0.021
Cu	0.001-0.09
Mn	0.001-0.01
Pb	0.004-0.005
Se	0.004-0.006
Sn	0.003
Mo	0.0003-0.011
Ni	0.0001-0.0026
V	0.0002-0.0046
Hg	0.00003
Ag	0.00015-0.0003
Co	0.0001-0.0077
Cd	0.00003
Cr	0.00004-0.0025

* C.R. Parker, Handbook of Chemistry and Physics, 1961, and Water Analysis by Atomic Absorption Spectroscopy, Varian Techtron, 1972.

TABLE VII-6

PROPOSED EPA WATER QUALITY CRITERIA
RELEVANT TO STEAM ELECTRIC POWER PLANTS

CLASSIFICATION

	PUBLIC SUPPLY	FRESHWATER AQUATIC LIFE	MARINE WATER AQUATIC LIFE	RECREATIONAL WATERS	WILDLIFE
ACIDITY	NL	Addition of acids unacceptable	-	-	-
ALKALINITY	NL	75% natural level	-	-	30-130 mg/l
ALUMINUM	-	-	1/100 96-hr. LC 50 <1.5 mg/l.	-	-
BORON	1.0 mg/l	-	1/10 96-hr. LC_{50} ~4.5 mg/l. ambient	-	-
BROMIDE	-	-	0.1 mg/l (free) 100 mg/l (ionic)	-	-
CADMIUM	0.01 mg/l	0.03 mg/l (hard) 0.004 mg/l (soft)	1/100 96 hr. LC_{50} <0.01 mg/l		
CHLORIDE	250 mg/l	-	-	-	-
CHLORINE	-	0.003 mg/l or 0.05 mg/l (30 min)	1/10 96 hr. LC_{50} <0.01 mg/l	-	-

Quirk, Lawler & Matusky Engineers

TABLE VII-6 (Continued)

	PUBLIC SUPPLY	FRESHWATER AQUATIC LIFE	MARINE WATER AQUATIC LIFE	RECREATIONAL WATERS	WILDLIFE
CHROMIUM	0.05 mg/l	0.03 mg/l	1/100 96-hr. LC_{50} <0.1 mg/l	-	-
COLIFORM, FECAL	2000/ 100 ml	-	-	2000/100 ml (Avg.) 4000/100 ml (max.)	-
COPPER	1 mg/l	1/10 96-hr. LC_{50}	1/100 96-hr. LC_{50} <0.05 mg/l	-	-
FLUORIDE	-	-	1/10 96-hr. LC_{50} <1.5 mg/l		
HARDNESS	NL	Bioassay	-	-	-
IRON	0.3 mg/l	-	0.3 mg/l	-	-
LEAD	0.05 mg/l	0.03 mg/l	1/50 96-hr. LC_{50} or 1/100 LD_{50}		
MAGNESIUM	-	-	-	-	-
MANGANESE	0.05 mg/l	-	1/50 96-hr. LC_{50} <0.01 mg/l	-	-

TABLE VII-6 (Continued)

	PUBLIC SUPPLY	FRESHWATER AQUATIC LIFE	MARINE WATER AQUATIC LIFE	RECREATIONAL WATERS	WILDLIFE
MERCURY	0.002 mg/l total	0.2µg/l (total) 0.05µg/l (avg conc) 0.5µg/g (BOdy Burden)	1/100 96-hr. LC_{50} <1µg/l	-	0.5µg/g in fish
NICKEL	-	1/50 96-hr. LC_{50}	1/50 96-hr. LC_{50} <0.1 mg/l	-	-
NITROGEN-AMMONIA	0.5 mg/l	1/20 96-hr. LC_{50} <0.02 mg/l	0.4 mg/l	-	-
NITROGEN-NITRATE	10 mg/l	-	-	-	-
NITROGEN-ORGANIC	-	-	-	-	-
NITROGEN-TOTAL KJELDAHL	-	-	-	-	-
OIL AND GREASE	-	No visible oil 1/20 96-hr. LD_{50} Sediments: 1000 mg/kg	No film or odor No Tainting of fish No onshore oil deposit	-	No visible floating oils
OXYGEN-DISSOLVED	NL	detailed table	6.0 mg/l	-	-
OXYGEN DEMAND-BIOLOGICAL	-	-	-	-	-
OXYGEN DEMAND-CHEMICAL	-	-	-	-	-

Quirk, Lawler & Matusky Engineers

TABLE VII-6 (Continued)

	PUBLIC SUPPLY	FRESHWATER AQUATIC LIFE	MARINE WATER AQUATIC LIFE	RECREATIONAL WATERS	WILDLIFE
PHENOLS	1µg/l	1/20 96-hr. LC_{50} <0.1 mg/l	-	-	-
pH	5.0-9.0	6.0-9.0	6.5-8.5	6.5-8.3 (acceptable) 5.0-9.0 (manditory)	6.0-9.0
PHOSPHORUS-ORTHO (ATE)	-	-	-	-	-
PHOSPHORUS-TOTAL (ATE)	-	-	-	25µg/l (Lakes + res) 50µg/l (confluence) 100µg/l (streams)	
SALINITY	-	-	-	-	No rapid fluctuations
SELENIUM	0.01 mg/l	-	1/100 96-hr. LC_{50} <0.01 mg/l	-	-
SOLIDS - TDS	NL	Bioassays	-	-	-
SOLIDS - TSS	-	-	-	-	-
SOLIDS - TS	-	-	-	-	-
SOLIDS - TVS	-	-	-	-	-
SULFUR - SULFATE	250 mg/l	-	-	-	-
SULFUR - SULFITE	-	-	-	-	-

TABLE VII-6 (Continued)

	PUBLIC SUPPLY	FRESHWATER AQUATIC LIFE	MARINE WATER AQUATIC LIFE	RECREATION WATERS	WILDLIFE
SURFACTANTS	-	1/20 96-hr. LC_{50} <0.2 mg/l (LAS)	-	-	-
TURBIDITY	NL	<10%	-	4 ft. secchi	-
VANADIUM	-	-	1/20 96-hr. LC_{50}	-	-
ZINC	5 mg/l	5/1000 96-hr. LC_{50}	1/100 96-hr. LC_{50} <0.1 mg/l	-	-

parameters of interest to the present study. These descriptions are intended to give some basic insight into the relevance of the various water constituents.

(c) Hudson River Classification and Water Quality Standards. The water in the Lower Hudson River has been classified by the New York State Department of Environmental Conservation (NYSDEC) as follows:

Location Description	Mile Point	Section Length (miles)	Class
Battery	0.0	22	Special Class I
New York-New Jersy Line	22	24.7	SB
Bear Mountain Bridge	46.7	17.3	B
Vicinity of Newburgh and Chelsea	64	61	A
South of Albany	125	28.7	C
Federal Dam at Troy	153.7		

The Hudson River in the vicinity of Roseton (Low Point on east shore, Roseton on west shore) changes from Class B waters downstream to Class A waters upstream. The Roseton plant lies close to the boundary cited by NYSDEC. The existing NYSDEC operating permit for the Roseton cooling water discharge places the discharge in Class B waters. Permits for the Danskammer Point plant place the discharge in Class A waters.

The NYSDEC permits the discharge of wastes to waterways only if the best usage of the receiving waters or any other state waters into which the receiving waters may flow is not impaired. The water quality standards for

Class 'A' and 'B' waters are presented in Table VII-7. The Hudson River in the Roseton/Danskammer Point vicinity may, on occasion, have characteristics outside the limits described above, which relate to the condition of the waters as they are affected by man-made discharges and not the natural variations.

B. METHODS AND PROCEDURES

1. General

The 1973 Roseton-Danskammer Point water quality sampling program consisted of a set of six stations sampled on a monthly basis. These stations were selected so as to furnish data that would be representative of the river section under study. The locations of the six stations are shown in Figure VII-19 and a description of each station is contained in Table VII-8.

A list of the water quality parameters selected for monthly analysis is contained in Table VII-9. These parameters were selected either on the basis of a relationship to discharges from the plants or because they were judged to be important in describing the water quality of the study area.

In addition to the monthly collection of water samples for extensive analysis, field measurements of some parameters were made on a more frequent basis in conjunction with biological field collections.

TABLE VII-7

NEW YORK STATE WATER QUALITY CRITERIA
CLASS A AND CLASS B WATERS

CLASS "A"

Best usage of waters. Source of water supply for drinking, culinary or food processing purposes and any other usuages.

Conditions related to best usage of waters. The waters, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to reduce naturally present impurities will meet New York State Department of Health drinking water standards and will be considered safe and satisfactory for drinking water purposes.

QUALITY STANDARDS FOR CLASS "A" WATERS

ITEMS	SPECIFICATIONS
1. Coliform	The monthly median coliform value for one hundred ml of sample shall not exceed five thousand from a minimum of five examinations and provided that not more than twenty percent of the samples shall exceed a coliform value of twenty thousand for one hundred ml of sample and the monthly geometric mean fecal coliform value for one hundred ml of sample shall not exceed two hundred (200) from a minimum of five examinations.
2. pH	Shall be between 6.5 and 8.5.
3. Total Dissolved Solids	Shall be kept as low as practicable to maintain the best usage of waters, but in no case shall it exceed 500 milligrams per liter.
4. Dissolved Oxygen	For cold waters suitable for trout spawning, the DO concentration shall not be less than 7.0 mg/l from other than natural conditions. For trout waters, the minimum daily average shall be not less than 6.0 mg/l. At no time shall the DO concentration be less than 5.0 mg/l. For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l. At no time shall the DO concentration be less than 4.0 mg/l
5. Phenolic Compounds	Shall not be greater than 0.005 milligrams per liter (phenol).
6. Radioactivity	
a. Gross Beta	Shall not exceed 1,000 picocuries per liter in the absence of Sr^{90} and alpha emitters.
b. Radium 226	Shall not exceed 3 picocuries per liter.
c. Strontium 90	Shall not exceed 10 picocuries per liter.

TABLE VII-7
(Continued)

NOTE 1: With reference to certain toxic substances affecting fishlife, the establishment of any single numerical standard for waters of New York State would be too restrictive. There are many waters, which because of poor buffering capacity and composition will require special study to determine safe concentrations of toxic substances. However, most of the non-trout waters near industrial areas in this State will have an alkalinity of 80 milligrams per liter or above. Without considering increased or decreased toxicity from possible combinations, the following may be considered as safe stream concentrations for certain substances to comply with the above standard for this type of water. Waters of lower alkalinity must be specifically considered since the toxic effect of most pollutants will be greatly increased.

Ammonia or Ammonium Compounds	Not greater than 2.0 milligrams per liter expressed as NH, at pH of 8.0 or above.
Cyanide	Not greater than 0.1 milligrams per liter expressed as CN.
Ferro-or Ferricyanide	Not greater than 0.4 milligrams per liter expressed as Fe(CN)6.
Copper	Not greater than 0.2 milligrams per liter expressed as Cu.
Zinc	Not greater than 0.3 milligrams per liter expressed as Zn.
Cadmium	Not greater than 0.3 milligrams per liter expressed as Cd.

CLASS "B"

Best usage of waters. Primary contact recreation and any other uses except as a source of water supply for drinking, culinary or food processing purposes.

QUALITY STANDARDS FOR CLASS "B" WATERS

ITEMS	SPECIFICATIONS
1. Coliform	The monthly median coliform value for one hundred ml of sample shall not exceed two thousand four hundred from a minimum of five examinations and provided that not more than twenty percent of the samples shall exceed a coliform value of five thousand for one hundred ml of sample and the monthly geometric mean fecal coliform value for one hundred ml of sample shall not exceed two hundred (200) from a minimum of five examinations. This standard shall be met during all periods when disinfection is practiced.
2. pH	Shall be between 6.5 and 8.5.
3. Total Dissolved Solids	None at concentrations which will be detrimental to the growth and propagation of aquatic life. Waters having present levels less than 500 milligrams per liter shall be kept below this limit.
4. Dissolved Oxygen	For cold waters suitable for trout spawning, the DO concentration shall not be less than 7.0 mg/l from other than natural conditions. For trout waters, the minimum daily average shall not be less than 5.0 mg/l. For non-trout waters, the minimum daily average shall not be less than 5.0 mg/l. At no time shall the DO concentration be less than 4.0 mg/l

TABLE VII-8

WATER QUALITY SAMPLING STATIONS: 1973
ROSETON/DANSKAMMER POINT VICINITY

STATION DESIGNATION	DESCRIPTION
CH-1	North Control - off wooden railroad trestle in deepest section of channel; sample surface and bottom.
CH-2	Danskammer Point Intake - immediately in front of bar racks; sample surface and bottom (approximately 25').
CH-3	Roseton Intake - immediately in front of bar racks; sample surface and bottom (approximately 25').
CH-4	Roseton Deep East - east side of channel at deepest point (approximately 80'); sample surface mid-depth and bottom.
CH-5	Roseton Shallows East - east side of river at same depth as Roseton Intake; sample surface and bottom.
CH-6	South Control - north of the Newburgh-Beacon Bridge in the area described on the navigation maps as Balmville. Just north of a slight projection of land on which contemporary house is located is a small tributary. The station is just north of the creek, at the deepest point in the channel; sample surface and bottom.

TABLE VII-9

WATER QUALITY ANALYSES

ROSETON/DANSKAMMER POINT VICINITY

STATION DESIGNATION	MILE POINT	STATION LOCATION	ANALYSES	REMARKS
CH-1	68.2	NCS	Alk, BOD_5, COD, TS, TDS, TVS, TSS, NH_3-N, TKN, NO_3-N, TP, Cl, SO_4, Cr, Zn, Phl, DO, pH, SpC, T	Preserve sample for possible future testing for Cu, Ni, Pb, Fe, V, Mg, Mn; Grab Samples
CH-1	68.2	NCB	"	"
CH-2	66.7	DIS	"	"
CH-2	66.7	DIB	"	"
CH-3	66.2	RIS	"	"
CH-3	66.2	RIB	"	"
CH-4	66.5	RE80S	"	"
CH-4	66.5	RE80M	"	"
CH-4	66.5	RE80B	"	"
CH-5	66.5	RE25S	"	"
CH-5	66.5	RE25B	"	"
CH-6	62.7	SCS	"	"
CH-6	62.7	SCB	"	"

STATION LOCATIONS

NC = North Control
DI = Danskammer Intake
RI = Roseton Intake
RE80 = Roseton Deep East
RE25 = Roseton Shallow East
SC = South Control
S = Surface
M = Mid-Depth
B = Bottom

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2. Field Collection Procedures

Monthly grab samples for water quality analysis were collected with a Kemmerer water sampler or similar device, transferred to plastic sample containers, stored in refrigerated coolers, and transported to the laboratory for analysis. In addition to the water quality sample, a sample for dissolved oxygen analysis was taken and fixed in the field, or dissolved oxygen readings were obtained using YSI or Martek® D.O. meters with submersible probe. For all samples, water temperature was measured using a temperature instrument with submersible sensors.

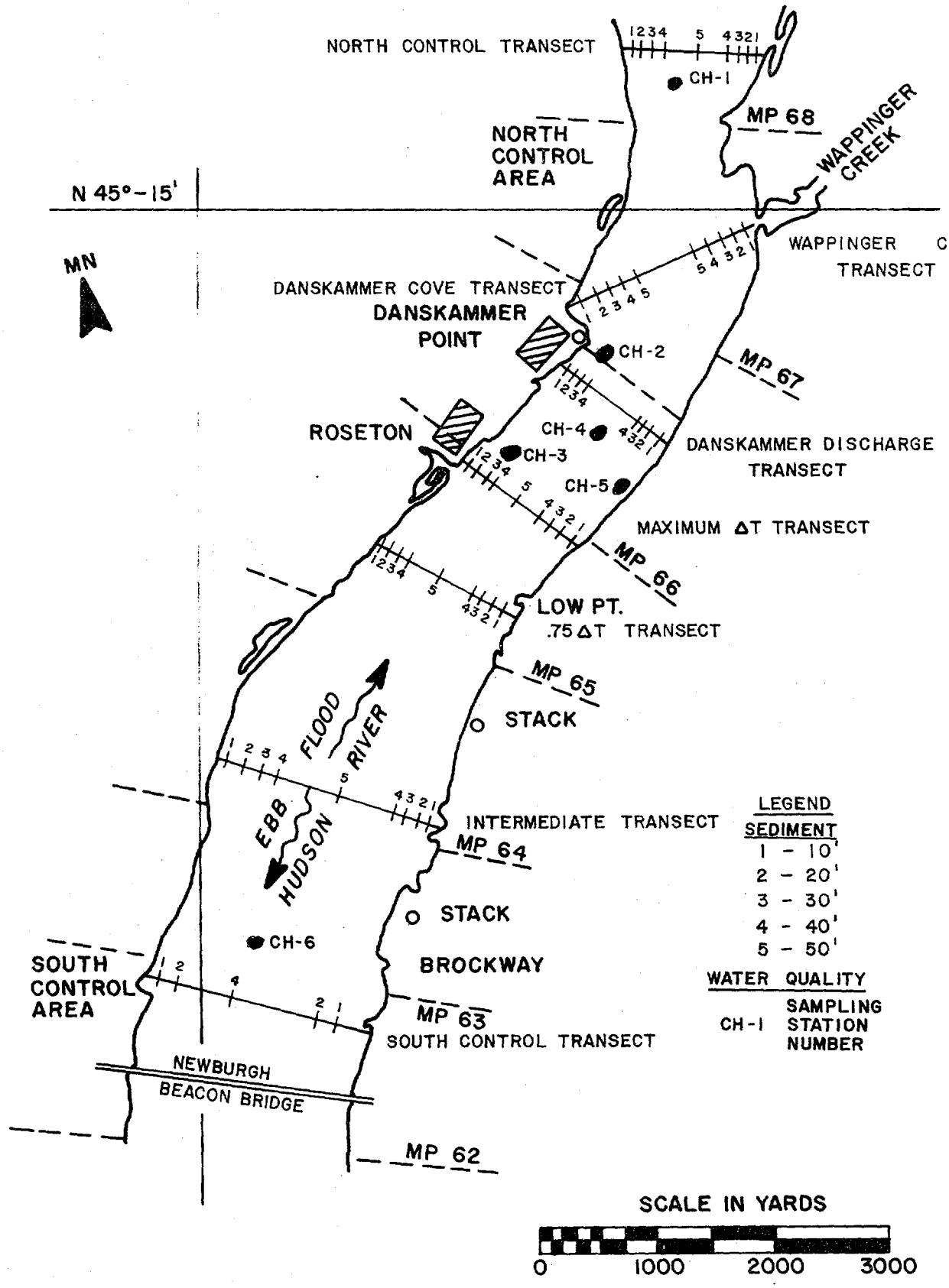
If instrumentation was available, pH and specific conductivity were measured in the field; otherwise these parameters were measured at the laboratory. The field measurements done in conjunction with the biological collections were obtained with either a YSI or Martek® IV instrument, with samples occasionally being collected for calibration checks.

In order to characterize the bottom sediments in the Roseton-Danskammer Point area, core samples were obtained from selected benthic sampling stations during October 1973. The locations of the core samples are shown in Figure VII-19. Core samples were taken along transects at ten (10) foot depth intervals.

All samples were obtained by a gravity tube corer, equipped with a plastic tip and plastic core liners. Egg shell core catchers were used to prevent loss of sample during sample retrieval.

CENTRAL HUDSON GAS AND ELECTRIC

WATER QUALITY AND SEDIMENT SAMPLING STATIONS 1973



3. Laboratory Analytical Procedures

The U.S. Environmental Protection Agency has promulgated guidelines establishing test procedures for the analysis of pollutants. These methods of analysis are outlined in the Federal Register (38 (199), 28758), dated October 16, 1973. They are also included under Title 40 of the Code of Federal Regulations, Part 136.

All analyses presently conducted conform to these guidelines. Permission has been requested through the EPA Region II laboratory to use current standard methods for fluoride and selenium only. Analyses for parameters not covered in the EPA documents generally conform to accepted procedures published in one of the following documents:

STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTE WATER, 13th Edition, 1971. This publication is available from the American Public Health Association.

ANNUAL BOOK OF STANDARDS, Part 23, "Water, Atmospheric Analysis," 1972. This publication is available from the American Society for Testing and Materials.

METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, 1971. Environmental Protection Agency. A new edition is in final draft form.

All of the sediment characterization samples were analyzed for percentage of organic material and for inorganic particle size distribution. Additional analyses were done on selected samples to determine chemical characteristics of the wet sediments.

Samples for analysis of organic material were weighed, dried at 103°C and reweighed. The samples were then ashed at 550°C and carefully ground with a rubber pestle. Particles greater than 2mm in diameter were removed and their weight recorded as "stones."

A sample of known weight, usually 50 gm, was placed in a beaker, deflocculated with approximately 0.2% Sodium Silicate solution, transferred to a one liter cylinder, diluted to 1.0 liter, and allowed to settle. Periodic hydrometer and thermometer readings resulted in determination of particle size distribution by application of Stoke's Law, assuming a particle density of 2.65 gm/ml.

C. RESULTS AND DISCUSSION

Results of water quality sampling conducted in 1971 and 1972 in the Roseton/ Danskammer Point vicinity of the Hudson River have been reported previously (Quirk, Lawler & Matusky Engineers, 1973a). The results presented herein refer to the 1973 program only; where appropriate the results of previous sampling programs are discussed. Results of the 1973 sampling program are presented in Appendix VII-C.

1. Flow and Salinity

As discussed previously the extent of salinity intrusion in an estuary is related inversely to the freshwater flow. Figure VII-20 shows the monthly average freshwater flows at Green Island for 1973 and for the 25 year period 1949-1973. Figure VII-21 presents weekly average flows for 1973 at Green Island and also corrected values for the Lower Hudson (an average correction of 1.225 was used for all flows).

Figure VII-20 indicates that 1973 was a high flow year, relative to the 25 year average, especially during the winter months. The high winter flows were probably due to the lack of an extended freeze or snow building during the year. The intermittent warm spells allowed the precipitation to run off almost continually.

The dry summer is indicated by lower than average flows during late summer and early fall. These low summer flows somewhat balanced the high winter flows. The 1973 yearly average flow was 17,670 cfs as compared to the 25-year average of 13,070 cfs, again indicating a high flow year.

It should be pointed out that the yearly average flow in 1973 (17,670 cfs) was less than the yearly average flow in 1972 (18,670 cfs). Both years, while considered high flow years with respect to the 25 year average, approximated the conditions exhibited by the long term (1918-1970) yearly average (18,200 cfs) as shown in Figure VII-7.

The 1973 weekly average flows were used, along with chloride data from the Lower Hudson to indicate location of the salt front (defined herein as 100 ppm salinity in excess of freshwater salinity) over the year (Figure VII-22),

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

HUDSON RIVER FLOW AT GREEN ISLAND - 1973

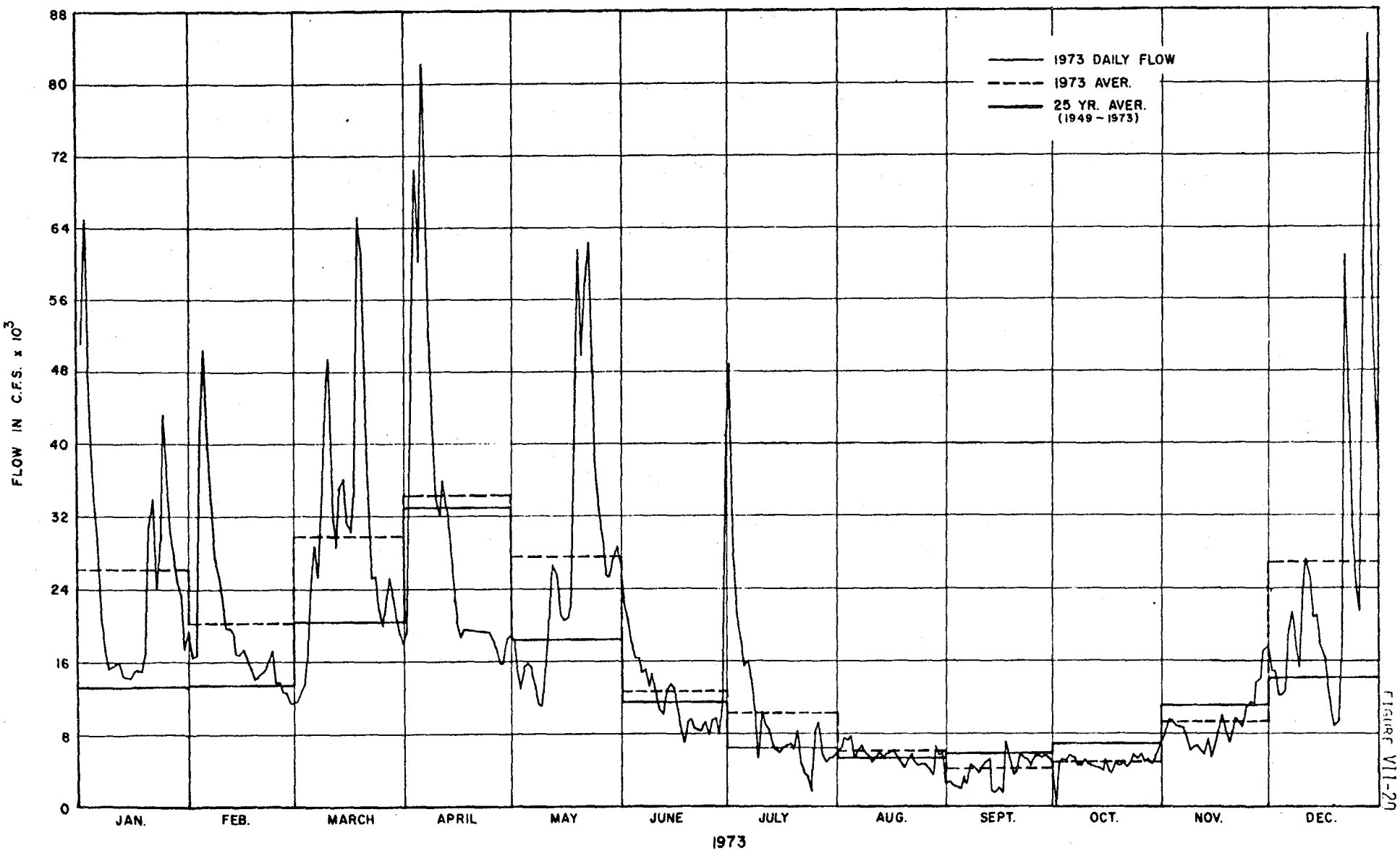


FIGURE VII-2A

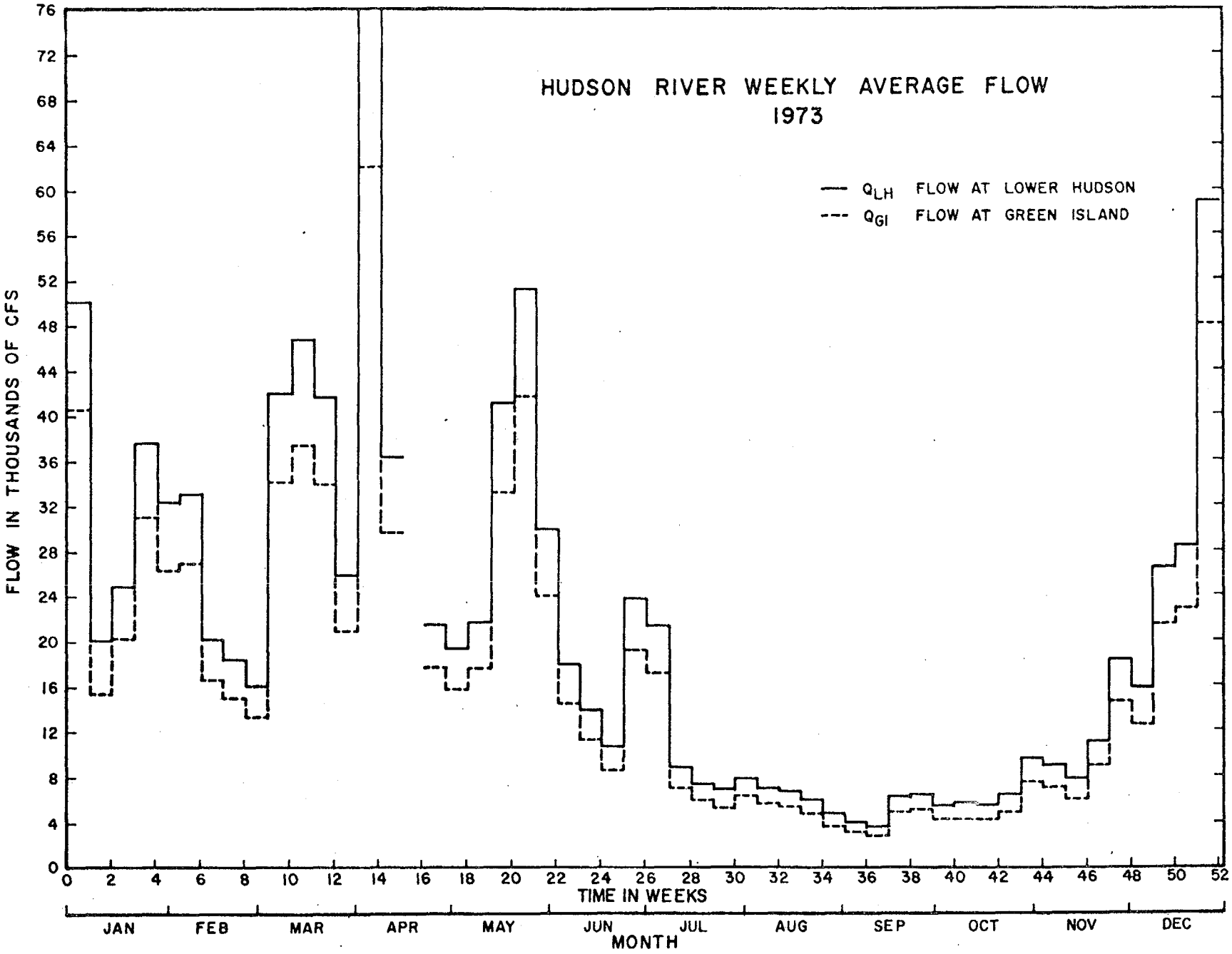


FIGURE VII-21

HUDSON RIVER WEEKLY LOCATION OF SALT FRONT
1973

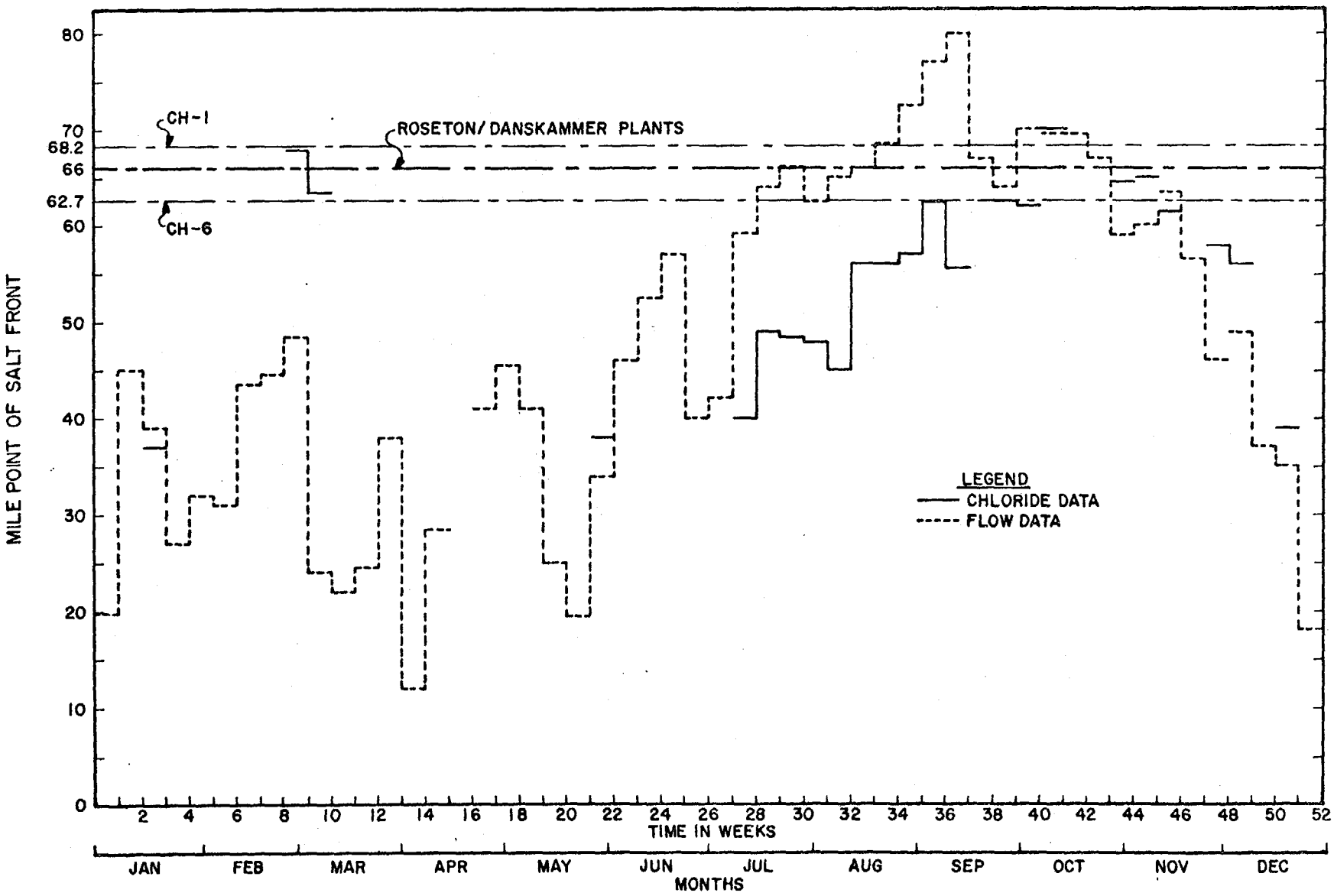


FIGURE VII-22

using the generalized mean salinity profiles (see Figure VII-23) and assuming steady state conditions. The chloride based curve was constructed by converting measured chloride values to excess salinity using the equation S(ppm) = 1.8 Cl(ppm) + 30 ppm, and assuming 15 ppm chlorides in freshwater.

Using the calculated salinity and known mile point, the corresponding flow was determined from Figure VII-23. The flow based plot was constructed for a given flow by determining the mile point of the 100 ppm concentration.

The discrepancy between the results of the two methods, most obvious in spring and early summer, is most likely due to the steady state assumption. This is borne out by the fact that during the period of decreasing flow (mid-May to mid-September) the mile point predictions based on flow are higher than those based on chlorides, indicating that there is a lag between observed flow at Green Island and true flow down river, which was the expected result.

Under rising flow conditions (late October-December) the effect of the lag would be to make the flow-based mile point prediction low relative to the chloride based value, which is also demonstrated in Figure VII-22. The predictions of both methods agree quite closely for the time period from mid-September to late October. An examination of Figure VII-21 shows this time period to be one of stable flow conditions, approximating steady state, when the predictions were expected to be the most accurate.

The steady state model predicts that the salt front (excess salinity of 100 ppm) would reach the Roseton/Danskammer Point area when river flow decreases below approximately 7000 cfs, which occurred from mid-August to late

HUDSON RIVER
GENERALIZED MEAN SALINITY PROFILES
STEADY-STATE CONDITIONS

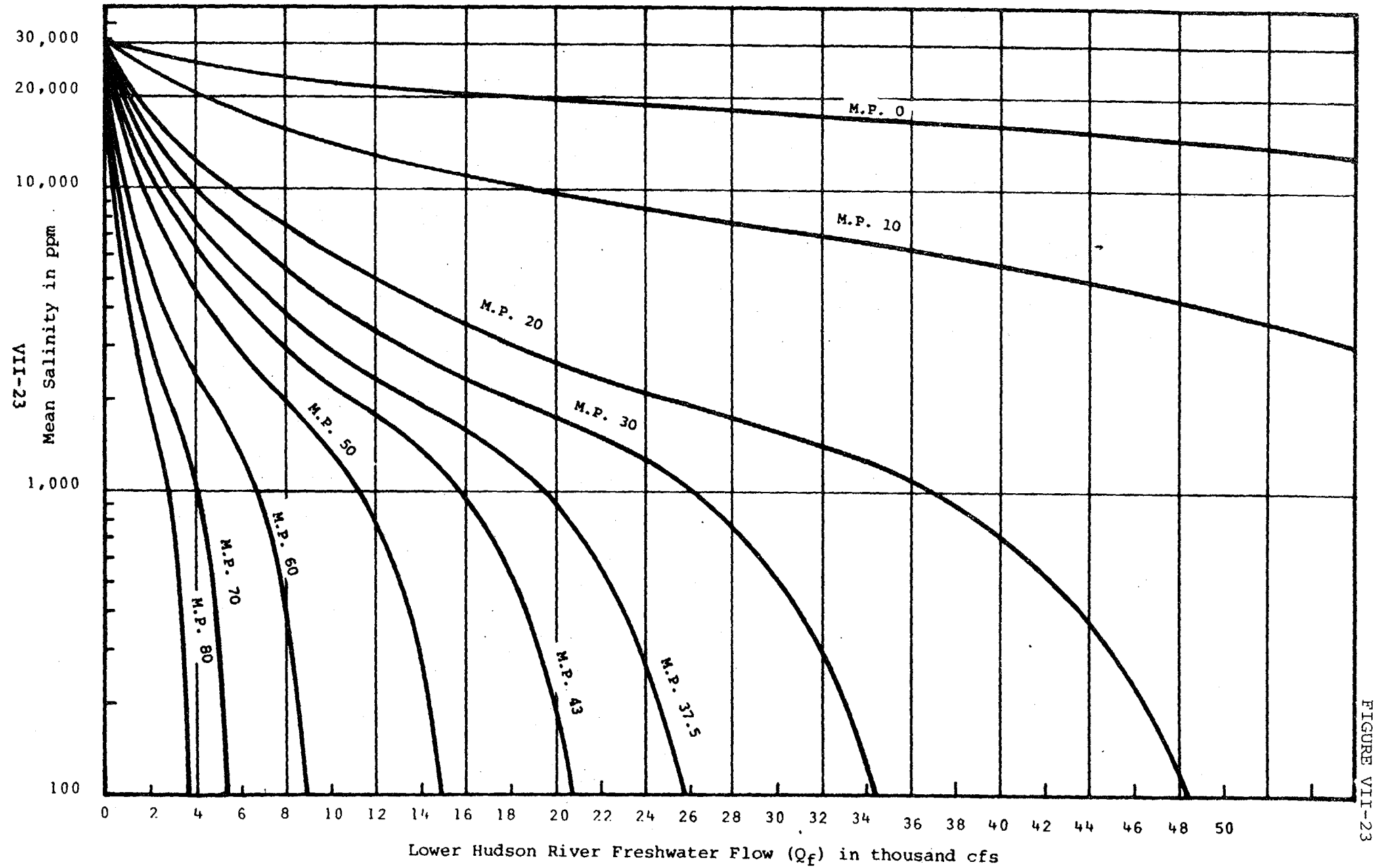


FIGURE VII-23

October in 1973 in the Lower Hudson (see Figure VII-21). Based on the previous discussion of the existence of steady state conditions from mid-September through late October (flow of 6000-7000 cfs) the salt front would be expected to be in the Roseton/Danskammer Point area during that period.

Figure VII-24 shows the concentration of NaCl at the Danskammer Point intake during 1973, based on measurements made by Central Hudson personnel. The NaCl concentration equivalent to 100 ppm excess salinity approached or intersected the curve from mid-September through early November and again in late November through mid-December, with some time in between not included. The above analyses and data indicate significant intrusion of the salt front up the estuary to Roseton/Danskammer Point occurred only during the late summer and early fall.

Figure VII-24 also illustrates the variability of chlorides from day to day. This variability was due in part to variations of sampling time with respect to tidal phase and in part due to the highly variable nature of chlorides and associated parameters in the immediate vicinity of the salt front. In this immediate area, there will be significant vertical and lateral salinity variations and the patterns of such variations will change rapidly in time.

In addition there will be a significant and persistent longitudinal variation. Figure VII-22 illustrates that the salt front may reach station CH-6 (South Control) several weeks before it reaches CH-1 (North Control), only 5 1/2 miles north of CH-6. These variations are further illustrated in the monthly chemical data, discussed later.

CENTRAL HUDSON GAS AND ELECTRIC CHLORIDE CONCENTRATION AT DANSKAMMER
1973

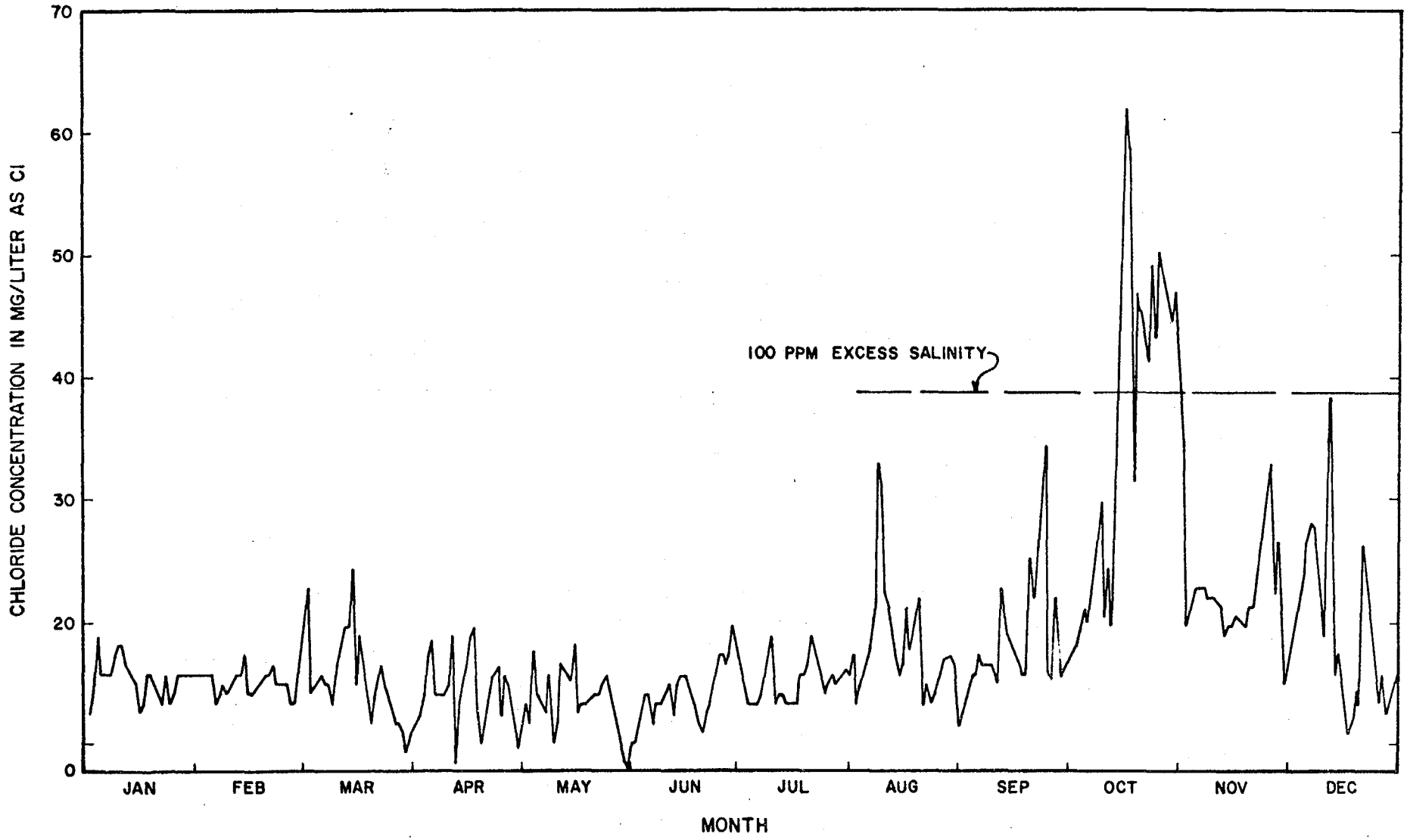


FIGURE VII-24

2. Temperature Distribution

Figure VII-25 shows river temperature versus time for three locations: Roseton/Danskammer Point (mile point 65), Lovett (mile point 42), and Bowline (mile point 37.5). These temperatures represent averages for each day of measurement over the time period of measurement at all depths at locations judged to be relatively unaffected by thermal discharges and representative of the main channel waters. The plot indicates the expected spring warming, summer equilibrium, and fall cooling trends.

There does not appear to be any significant difference between temperature changes at the three locations, over the year, but some variation on specific dates is shown. A short-term maximum of approximately 82.5°F at Bowline and Lovett is slightly higher than the short-term 81.0°F maximum observed at Roseton/Danskammer Point.

3. Dissolved Oxygen

Figure VII-26 is a plot of dissolved oxygen (D.O.) in the river over time for the Roseton/Danskammer Point area. The D.O.'s shown are averages over a sampling period at stations unaffected by the plant. If Figure VII-24 and VII-25 are compared, the inverse relationship of temperature and dissolved oxygen is clear. The combined effect at higher temperatures of lower gas solubility and increased bacterial activity at these temperatures would account for the decrease in dissolved oxygen concentration.

4. Chemical Parameters

(a) General. Complete analytical results of the monthly water quality surveys are presented in Appendix VII-C.

HUDSON RIVER TEMPERATURE
1973

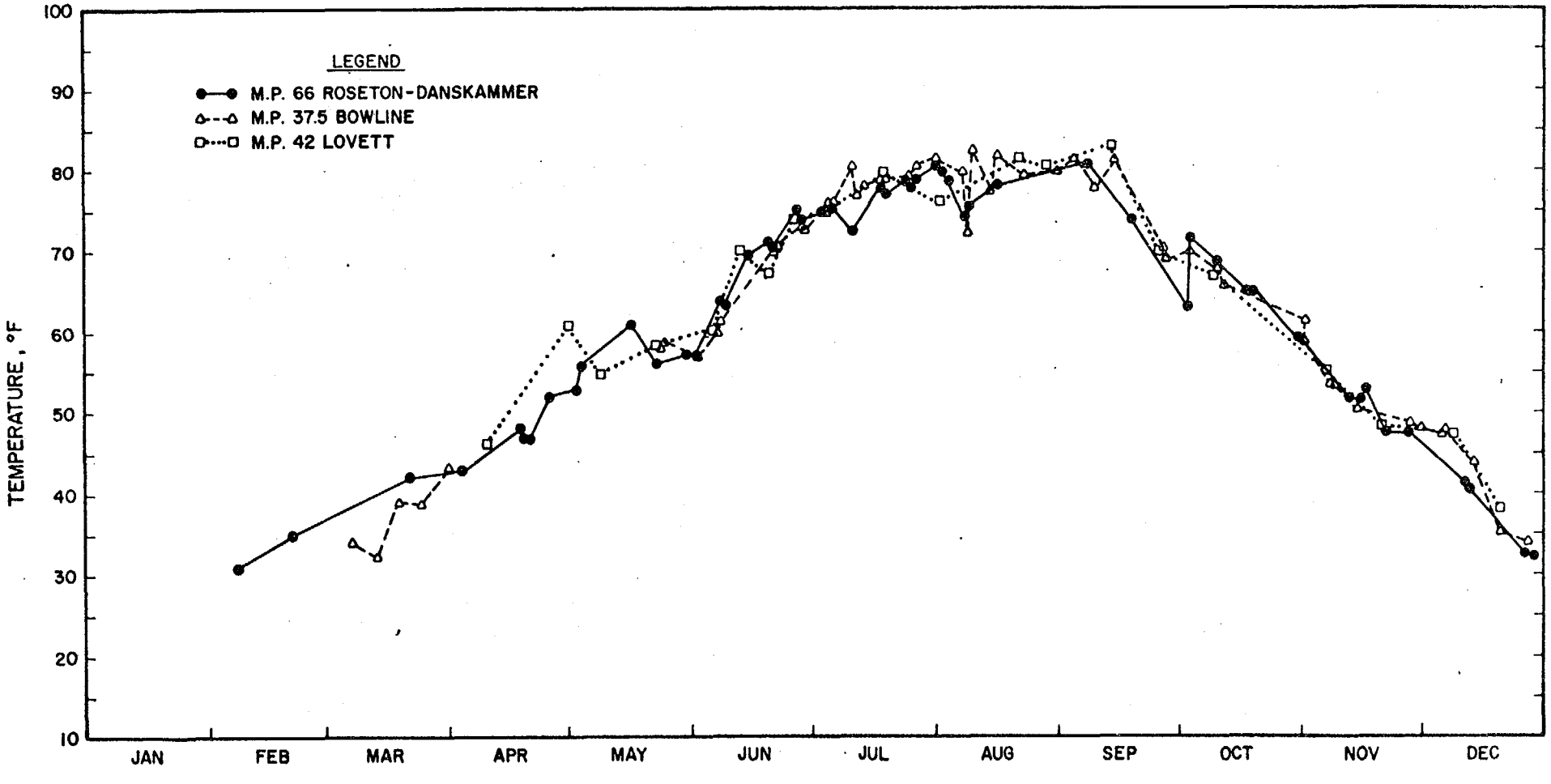


FIGURE VII-25

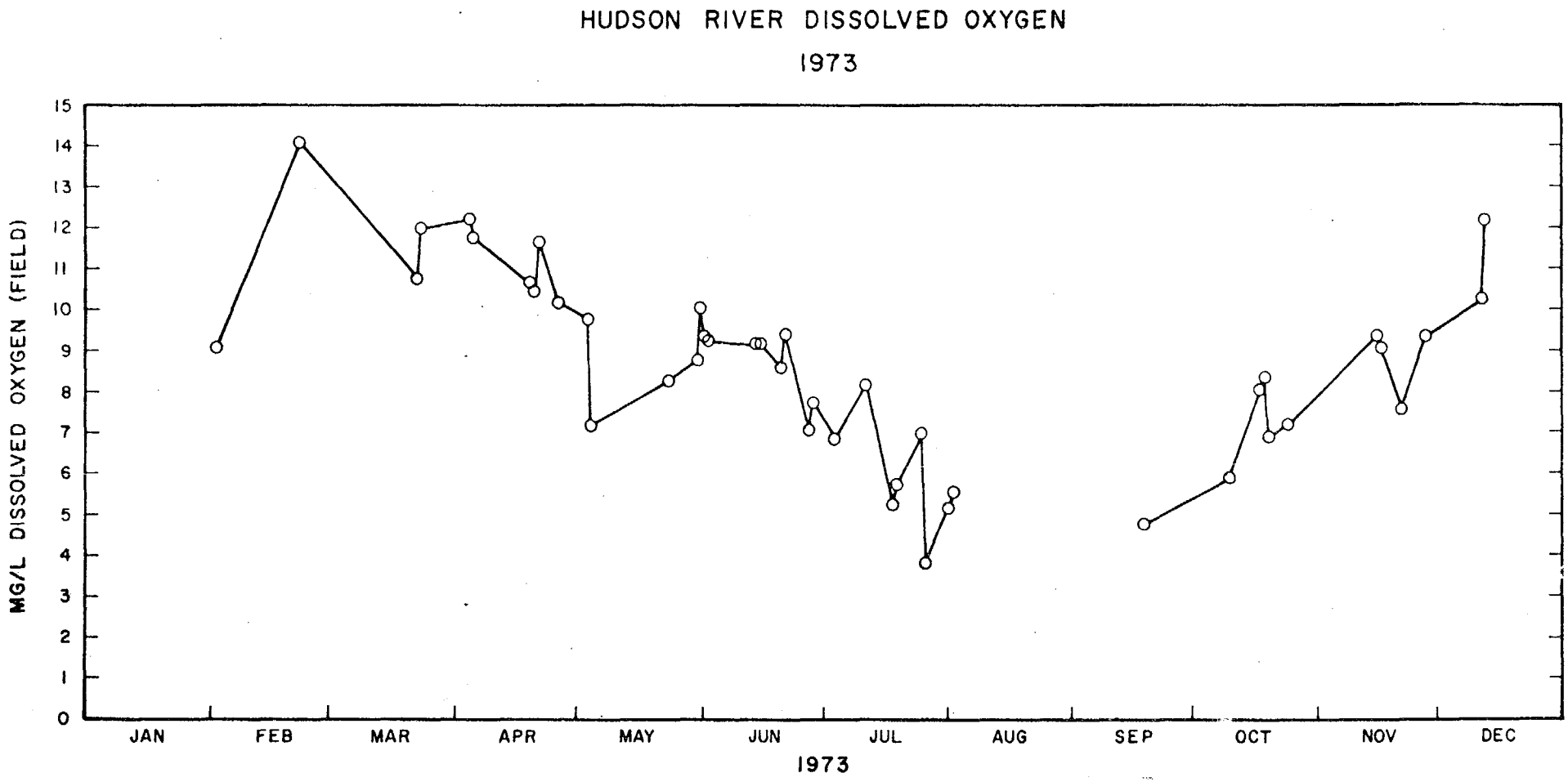


FIGURE VII-26

(b) Selected Data Presentations. For the data presented in this section, values for parameters affected by the suspended solids fraction have been deleted for four samples, which were bottom samples with unusually high suspended solids values. The samples were judged to be non-representative with respect to the particulate fraction as the result of disturbance of the sediment during sampling. Thus, values for TS, TVS, TSS, BOD, COD, TP, Zn, Cr, TKN, and phenols were omitted from consideration, values for TDS, NH_3-N, NO_3-N, Cl, pH, alkalinity and SO_4 were included.

(i) Station Averaged Values

Figures VII-27 through VII-33 present 1973 average monthly river concentrations for all parameters measured. In each figure, values for all stations and all depths have been averaged for each sampling date. This allows an overview of water quality without the complicating features of variations attributable to vertical stratification and lateral variations.

Figures VII-34 through VII-36 present daily data for NH_3, silica, total hardness, turbidity and alkalinity at the Danskammer Point intake.

The variation of concentration with time for Cl, SO_4, TDS and TS (Figures VII-28 and 29) reflects decreasing freshwater flow from May through September; this caused slight increases in dissolved conservative components. The time series also reflects salt intrusion experienced from approximately late September to early November.

HUDSON RIVER WATER QUALITY
M.P. 62.7 TO 68.2
CHLORIDE, SULFATE, AND TOTAL DISSOLVED SOLIDS

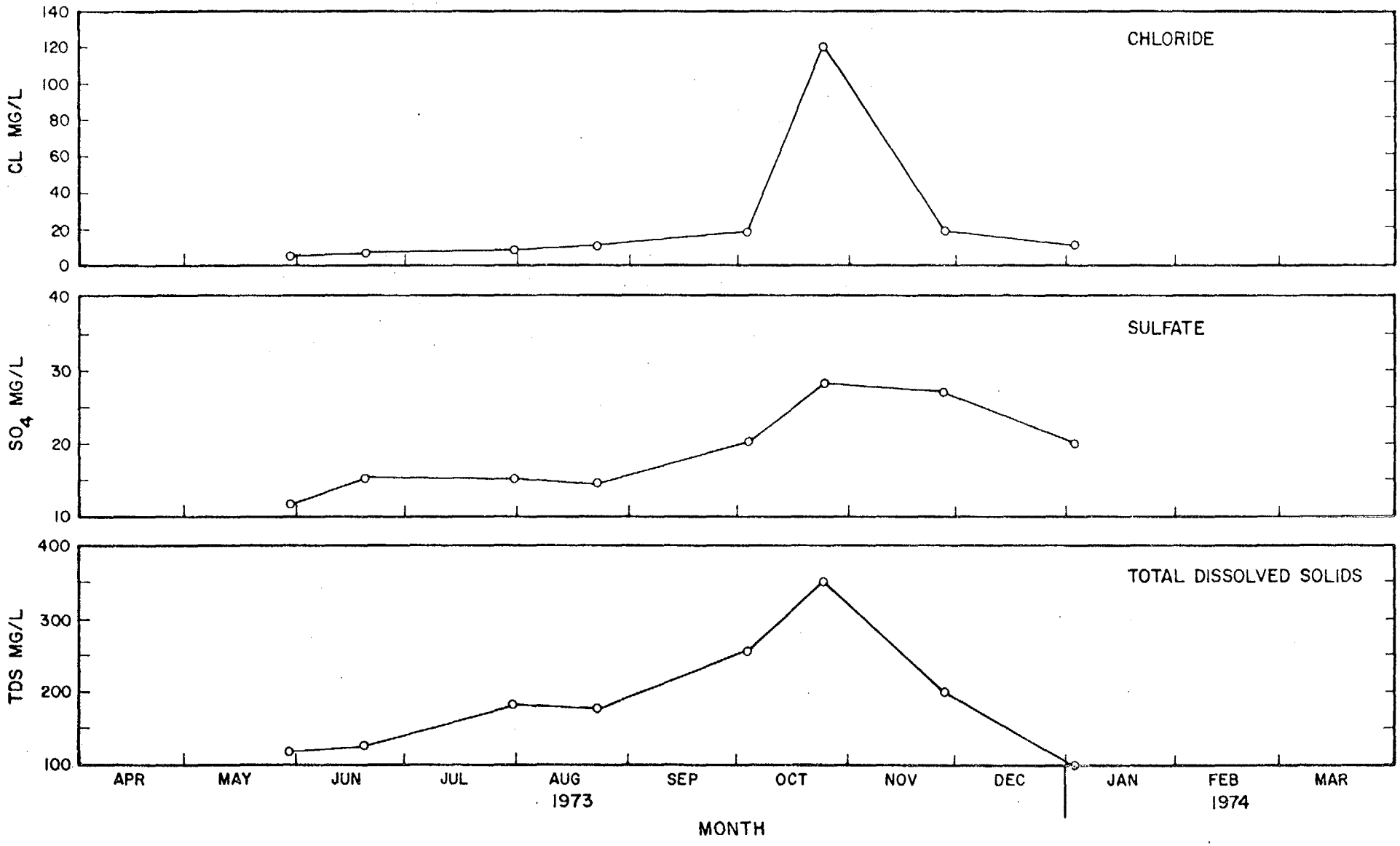


FIGURE VII-27

HUDSON RIVER WATER QUALITY
M.P. 62.7 TO 68.2
TOTAL SOLIDS, TOTAL VOLATILE, AND TOTAL SUSPENDED SOLIDS

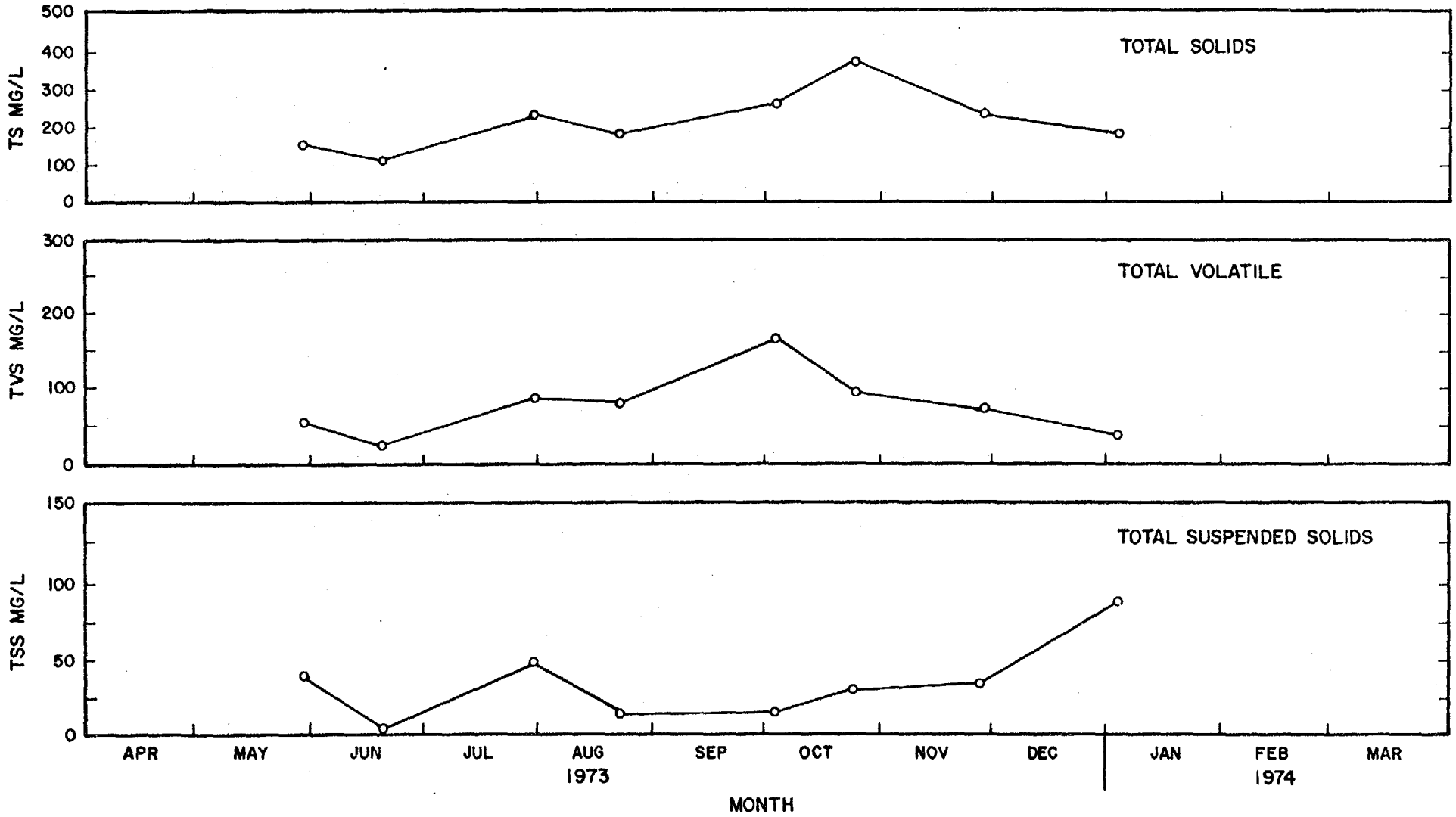


FIGURE VII-28

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
BOD AND COD

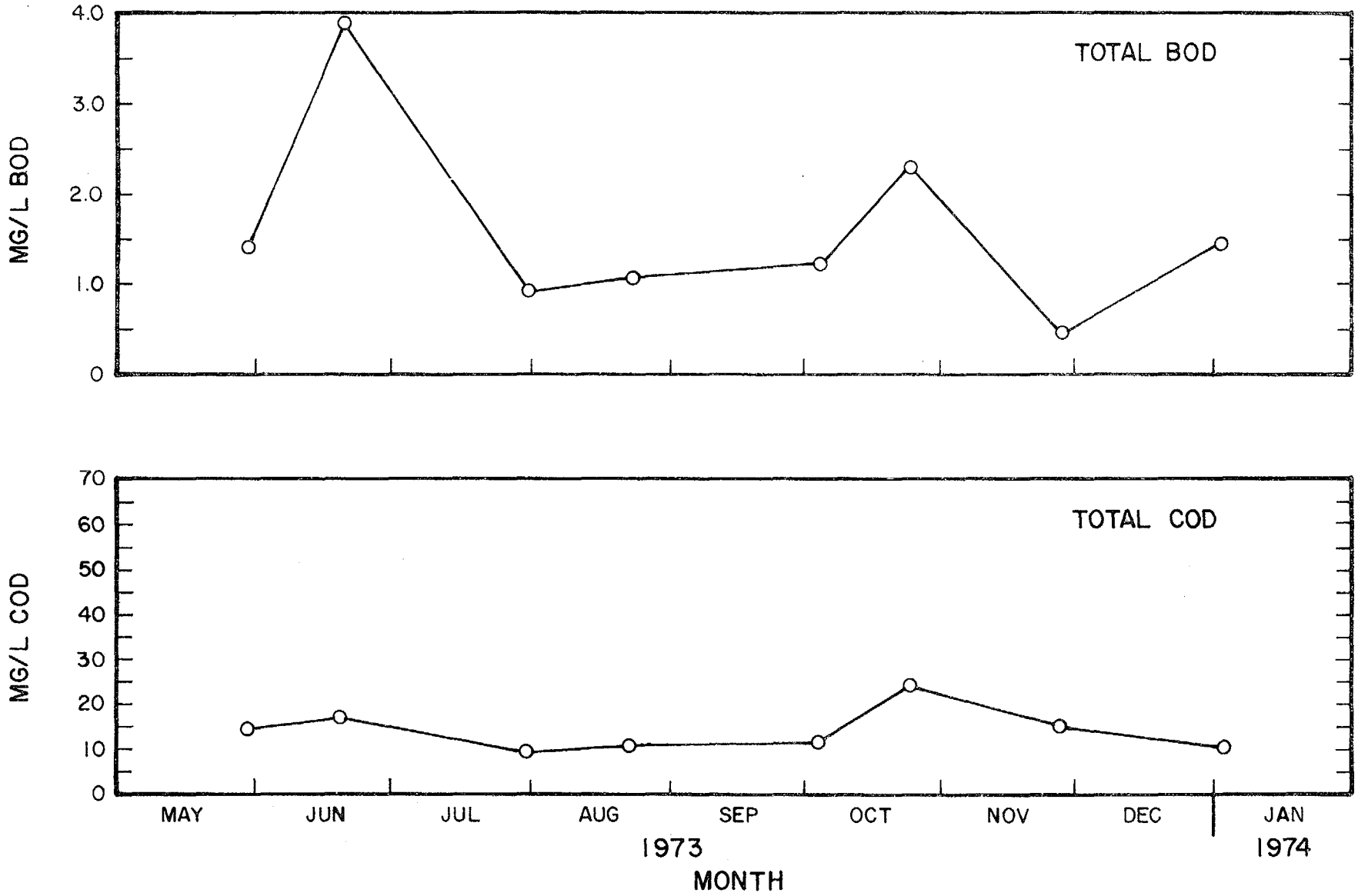


FIGURE VII-29

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
AMMONIA AND TOTAL KJELDAHL NITROGEN

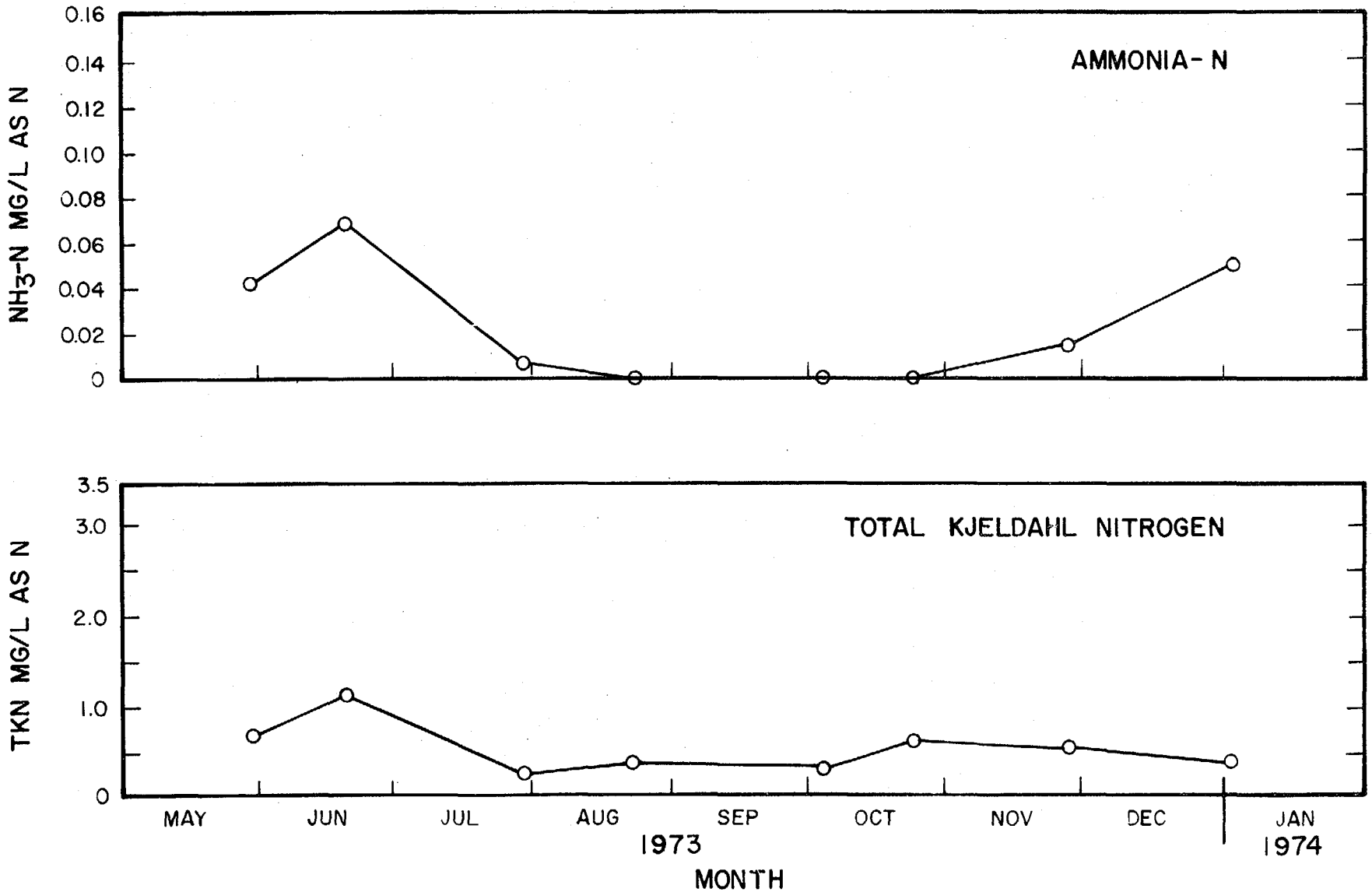


FIGURE VII-3U

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
TOTAL PHOSPHORUS AND NITRATE NITROGEN

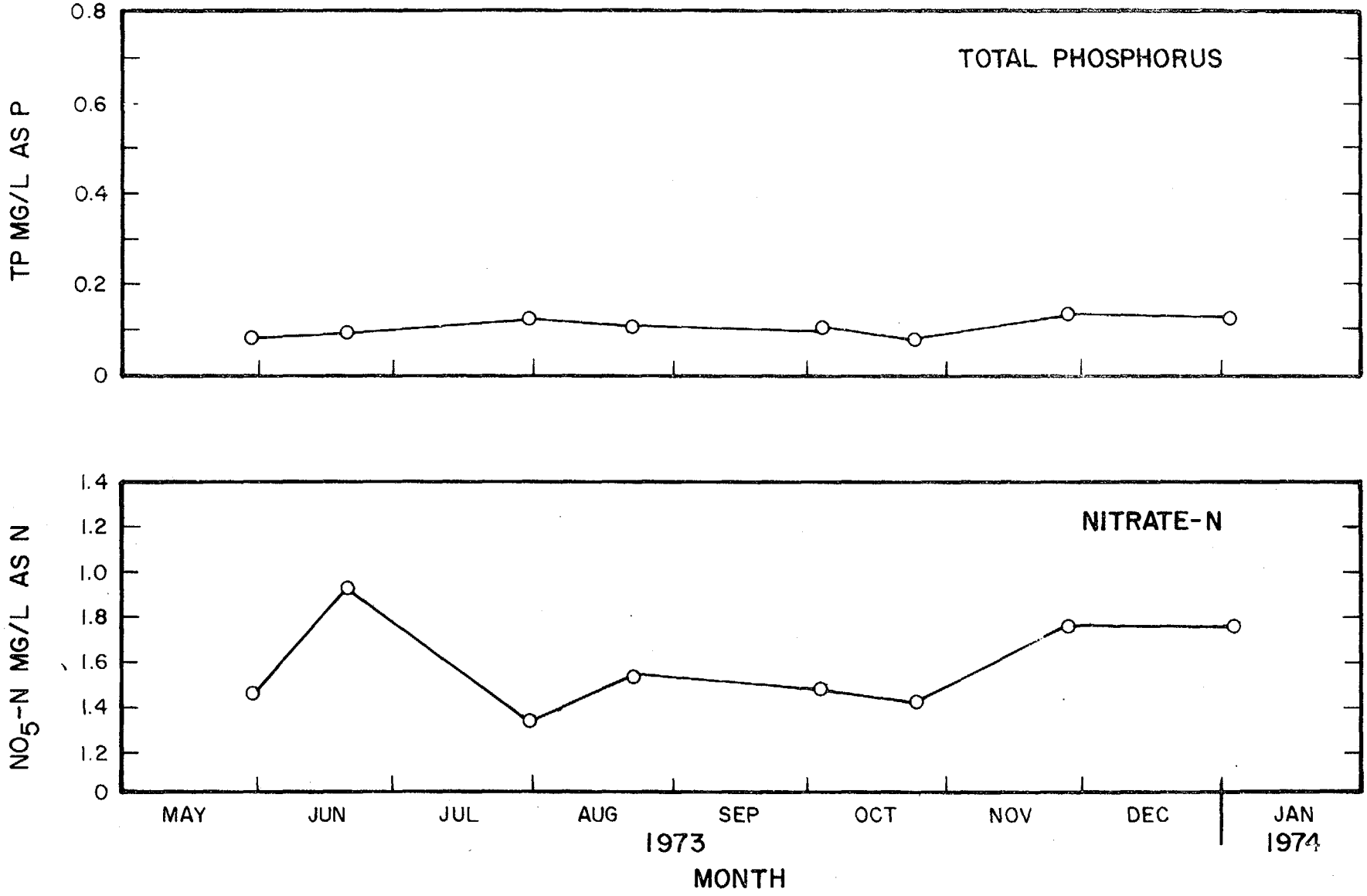


FIGURE VII-31

HUDSON RIVER WATER QUALITY
M.P. 62.7 TO 68.2
ZINC, CHROMIUM, AND PHENOL

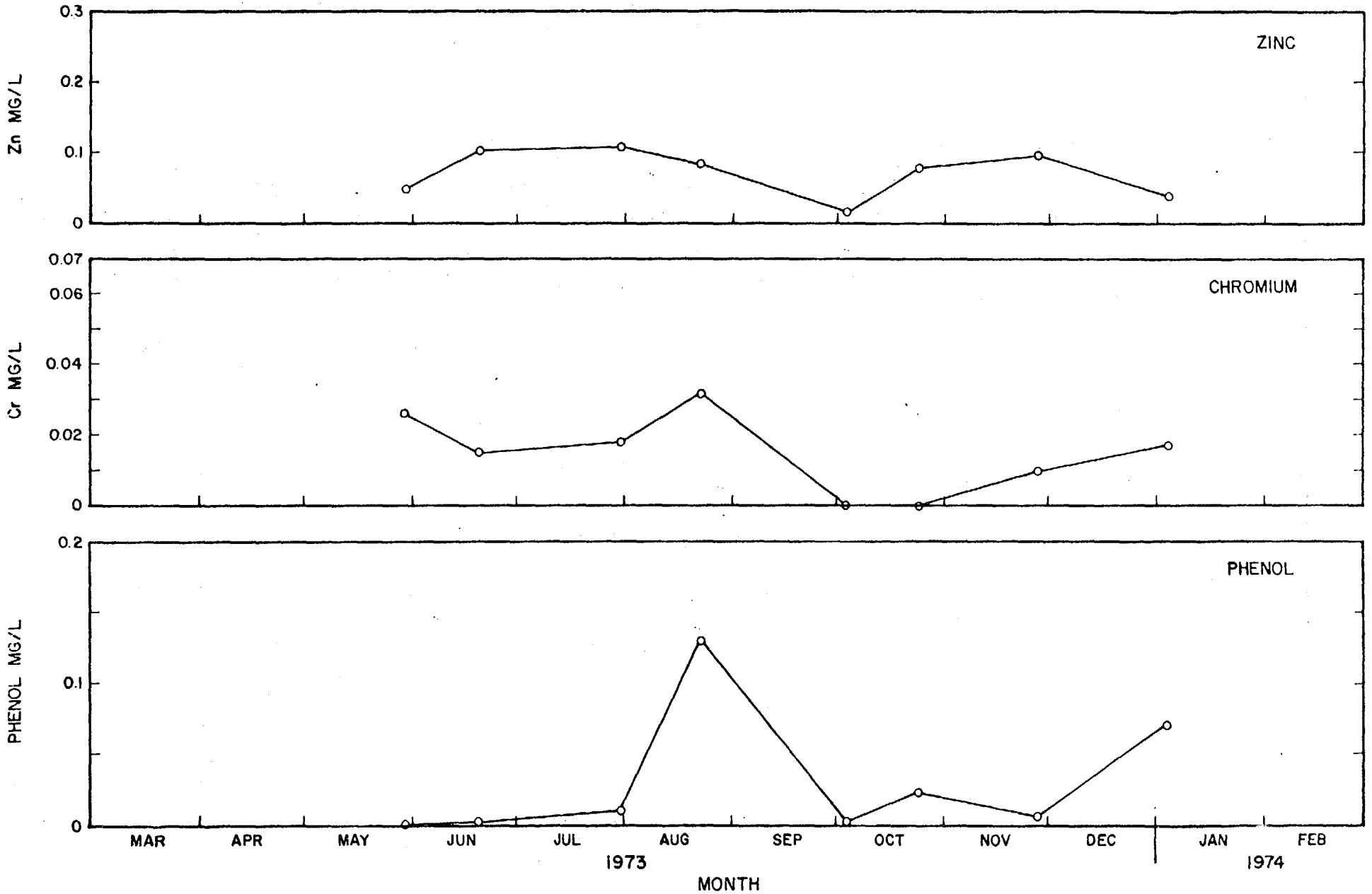


FIGURE VII-57

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
pH AND ALKALINITY

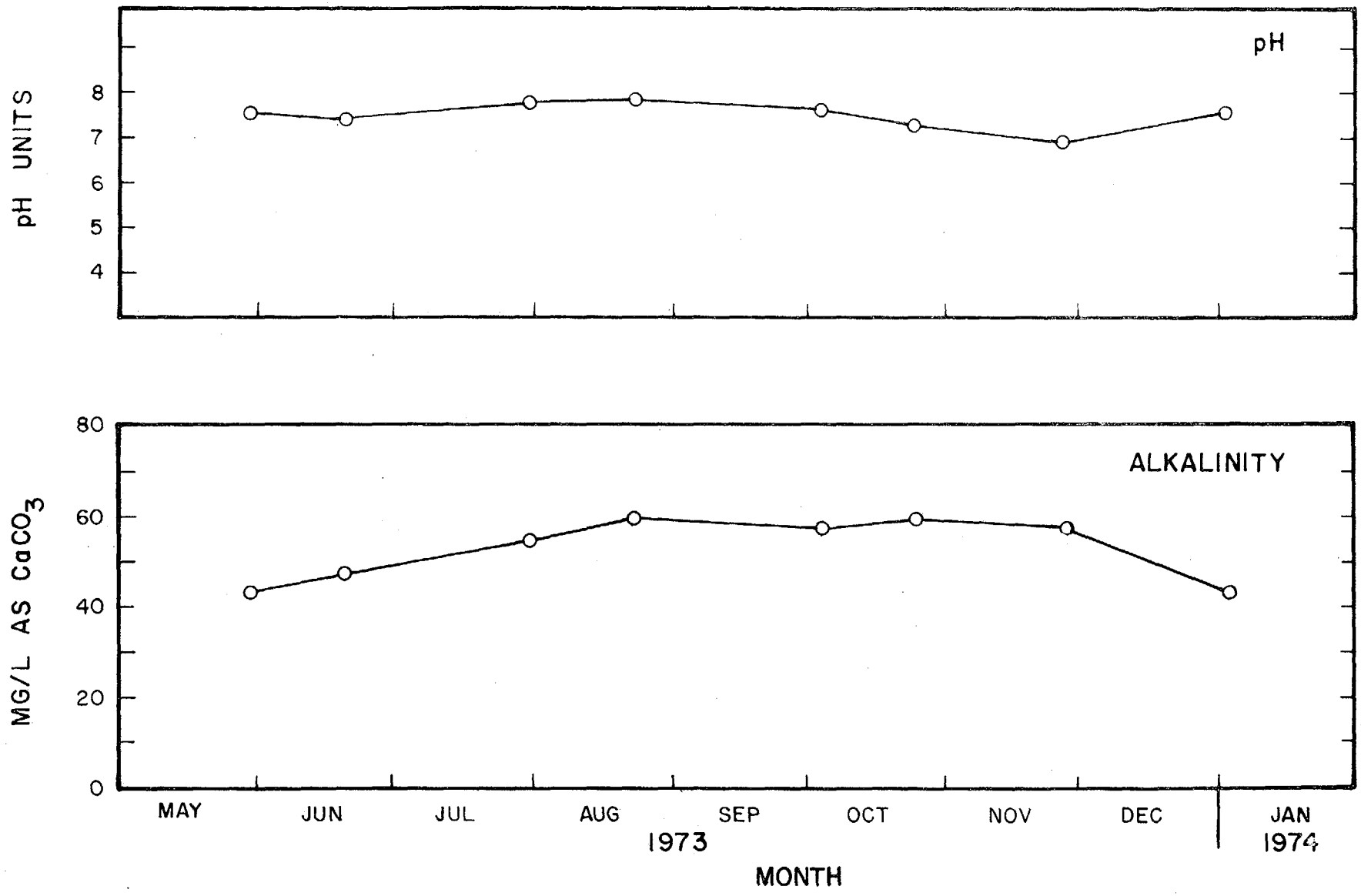


FIGURE VII-33

CENTRAL HUDSON GAS AND ELECTRIC
AMMONIA AND SILICA AT DANSKAMMER
1973

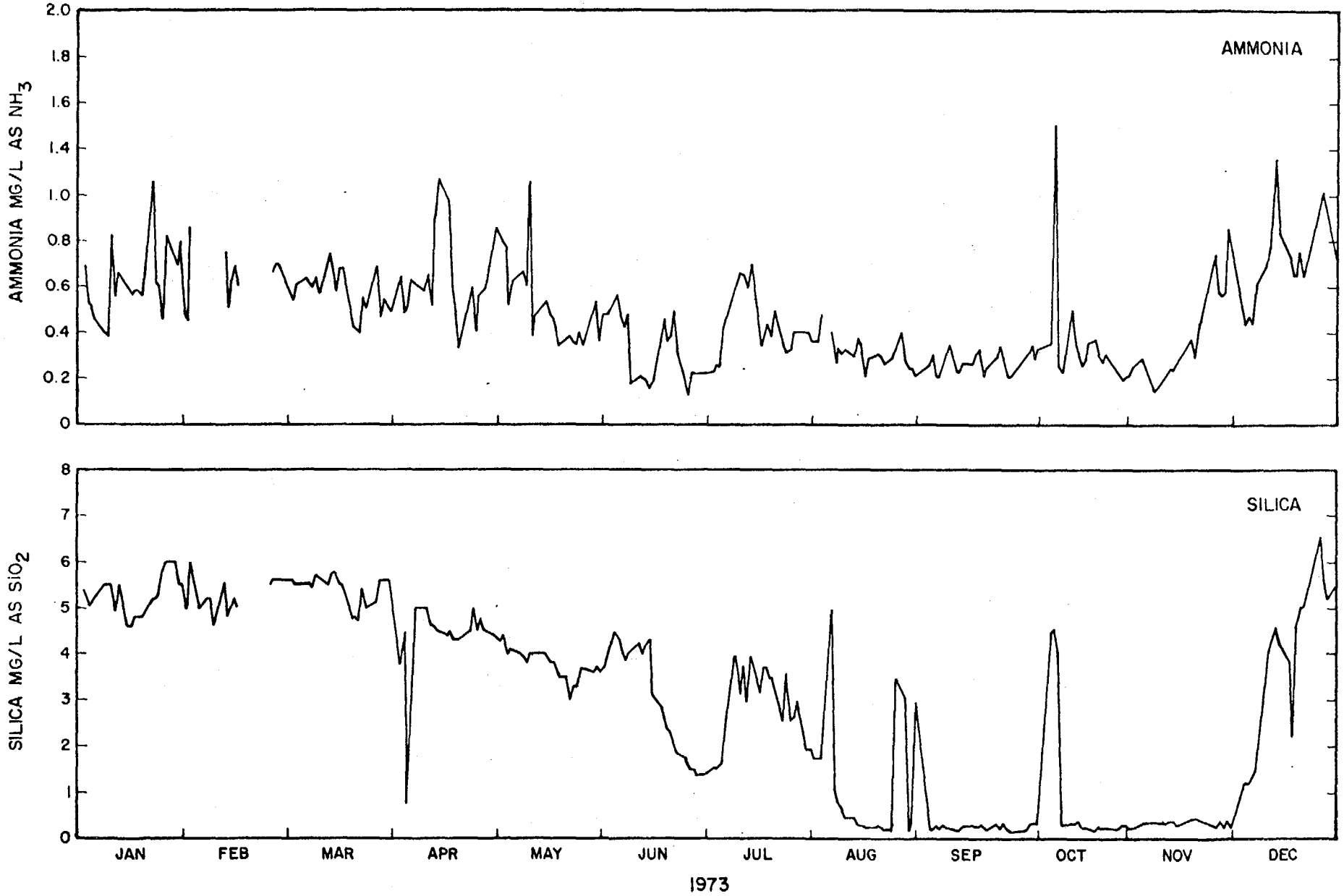


FIGURE VII-34

CENTRAL HUDSON GAS AND ELECTRIC
TOTAL HARDNESS AT DANSKAMMER
1973

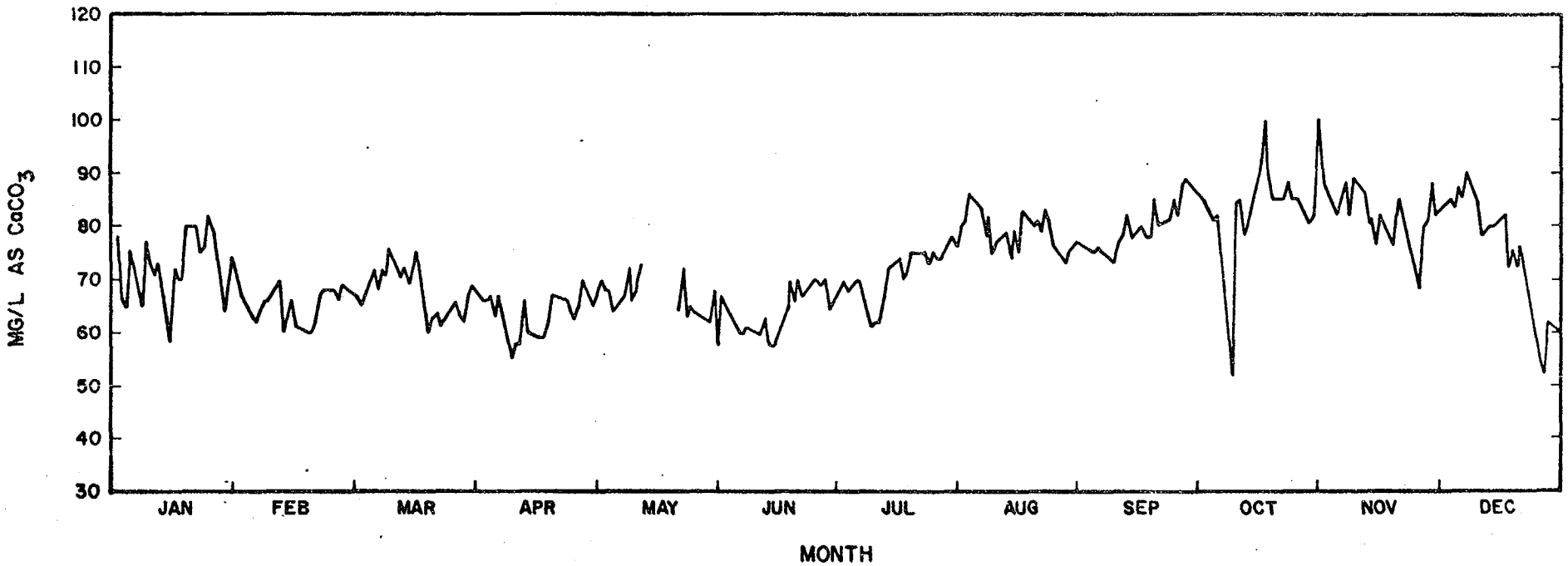


FIGURE VII-35

CENTRAL HUDSON GAS AND ELECTRIC
TURBIDITY AND ALKALINITY AT DANSKAMMER
1973

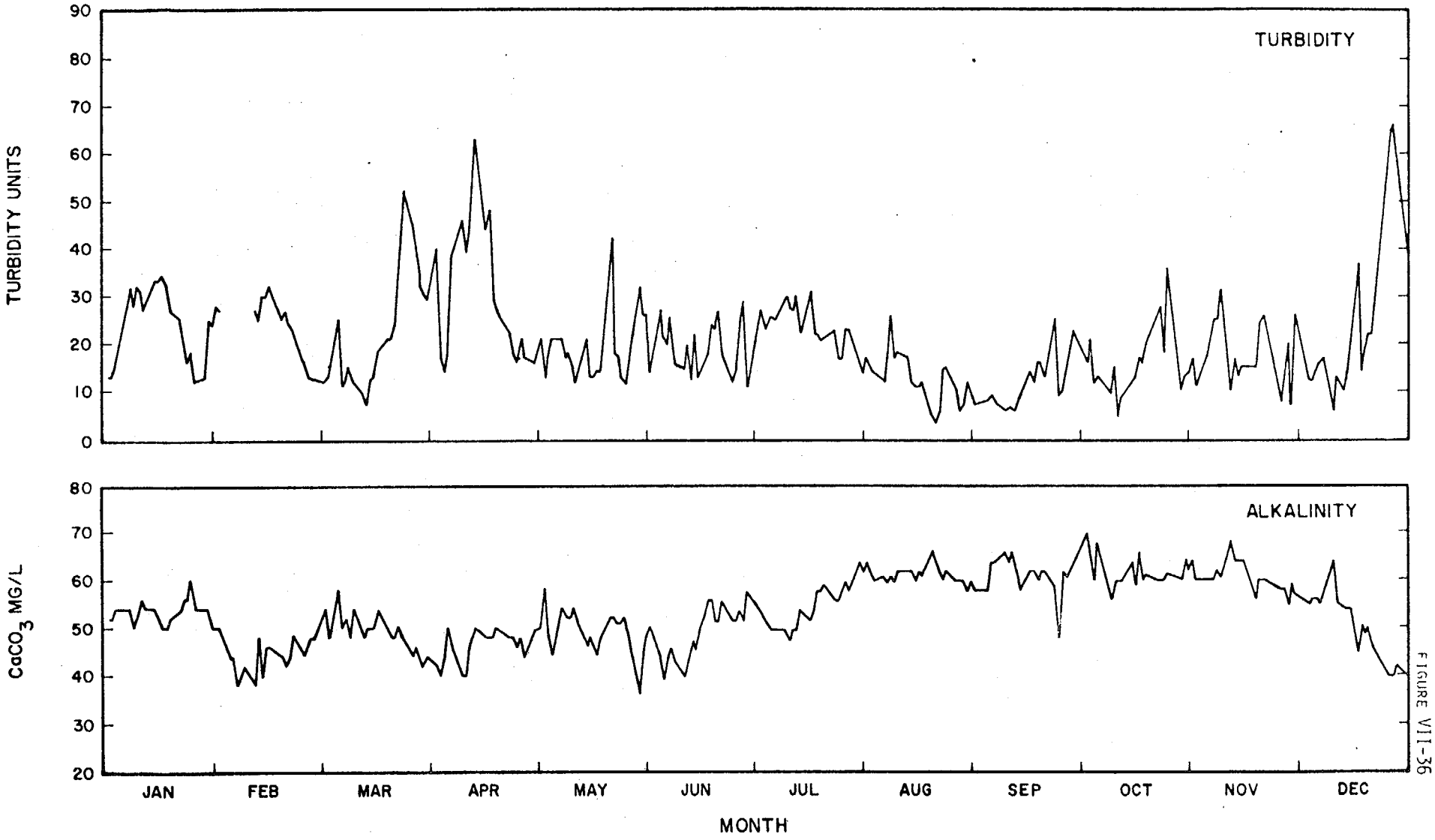


FIGURE VII-36

The time series for TVS (Figure VII-28) is similar except that the annual peak was observed during early October rather than during late October. No explanation for this is apparent, but the parameter has limited significance because of its non-specificity and dependence on water of hydration.

The time series for TSS (Figure VII-28) probably represents a random process, but it is possible that the high January 1974 value was due to high winter freshwater flow conditions compared to relatively low flows for the June through November period.

Figure VII-29 indicates similar patterns for BOD and COD, both of which exhibited peaks in June and late October; the latter peak may reflect intrusion of relatively polluted water from the New York City area. It is significant that the June peak in BOD and COD cannot be attributed to suspended solids *per se*, since suspended solids have a relatively low average during June. It is possible that the June peak also reflected increased algal activity during this period.

Figures VII-30 and VII-31 present time series for the various nitrogen forms. All three nitrogen forms were relatively low in the July to October period and relatively high during other periods, so that conversions from one form to another were not obvious. The low concentrations involved, the flow variations during the year, and possible unknown inputs preclude definitive evaluation of such conversions, but it is probable that the decrease in NH_3 reflected increased nitrification in the river or before reaching the river.

Total phosphorus did not vary significantly during the year. The Zn, Cr, and phenols patterns illustrated in Figure VII-32 can probably be attributed to random fluctuations.

Alkalinity increased during low flow periods, probably due to increased concentrations of dissolved constituents (see Figure VII-33). The pH increase during the July to September period may reflect increased algal activity with concomitant dissolved CO_2 removal (see Figure VII-33).

Data collected at the Danskammer Point intake by Central Hudson personnel is presented in Figures VII-34, 35 and 36.

Figure VII-34 presents time series plots of NH_3 (as NH_3) and silica (as SiO_2) as observed at the Danskammer Point intake. The NH_3 pattern agreed in form with that in Figure VII-30 but did not go to zero during September and October. This may represent differences in analytical technique.

The pattern exhibited by silica closely parallels the flow patterns shown in Figure VII-21. As discussed previously, on an annual basis silica tends toward relatively low concentrations in the Roseton/ Danskammer Point area.

Figure VII-35 presents a time series plot for total hardness (as $CaCO_3$). The pattern appears to be similar to that illustrated in Figures VII-27 and VII-28 for Cl, SO_4, TDS and TS.

Figure VII-36 presents time series plots for turbidity and alkalinity. The alkalinity pattern is generally the same as that illustrated in Figure VII-33. The slight turbidity decrease in the August to November period may reflect increased sediment deposition upstream of the subject area during low freshwater flow conditions.

(ii) Depth Averaged Values

Figures VII-37 through VI-40 present time series plots for selected parameters. The values for all stations within a given depth interval have been averaged for each sampling date. The parameters presented have been selected on the basis of an apparent difference between the averages for the various depths. No significant depth difference was apparent for the parameters TDS, TS, TVS, Cl, SO_4, COD, BOD, TKN, NO_3, TP, phenols, pH and alkalinity.

NH_3-N values are presented in Figure VII-37. The depth differences vary with date, but no explanation is apparent for the depth differences or the variation in the pattern of those differences.

Figure VII-38 presents time series plots for suspended solids. There appear to be higher concentrations of suspended solids at the deeper stations. The increase in suspended solids paralleling the freshwater flow increase late in the year is apparent for all depth intervals.

Figures VII-39 and VII-40 present time series plots for Cr and Zn, respectively. The patterns are fairly similar for all depth intervals, but distinct differences do exist. The generally low concentrations

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
AMMONIA NITROGEN AT VARIOUS DEPTHS

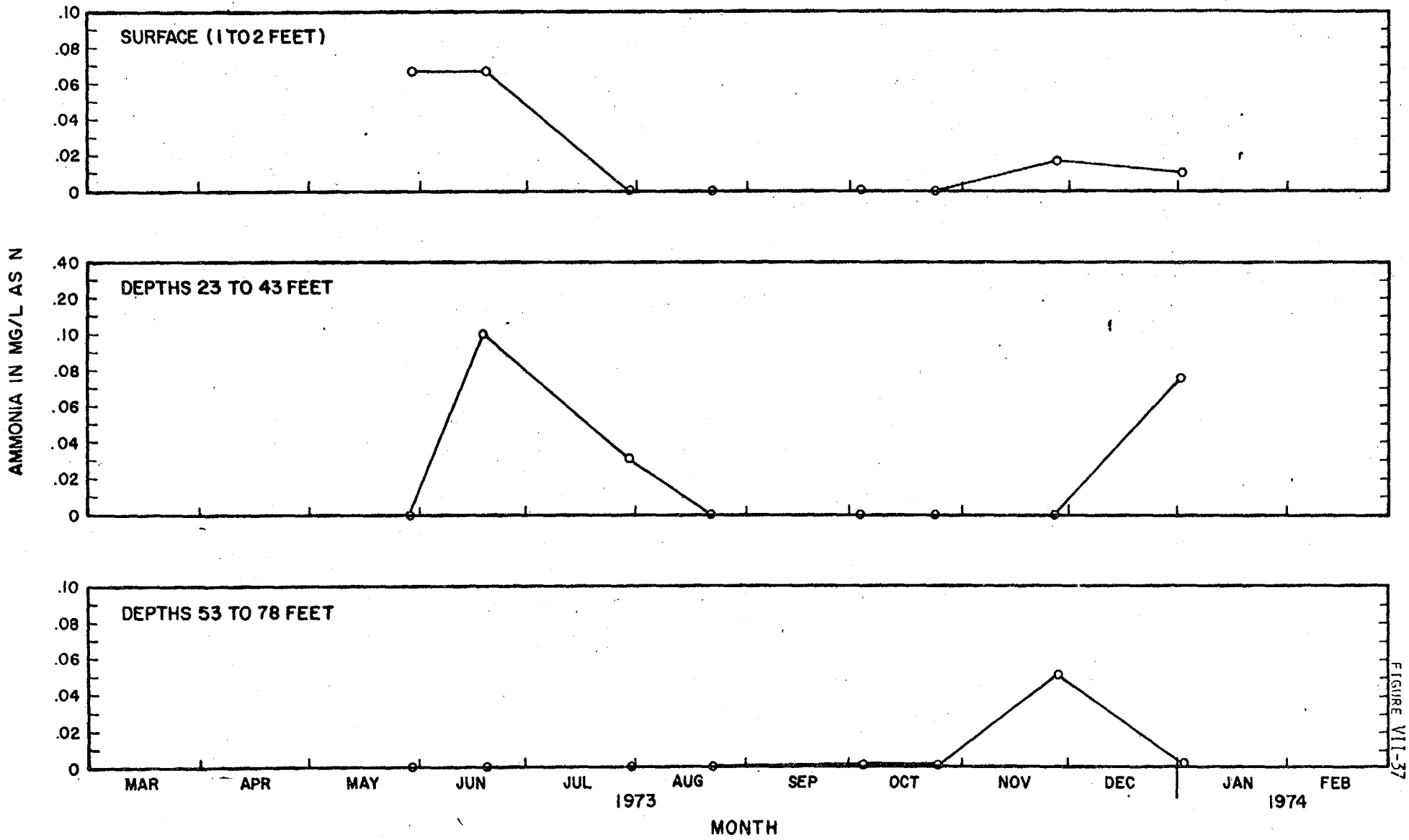


FIGURE VII-37

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
TOTAL SUSPENDED SOLIDS AT VARIOUS DEPTHS

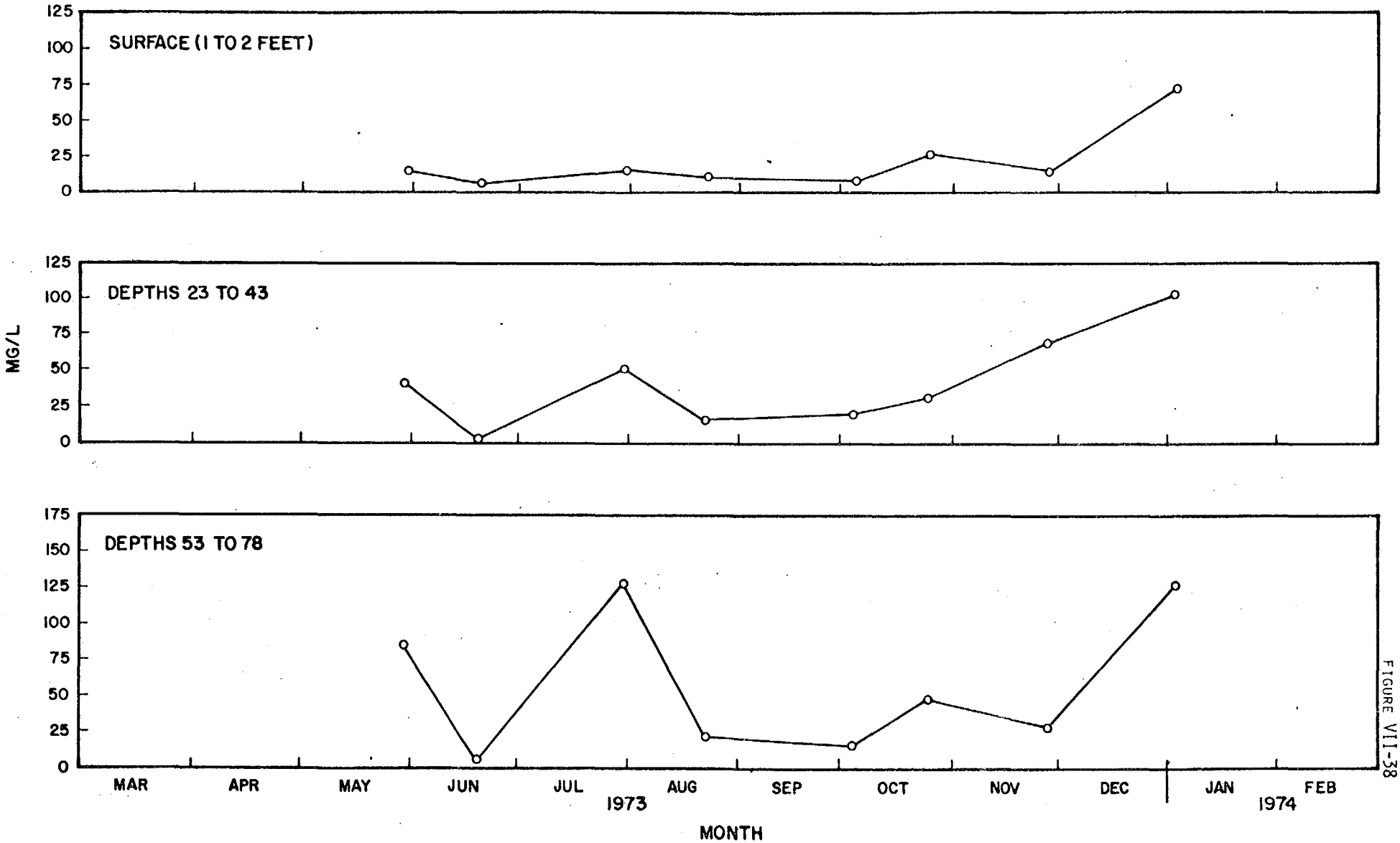


FIGURE VII-38

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
CHROMIUM AT VARIOUS DEPTHS

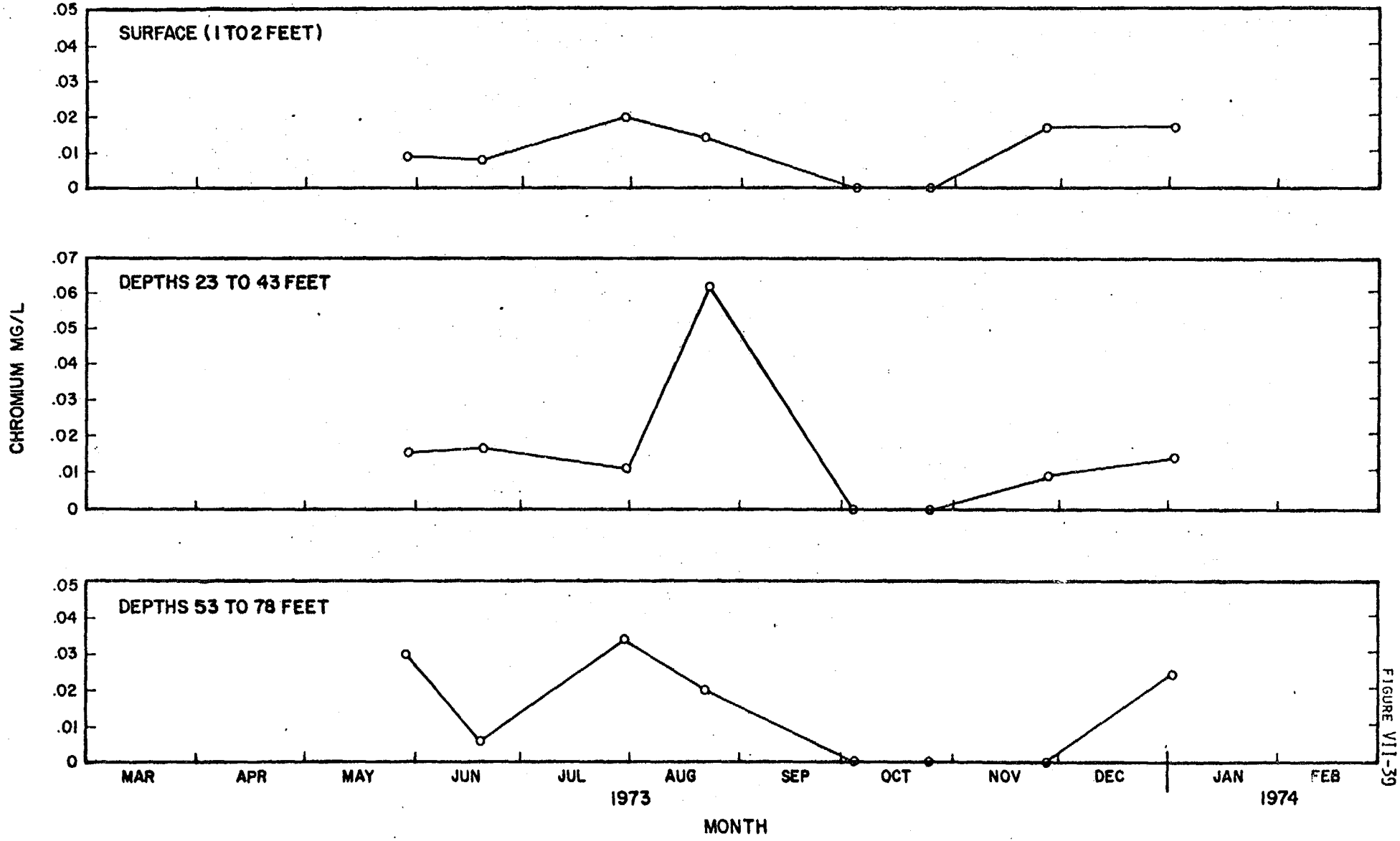


FIGURE VII-39

HUDSON RIVER WATER QUALITY
MP 62.7 TO 68.2
ZINC AT VARIOUS DEPTHS

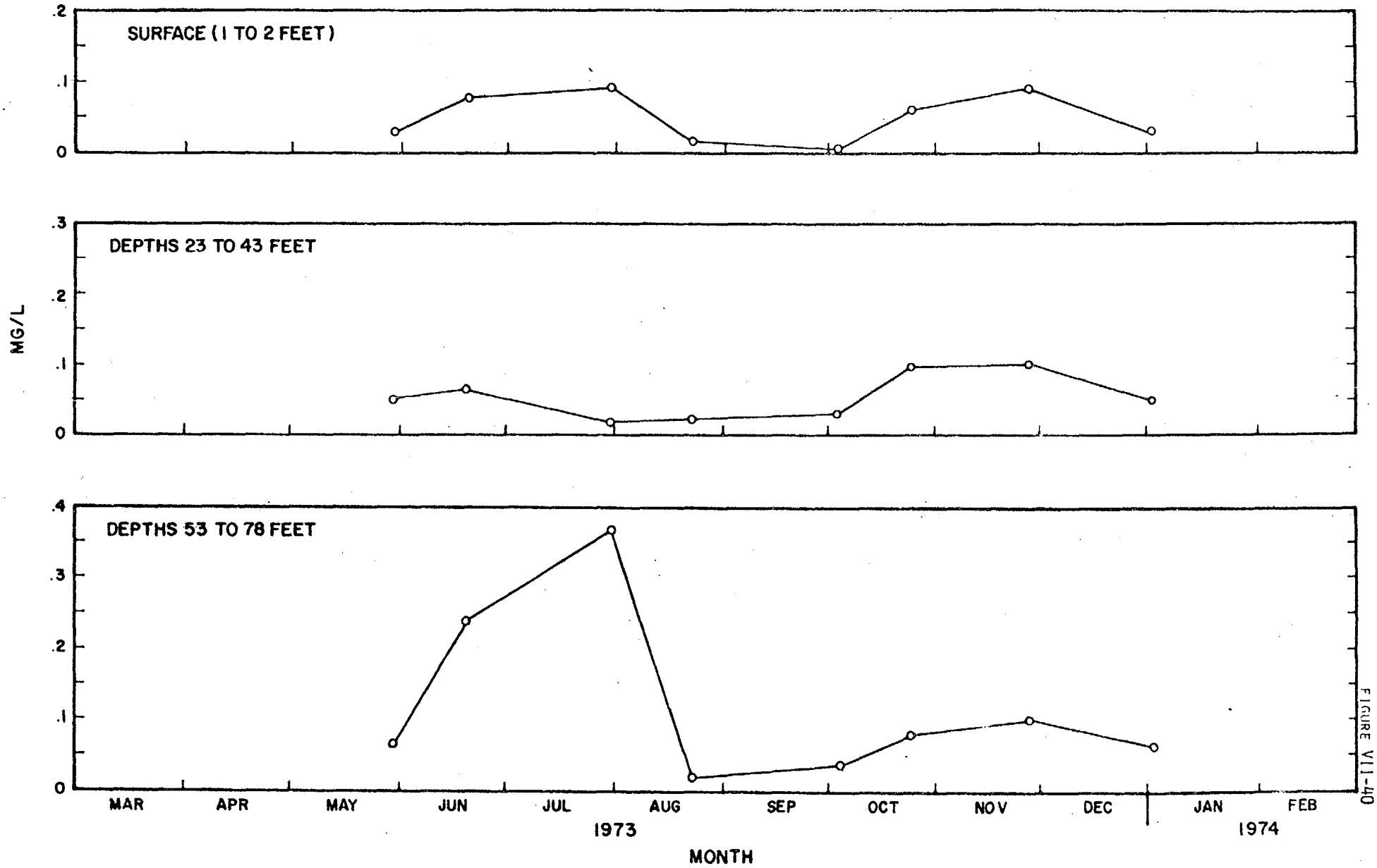


FIGURE VII-40

for late summer and early fall may be attributable to lower freshwater flow and increased deposition of suspended matter, but the periods of low concentration do not coincide exactly for the two metals.

If Figures VII-39 and VII-40 are compared with Figure VII-38, it may be postulated that Cr and Zn are positively correlated to suspended solids. Particulate matter would be expected to be higher in metals content than the dissolved fraction of the river water.

(c) Statistics and Correlations. Appendix VII-D presents the 1973 monthly water quality data in statistical form for different combinations of location, depth, and date. Each table contains a list of the chemical parameters analyzed, the number of samples fitting the group description at the head of the table, and the maximum, minimum, mean, variance, and standard deviation for each parameter.

Following this table is a matrix of correlation coefficients for each possible pair of parameters. Several sets of tables are presented for each sample group (i.e., each combination of location, depth, and date), each set having a different list of parameters.

For convenience of referencing, the analyses are divided into major categories according to several typical groupings of the samples; these categories and the sample groupings in each are listed in Table VII-10.

The statistics in Appendix VII-E along with similar statistics for other Hudson River programs have been summarized in Tables VII-11 through VII-14. Table VII-11 presents statistics for the groupings of all samples

TABLE VII-10

CATEGORIES OF WATER QUALITY STATISTICAL ANALYSES

ROSETON/DANSKAMMER POINT VICINITY

CATEGORY	STATIONS	DEPTHS	MONTH
1	All, individually	All, individually	All, combined
2	All, individually	All, combined	All, combined
3	All, combined	All, combined	All, combined
4	All, combined	All depths	All, individually
5	All, combined	Surface only	All, combined
6	All, combined	All between 20 and 45	All, combined
7	All, combined	All between 45 and 80	All, combined
8	All, combined	Surface only	All, individually
9	All, combined	All between 20 and 45	All, individually
10	All, combined	All between 45 and 80	All, individually

Quirk, Lawler & Matusky Engineers

TABLE VII-11

COMPARISON OF WATER QUALITY RESULTS WITH BACKGROUND VALUES

ROSETON/DANSKAMMER POINT VICINITY

Parameter (all values in mg/l where appropriate)	1973 Water Quality Results Roseton/Danskammer Point Stations* (99 samples)				Expected Hudson River Values, Freshwater Conditions Mile Point 40 to 120	Mean, North American Rivers (Table VII-3)	Summary of Trace Elements in U.S. Waters (Table VII-4)	Summary of Water Quality Criteria (Table VIII-6)
	Min	Max	Std. Dev.	Mean	(Table VII-1)			
TCOD	3.0	130	13.3	14.0	12			
TBOD	0	6	1.2	1.5	2			
TKN	0	1.73	.32	.51	.3			.4(MW), .5(PS)
NH_3-N	0	.20	.048	.021	.2			.02 (FW)
NO_3-N	.19	.84	.177	.538	.7	1		10 (PS)
TP	.02	.81	.091	.11	.1			
TSS	0	210	39.5	35.3	30			
TS	100	735	106	221	180			
TDS	30	670	103	185	150			
TVS	2.0	540	70.6	78.4				
pH	6.9	7.9	.33	7.5				6.5-8.5 (MW)
ALK	39	62	6.85	52.7		56**		30-130(W)
SO_4	10	50	7.5	19.8	20	20		250(PS)
Cl	0	275	41.1	24.3	10	8		250(PS)
Phl	0	.283	.059	.031	.01			.001(PS), .1 (FW)
Zn	0	.875	.121	.072			.064	5 (PS), .1 (MW)
Cr	0	.17	.028	.014			.01	.05 (PS), .03(FW), .1(MW

* Samples with unusually high TSS excluded for all parameters

** Alkalinity = HCO3 x 50/61

NOTE: PS = Public Supply, FW = Freshwater Aquatic Life, MW = Marine Aquatic Life, W = Wildlife

TABLE VII-12

COMPARISON OF WATER QUALITY RESULTS
BY DEPTHS

ROSETON/DANSKAMMER POINT VICINITY

PARAMETER (all values in mg/l where appropriate)	DEPTH CATEGORY: 1-2 feet (CH-1 to CH-6) 48 Samples				23 to 43 feet (CH-2. 3 . 4. 5. 6) 39 Samples				53 to 78 feet (CH-1. 4) 16 Samples			
	MIN.	MAX.	STD DEV.	MEAN	MIN.	MAX.	STD DEV.	MEAN	MIN.	MAX.	STD DEV.	MEAN
TCOD	3.0	26.0	5.8	10.8	5.0	155.	30.4	22.8	9.0	28.0	5.1	16.9
TBOD	0	4	1.1	1.5	0	9	1.8	1.8	0	4	1.11	1.8
TKN	0	1.31	.29	.50	0	3.84	.47	.88	0	1.12	.29	.54
NH_3-N	0	.20	.054	.027	0	.30	.070	.033	0	.10	.025	.006
NO_3-N	.19	.84	.175	.516	.27	1.58	.272	.599	.21	.84	.208	.568
TP	.02	.81	.11	.097	.04	1.43	.24	.176	.03	.22	.052	.125
TSS	0	90	22.9	20.7	1.0	560	99.3	60.4	0	325	81.8	75.0
TS	100	630	96.5	200	115	870	164	269	105	665	144	264
TDS	70	610	95.8	179	30	670	121	202	75	430	94.1	188
TVS	2.0	540	80.0	73.8	8.0	390	65.7	90.2	15	570	131	95.8
pH	6.9	7.9	.30	7.5	6.9	7.9	.35	7.5	6.9	7.8	.34	7.4
ALK	39	62	7.01	52.4	43	62	6.38	53.3	40	62	7.36	52.7
SO_7	10	41	6.07	19.2	11	50	8.10	20.5	11	38	8.5	20.4
Cl	4	166	32.8	21.9	5	275	54.6	305	0	130	32.8	21.4
Phl	0	.283	.059	.028	0	.248	.064	.035	0	.17	.044	.026
Zn	0	.305	.055	.052	0	.875	.140	.084	.005	.695	.185	.121
Cr	0	.09	.020	.011	0	.17	.037	.020	0	.06	.020	.015

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TABLE VII-13

COMPARISON OF NORTH AND SOUTH CONTROL STATIONS

ROSETON/DANSKAMMER POINT VICINITY

PARAMETER (all values in mg/l where appropriate)	North Control (CH-1) (16 Samples)				South Control (CH-6) (16 Samples)			
	MIN.	MAX.	STD. DEV.	MEAN	MIN.	MAX.	STD. DEV.	MEAN
TCOD	3	23	5.83	12.5	4	130	30.2	21.3
TBOD	0	4	1.0	1.6	0	6	1.5	1.6
TKN	0	.95	2.61	.448	.06	1.6	.405	.538
NH_3-N	0	.20	.0544	.0188	0	.20	.060	.031
NO_3-N	.27	.83	.20	.539	.4	.84	.157	.575
TP	.02	.23	.056	.096	.02	.37	.078	.105
TSS	1	145	463	39.3	3	90	30.3	33.9
TS	105	320	64.7	193	115	735	159	228
TDS	75	275	55.8	153	95	670	146	194
TVS	16	120	29.2	57.7	12	134	35.5	62.4
pH	6.9	7.8	.31	7.5	6.9	7.9	.36	7.4
ALK	40	61	7.46	52.6	39	62	7.87	52.8
SO_4	12	30	6.33	18.9	10	50	11.0	21.4
Cl	6	69	17.5	16.8	4	275	74	39.2
Phl	0	.05	.019	.015	0	.248	.062	.028
Zn	.006	.456	.105	.080	0	.875	.210	.096
Cr	0	.06	.018	.015	0	.14	.036	.018

TABLE VII-14

COMPARISON OF 1973 HUDSON RIVER WATER QUALITY
BY MILE POINT

Parameter (all values in mg/l where appropriate)	MILE POINTS 37-42 May 2,73 to Dec.13,73 All Depths (6 Samples) Mean (Min-Max)	MILE POINTS 62-68 May 29,73 to Jan.3,4 All Depths (99 Samples) Mean (Min-Max)	MILE POINTS 77 Jun.11,73 to Nov.13,73 All Depths (37Samples) Mean (Min-Max)	MILE POINTS 96 May 16,73 to Dec3,73 All Depths (32 Samples) Mean (Min-Max)
TCOD	14.7 (4-34)	14.0 (3-130)	26.2 (6-370)	13.3 (4-44)
TBOD	2.0 (0-11)	1.5 (0-6)	2.9 (0-9)	2.1 (1-4)
TKN	.765 (0-1.7)	.51 (0-1.73)	.561 (0-2.55)	.564 (.16-1.29)
NH_3-N	.14 (0-.9)	.021 (0-.2)	.035 (0-.3)	.050 (0-.2)
NO_3-N	.71 (.12-1.69)	.538 (.19-.84)	.349 (.03-1.98)	.502 (.06-.69)
TP	.105 (.02-.44)	.11 (.02-.81)	.097 (0-.42)	.073 (.02-.16)
TSS	37.4 (5-270)	35.3 (0-210)	15.2 (1-175)	20.3 (4-87)
TS	2,370 (110-7480)	221 (100-735)	235 (120-780)	186 (125-310)
TDS	2,360 (95-7300)	185 (30-670)	219 (115-745)	166 (105-270)
TVS	491 (25-1600)	78.4 (2-540)	74.7 (40-120)	64.3 (37-160)
pH	7.6 (7.1-7.9)	7.5 (6.9-7.9)	7.6 (6.9-7.9)	7.5 (6.9-7.9)
ALK	54.9 (39-67)	52.7 (39-62)	56.0 (42-61)	54.8 (50-66)
SO_4	119 (5-415)	19.8 (10-50)	21.2 (14-31)	20.0 (11-25)
Cl	959 (5-3500)	24.3 (0-275)	11.7 (5-18)	13.2 (7-21)
Phl	.0463 (0-.8)	.031 (0-.283)	.0325 (0-.127)	.0072 (0-.045)
Zn	.0482 (0-.245)	.072 (0-.875)	.0192 (0-.127)	.0463 (.01-.25)
Cr	.0208 (0-.19)	.014 (0-.17)	.0064 (0-.08)	.0031 (0-.055)

* Four samples with unusually high TSS deleted.

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(excluding those four with unusually high suspended solids) of values discussed previously. The observed values correspond closely with expected Hudson River freshwater values, indicating that the major components of the river were similar in 1973 to previous years.

The relatively low 1973 mean value for NH_3-N may reflect a slight improvement in conditions or may be the result of analytical procedure changes. Some values, such as Ts, TDS, and Cl, are slightly higher than expected values because of the salinity intrusion from late summer to early fall in the Roseton/Danskammer Point area.

Table VII-11 also provides an indication of variabilities of the various parameters for the entire data record. Using the value of 1.0 for the coefficient of variance (standard deviation divided by mean) as a criterion of degree of variability, the following parameters are indicated as highly variable:

NH_3-N

TSS

Cl

Phenol

Zn

Cr

Judging from the position of the mean with respect to the minimum and maximum for these parameters, each is characterized by a frequently observed probability distribution with relatively many values between, or including,

zero and the mean and relatively few values greater than the mean. In the case of NH_3-N and Cr, this is due in part to the mean values being close to the detection limits (about .02 and .01 for NH_3-N and Cr, respectively).

For any analytical procedure there is, by definition, a small but definite chance of having a positive result near the detection limit even when the actual value is below the detection limit, or even zero. If interfering substances are present, the problem will be compounded. Such occurrence will strongly bias reported mean values. In the case of Cl, the variation is due to the physical phenomena associated with freshwater flow and salinity intrusion. In the case of NH_3, the variation may be in response to temperature variations.

Table VII-12 compares statistics for groupings of samples by depth of sample, where the depth ranges used are 1 to 2 feet (6 surface stations), 23 to 43 feet (4 bottom stations plus 1 mid-depth station), and 53 to 78 feet (2 bottom stations). The means for each parameter were compared for pairs of depth groupings using the Student's t-Test.

Thus, at the 95% confidence level, the 23 to 43-foot samples were significantly higher than surface samples with respect to TCOD, TKN, TP, TSS, and TS. The 53 to 78-foot samples were significantly higher than surface samples with respect to TCOD, TSS, TS, and Zn. The 23 to 43-foot samples were significantly higher than those from 53 to 78-feet with respect to TKN.

It should be noted that the summaries in Table VII-12 include the four bottom water samples with unusually high TSS values and often correspondingly high values of parameters such as TCOD, TP, TKN, TS, TVS, and NO_3-N. This may

explain most of the differences found to be significant. It must also be noted that the depth groupings create longitudinal groupings to some extent. Thus, while surface samples include all stations, the other depth groupings are biased: direct southward for the 23 to 43 foot grouping and northward for the 53 to 78 foot grouping.

Table VII-13 compares statistics for the North Control station (CH-1) to those for the South Control station (CH-6). Substantial differences in mean values exist for several parameters, but these differences are not statistically significant at the 95% confidence level based on the Student's t-Test.

Of course, the simple statistical comparison of mean values for the entire year implies that the values for each sample grouping are statistical samples from a defined statistical population. In reality, such statistical populations change statistical characteristics with time (i.e., they are random processes) and the differences in mean values may reflect very real differences at certain times of the year.

Table VII-14 presents yearly water quality statistics for several surveys at different mile points or ranges of mile points on the Hudson River in 1973. Complete statistical descriptions, including correlation coefficients for parameter pairs within a given area are presented in Appendix VII-E.

Figure VII-22 predicts the presence of the salt front at or above mile points 37 through 42 well over 50% of the time. The effect of the salt intrusion is readily seen in Table VII-14 for the parameters TS, TDS, TVS, SO_4, and Cl.

The means for each parameter presented in Table VII-14 were compared for pairs of surveys using the Student's t-Test. Samples collected at Mile Points 37 to 42 were found to have higher mean values than those at Mile Points 62 to 68, at the 95% confidence level, for the parameters BOD, TKN, NH_3, NO_3,TS, TDS, TVS, Alkalinity, SO_4, and Cl. All of these differences can be attributed to intrusion of salt and other contaminants upstream into the mile point 37 to 42 area.

Figure VII-22 predicts the presence of the salt front at the mile point 62 to 68 area 5 to 15% of the time, at or above mile point 77 for only 1 or 2 weeks during the year,and never at mile point 96. The chloride concentrations in Table VII-14 indicate that the salt front was not present during sampling at either of the two upstream sample areas. The values therefore represent strictly freshwater conditions.

The Student's t-Test was used to compare these areas in a sequential manner at the 95% confidence level; i.e., the mile point 62 to 68 area was compared to the mile point 96 area. The mean values at the mile point 62 to 68 area were significantly higher than those at mile point 77 with respect to NO_3 and Zn, and they were significantly lower with respect to TBOD, TSS, and Alk. The mean values at mile point 77 were signigicantly higher than those at mile point 96 with respect to TDS, TVS, and phenols and significantly lower with respect to NO_3 and Zn.

These comparisons indicate that the mile point 77 area was relatively low in Zn and NO_3 compared to upstream and downstream areas.

The relatively high mean COD at mile point 77 is not statistically significant and is probably due to a single unusually high value. If this maximum

value is deleted, the mean COD is only 16.6 mg/l, very similar to the other mean values. The COD pattern suggested previously and illustrated in Figure VII-15 is not evident, but the pattern may be apparent only outside the limits of the several study areas (mile points 37 to 96).

The pattern of the mean ammonia concentrations is very similar to that presented in Figure VII-14. The pattern was attributed to municipal pollution from Albany upstream and New York City downstream, but Figures VII-30, VII-34 and VII-37 indicate that the pattern results from more complicated phenomena, since low ammonia values are recorded in the Roseton/Danskammer Point area during the general period of salt intrusion. Moreover, only the difference between mean values at mile points 37 to 42 and 62 to 68 was statistically significant at the 95% confidence level.

The TSS values do not exhibit the pattern discussed previously and illustrated as a consistent year-to-year pattern in Figure VII-17. In fact the mean TSS at mile point 77 was significantly lower than those for downstream areas.

The mean Cr values have a rather distinct pattern, with values decreasing with distance upstream. If this is a real pattern, it may be related to the patterns for Cu and Pb illustrated in Figure VII-16. However, the mean values were not found to be significantly different between adjacent study areas at the 95% confidence level.

The mean Cr value at mile points 37 to 42 was significantly higher than that at milepoint 96 at the 95% confidence level and was significantly higher than that at mile point 77 at just below the 95% confidence level. The mean

Cr value at mile points 62 to 68 was significantly higher than that at mile point 96, also.

The tables presented in Appendix VII-D can also be used to investigate correlations between variables. Rather than dwell on each major category and group, the correlation matrices were reviewed for consistency of correlation coefficients between the several categories and groups. Pairs of parameters which were found to be correlated consistently are presented in Tables VII-15 through VII-17.

Relatively high correlation coefficients were noted for parameter pairs during the one survey in which salinity intrusion was apparent (Table VII-15). During such intrusion, Cl, TDS, and SO_4 may all serve as tracers for the degree of mixing between freshwater and ocean water. The three parameters are closely correlated to each other, and other parameters are correlated similarly to each of the three. TDS has slightly higher correlation coefficients for most parameters than does Cl, but the two are very similar, and both generally have higher correlation coefficients than does SO_4.

The correlation coefficients indicate that, in addition to Cl, TDS, and SO_4 the saline water had higher values for NO_3, BOD, COD, TVS, and temperature and had a lower pH than fresh water, for the time period of the survey. The correlations for NO_3 may not be significant, since the range for NO_3 was only .04 mg/l, within the value allowing for experimental errors for sampling and analysis. The temperature correlation probably changes with season, leaving BOD, COD, and TVS as parameters which can be expected to be slightly higher in the saline portion of the Hudson than the fresh portion, with pH expected to be slightly lower in the saline portion.

TABLE VII-15

CORRELATION COEFFICIENTS
DURING SALT INTRUSION
OCTOBER 24, 1973

ROSETON/DANSKAMMER POINT VICINITY

CATEGORY 4 (TABLE VII-10)

PARAMETERS	COEFF.	PARAMETERS	COEFF.	PARAMETERS	COEFF.
Cl - TDS	.980				
Cl - SO4	.941	TDS - SO_4	.943		
Cl - NO_3	.542	TDS - NO_3	.559	SO_4 - NO_3	.596
Cl - BOD	.499	TDS - BOD	.451	SO_4 - BOD	.302
Cl - COD	.754	TDS - COD	.792	SO_4 - COD	.704
Cl - T	.613	TDS - T	.646	SO_4 - T	.614
Cl - pH	-.444	TDS - pH	-.510	SO_4 - pH	-.386
Cl - TVS	.706	TDS - TVS	.771	SO_4 - TVS	.641
pH - T	-.529				
BOD - T	.572				

NOTE: Concentrations, in mg/l, were:

	MIN.	MAX.	MEAN
Cl	47	275	120
TDS	210	670	351
SO_4	27	50	33
NO_3	.37	.41	.39
BOD	1	3	2.4
COD	5	130	26
T	71.6	73.4	72.2
pH	7.0	7.6	7.3
TVS	56	134	94

TABLE VII-16

CORRELATION COEFFICIENTS
CATEGORY 3 (Table VII-10)

ROSETON/DANSKAMMER POINT VICINITY

PARAMETER PAIR	COEFFICIENT (All Samples)	COEFFICIENT (Four Samples with high TSS Delected)
Cl - TDS	.731	.737
Cl - SO_4	.789	.788
Cl - COD	.371	.577
TDS - SO_4	.626	.623
TDS - TVS	.653	.711
T - pH	.458	.465
T - Cl	.357	.366
T - BOD	.520	.556
TKN - TCOD	.641	.231
TKN - TSS	.464	-.142
TP - TCOD	.687	.145
TP - TSS	.707	.266
TP - TKN	.580	-.096
TSS - TCOD	.663	.202
SO_4 - pH	-.593	-.592
TBOD - TCOD	.585	.274

TABLE VII-17

CORRELATION COEFFICIENTS
CATEGORY 2 (Table VII-10)

PARAMETER PAIR	STATION CH-1	CH-2	CH-3	CH-4	CH-5	CH-6
TDS-Cl	.645	.453	.611	.764	.497	.977
TDS-SO_4	.674	.449	.592	.612	.413	.864
TDS-TVS	.714	.752	.742	.599	.847	.652
Cl-SO_4	.692	.724	.759	.723	.832	.903
T-BOD	.386	.487	.596	.612	.627	.538
SO_4-pH	-.871	-.729	-.620	-.659	-.618	-.370

NOTE: Concentrations, in mg/l, were:

	MIN.	MAX.	MEAN
Cl	0	275	25.1
TDS	30	670	189
SO_4	10	50	19.8
TVS	2	570	83.4
BOD	0	9	1.7
T	46.4	73.4	63.5
pH	6.9	7.9	7.5

Table VII-16 indicates relatively high correlation coefficients for parameter pairs based on the entire data record for the monthly water quality program. Coefficients are presented before and after deletion of the four samples with unusually high suspended solids. Based on the change in correlation coefficients caused by deletion of these four samples, it can be concluded that the sediments are relatively high in COD, BOD, TP and TKN compared to the dissolved fraction of the river. A similar conclusion could be made for NO_3, (not shown in Table IV-16), however, the accuracy of the colorimetric analytical test is hindered by the presence of suspended solids.

It can be generally expected that variations due mainly to salt intrusion will create weaker correlations with the total data record than with selected data records which emphasize salt intrusion. This is because a larger fraction of total variance for each parameter will be due to other effects. Thus correlations between Cl, TDS, and SO_4 are significantly weaker than they were for the data during the salt intrusion of October 24, 1973 (see Table VII-15). The correlations between Cl or TDS and T, COD, BOD, TVS, and pH are also weaker, but generally have the same sign as for the data during salt intrusion.

The pH-T and BOD-T correlations are only slightly weaker and may reflect the effects of other factors. In particular, temperature variation coincides with variations in biological activity and freshwater flow, both of which can affect physical and chemical parameters of water quality. However, the pH-T and BOD-T correlations do not account for the major portions of variations of the parameters.

The pH-SO_4 correlation is significantly stronger than for the data during salt intrusion. This correlation is also seen in Table VII-17 which presents correlation coefficients for each sampling station.

The pH-SO_4 correlations is significantly stronger at the stations least affected by the salt intrusion. Thus, it appears that pH is controlled to a significant degree by the sulfate concentration within the freshwater portion of the Hudson River near Roseton/Danskammer Point.

The other parameter pairs in Table VII-17 reflect salt intrusion (TDS-Cl, TDS-SO_4, TDS-TVS, Cl-SO_4) or the BOD-T correlation noted above.

(d) Analysis of Variance. To test possible differences between sampling locations, depths, and dates, several analysis of variance (ANOVA) routines were utilized. The four samples with relatively high suspended solids were included for these analyses. The ANOVA methods were applied as described by Sokal and Rohlf (1969).

Table VII-18 summarizes the sample groupings and ANOVA techniques used. The ANOVA routine results were converted into F ratios and tested for significance at the .05 significance levels by reference to F-distribution tables according to procedures outlined by Simpson et al. (1960). Tables VII-19 and VI-20 summarize the treatments and interactions found to be significant.

When significant differences as main effects were found between stations, a Student-Newman-Keuls (SNK) test (Sokal and Rohlf, 1969) or a Least Significant Difference (LSD) test (Snedecor and Cochran, 1967) was performed to establish homogeneous subsets. Since the only depth distinction

TABLE VII-18

ANALYSIS OF VARIANCE
1973 ROSETON/DANSKAMMER POINT
WATER QUALITY INVESTIGATIONS

ROSETON/DANSKAMMER POINT VICINITY

ANOVA SET	ANOVA *	STATIONS	DEPTHS **	DATES	PARAMETERS
1	3-way	CH-1 through CH-6	S and B	5/29/73 through 1/3/74	TDS, Cl, SO_4, TCOD, pH, TVS, TS, TSS, TBOD, TKN, Phl, Alk, NH_3-N, TP, Cr, Zn, NO_3-N, T, DO
2	2-way	CH-1 through CH-6	No Depth Distinction	5/29/73 through 1/3/74	same as above

* 2-way and 3-way ANOVA performed according to Simpson et al (1960)

** All bottom samples treated as the same depth despite actual values of approximately 25, 45, 60, or 80 feet for sample depths.

TABLE VII-19

RESULTS OF ANOVA SET 1

ROSETON/DANSKAMMER POINT VICINITY

PARAMETER	TREATMENT			INTERACTION		
	DEPTH	STATION	DATE	DEPTH X STATION	DEPTH X DATE	STATION X DATE
TDS			X			X
Cl			X		X	X
SO_4			X		X	X
TCOD	X					
TVS			X			
TS	X		X			
TSS	X					
TBOD	X		X			X
TKN			X		X	
Phl			X			X
Alk			X	X		
NH_3-N			X			
TP	X					
Cr						
Zn						
NO_3-N			X	X	X	
pH			X		X	X
T			X		X	X
DO	X		X			X

Note: X = Significant at less than .05 significance level.

TABLE VII-20

RESULTS OF ANOVA SET 2

ROSETON/DANSKAMMER POINT VICINITY

PARAMETER	TREATMENT	
	STATION	DATE
TBS		X
pH		X
TDS		X
Cl		X
SO_4		X
NO_3-N	X	X
TCOD		X
T		X
TS		X
TSS	X	
TBOD		X
DO		X
TKN		X
Phl		X
Alk		X
NH_3-N		X
TP		
Cr		X
Zn		

NOTE: X = significant at less than .05 significance level.

was surface vs. bottom when significant differences as main effects were found between depths, the homogeneous subsets were simply composed of surface samples and bottom samples.

For interpreting these ANOVA results, the first step was to analyze which parameters had main effects or interactions involving each of the two or three factors (depth, station, date). According to Simpson et al. (1960), when an interaction between two factors in a 3-way ANOVA is significant, there is generally as much variation from level to level of the first factor, at a fixed second factor level, as there is from level to level of the second factor at a fixed first factor level. Thus, for example, station differences may be significant if a main effect is indicated or if an interaction involving stations is indicated.

Station differences were found to be significant for pH, DO, TDS, Cl, SO_4, BOD, phenol, alkalinity, NO_3, and temperature (Table VII-19). There were no main station effects, and, except for alkalinity and NO_3, the differences were attributable to a combination of station and data. In addition, all of the above parameters except DO, phenol, and alkalinity are associated with salt intrusion. Thus, it may be concluded that most of these station differences are attributable to the gradient in degree of intrusion during the one or possibly two sampling dates when salt intrusion was measured.

Although it is not possible to establish homogeneous subsets for samples exhibiting only interaction effects, it is useful to analyze mean values by station in a qualitative manner. For example, station means for phenol indicate that CH-1, CH-2, and CH-3 had relatively low phenol values, that CH-4 and CH-5 had relatively high values, and that CH-6 had

an intermediate mean value. This suggests that phenols may be introduced into the Hudson from Wappinger Creek during certain times of year.

NO_3 and TSS exhibited significant station effects (Table VII-20). The TSS station effect is simply a reflection of the depth effect which was not tested in the 2-way ANOVA. Table VII-22 verifies that the bottom samples created the station differences in TSS. No obvious patterns are exhibited by the overlapping homogeneous subsets for NO_3 given in Table VII-22.

Depth differences were important for pH, Cl , TSS, TP, SO_4, TS, TBOD, TKN, Alk, DO, COD, TS, NO_3, and T (Table VII-21). Main effects were evident for most of the parameters associated with the sediment fraction of the river in previous discussions, namely TCOD, TSS, TBOD, TS, and TP. The effects were most likely the result of the four bottom samples with unusually high TSS. A main effect was evident for DO, which was slightly lower in bottom samples than in surface samples, but the difference between surface and bottom means was only 0.4 mg/l. The depth effects for most other parameters were probably attributable to vertical stratification during salt intrusion (pH, Cl, SO_4, NO_3) or to the four samples with unusually high TSS (TKN). Judging from the low variations involved, the depth effect for alkalinity probably has no particular significance.

Date differences were exhibited for all parameters except TCOD, TSS, TP, Cr, and Zn (Table VII-21), ANOVA Set 1 and for all parameters except TSS, TP, and Zn (Table VII-20). The variance created by the four bottom samples with high suspended solids probably overwhelmed other variance components for TSS, TCOD, and TP. The Zn and Cr variances have no obvious cause or pattern.

TABLE VII-21

RESULTS OF ANOVA SET 1:
HOMOGENEOUS SUBSETS FOR DEPTH DIFFERENCE
ROSETON/DANSKAMMER POINT VICINITY

PARAMETER	SURFACE, MEAN	BOTTOM, MEAN	RANK
TCOD	10.9	22.31	B>S
TS	200	274	B>S
TSS	20.7	68.7	B>S
TBOD	1.5	1.8	B>S
TP	.098	.169	B>S
DO	8.24	7.81	B>S

TABLE VII-22

RESULTS OF ANOVA SET 2:
HOMOGENEOUS SUBSETS FOR STATION DIFFERENCES

ROSETON/DANSKAMMER POINT VICINITY

1. NO_3-N by Least Significant Difference, $\alpha = .05$

Rank	1	2	3	4	5	6	7	8	9	10	11
Mean	.473	.478	.483	.485	.533	.535	.538	.542	.547	.558	.582
Station	CH-5(S)	CH-2(B)	CH-3(S) CH-4(S)	CH-1(S)	CH-5(B)	CH-4(M)	CH-4(M)	CH-6(S)	CH-1(B) CH-4(B)	CH-3(B)	CH-6(B

2. TSS by Student-Newman-Keuls, $\alpha = .05$

Rank	1	2	3	4	5	6	7	8	9	10	11	12	13
Mean	12.7	17.8	20.1	23.8	24.6	24.8	29.1	29.7	38.4	56.1	93.1	107	142
Station	CH-4(S)	CH-5(S)	CH-1(S)	CH-3(S)	CH-4(M)	CH-2(S)	CH-6(S)	CH-5(B)	CH-6(B)	CH-1(B)	CH-4(B)	CH-3(B)	CH-2(B)

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5. Sediment Characteristics

The sediment analysis data for the eight transects are presented in Tables VII-23 through VII-30. Each table presents data for each transect on the basis of percents sand, silt and clay for soil classification of inorganic particules, and data on the basis of percents organic, stones, sand, silt and clay in total sediment. The size boundaries for classification were 0.074 mm for sand/silt and 0.002 mm for silt/clay.

The North Control (NC) transect data (Table VII-23) show a higher percent organic matter as well as a greater percentage of sand on the west side of the river, especially at the 10-foot depth. The high silt at the 10-foot depth on the east side may be due to the effects of a point of land which juts out into the river just downstream at New Hamburg; this would lower river velocities and increase the settling of finer silt particles, while the high velocities on the unobstructed west side could account for the lower percentage there of silt and higher percentage of sand.

The duplicate samples at 30-foot depths on each side of the transect indicate similar distributions for pairs of samples, but they also indicate a reasonably high degree of variation. This variation can be attributed to variations in the sediment itself rather than to analytical techniques.

The Wappinger Creek transect (Table VII-24) had east stations only. The shallow depth samples (10-foot and 20-foot) show a higher silt and lower sand content than the deep water (30, 40, and 50-foot) samples. This is most likely due to the combination of the deposition of material from Wappinger Creek in the wide shallow area and the lower velocities just downstream of the point, at New Hamburg, as compared to the higher velocities

TABLE VII-23

SEDIMENT CHARACTERIZATION
TRANSECT: NORTH CONTROL

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
2A	East	10	29	63	8	Silty Loam
3A	"	20	32	58	10	" "
4A	"	30	23	67	10	" "
2C	"	30	38	54	8	" "
5A	"	40	23	69	8	" "
1A	Middle	50	34	57	9	" "
24A	West	40	50	40	10	Sandy Loam
5C	"	30	44	46	10	Loam
23A	"	30	31	65	4	Silty Loam
3C	"	10	65	30	5	Sandy Loam

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
2A	East	10	7	0	27	58	8
3A	"	20	7	0	30	54	9
4A	"	30	6	0	22	63	9
2C	"	30	5	0	36	51	8
5A	"	40	7	0	21	64	8
1A	Middle	50	10	0	31	51	8
24A	West	40	7	0	47	37	9
5C	"	30	15	0	37	39	9
23A	"	30	11	0	27	58	4
3C	"	10	19	0	53	24	4
Transect Means			9	0	33	50	8
Standard Deviation			±4		±10	±13	±2

TABLE VII-24
SEDIMENT CHARACTERIZATION
TRANSECT: WAPPINGER CREEK

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
13A	East	10	12	0	40	42	6
14A	East	20	5	5	45	38	7
15A	East	30	7	16	61	12	4
16A	East	40	7	0	69	17	7
17A	EAst	50	5	0	80	12	3
Transect Means			7	4	59	24	6
Standard Deviations			±3	±9	±17	±15	±2

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
13A	East	10	45	48	7	Sandy Loam
14A	East	20	52	40	8	Sandy Loam
15A	East	30	83	13	4	Loamy Sand
16A	East	40	74	18	8	Sandy Loam
17A	East	50	84	13	3	Loamy Sand

TABLE VII-25

SEDIMENT CHARACTERIZATION
TRANSECT: DANSKAMMER COVE

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
19A	West	50	66	25	9	Sandy Loam
18A	West	40	48	39	13	Loam
22A	West	30	51	38	11	Sandy Loam
21A	West	20	33	51	16	Silty Loam
20A	West	10	34	50	16	Silty Loam

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
19A	West	50	8	0	61	23	8
18A	West	40	13	0	42	34	11
22A	West	30	14	0	44	33	9
21A	West	20	9	0	30	46	15
20A	West	10	9	0	31	45	15
Transect Means:			11	0	41	36	12
Standard Deviations:			±3		±13	±10	±3

TABLE VII-26

SEDIMENT CHARACTERIZATION
TRANSECT: DANSKAMMER DISCHARGE

ROSETON/DANSKAMMER POINT VICINITY

Sample #	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
31A	East	10	34	59	7	Silty Loam
32A	East	20	66	26	8	Sandy Loam
33A	East	30	50	48	2	" "
34A	East	40	54	40	6	" "
29A	West	40	50	46	4	" "
28A	West	30	47	40	13	Loam
17C	West	30	57	36	7	Sandy Loam
27A	West	20	54	36	10	" "
16C	West	10	60	33	7	" "
35A	West	10	51	37	12	" "
26A	West	10	44	43	13	Loam

Sample #	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
31A	East	10	8	0	31	54	7
32A	East	20	4	0	63	25	8
33A	East	30	5	0	46	47	2
34A	East	40	4	0	52	38	6
29A	West	40	8	0	46	42	4
28A	West	30	9	0	43	36	12
17C	West	30	7	0	53	33	7
27A	West	20	12	0	47	32	9
16C	West	10	10	0	54	30	6
35A	West	10	8	0	47	34	11
26A	West	10	8	0	40	40	12
Transect Means:			8	0	47	37	8
Standard Deviations:			±2		±8	±8	±3

TABLE VII-27

SEDIMENT CHARACTERIZATION
TRANSECT: MAXIMUM ΔT

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
6A	East	10	22	62	16	Silty Loam
7A	East	20	45	51	4	" "
30A	East	30	78	13	9	Sandy Loam
9A	East	40	45	51	4	Silty Loam
10A	Middle	50	53	42	5	Sandy Loam
25A	West	40	52	38	10	" "
12C	West	30	53	38	9	" "
12A	West	30	37	54	9	Silty Loam
11C	West	20	39	56	5	" "
11A	West	20	49	45	6	Sandy Loam
10C	West	10	48	41	11	Loam
8A	West	10	62	31	7	Sandy Loam

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
6A	East	10	8	0	20	57	15
7A	East	20	4	0	43	49	4
30A	East	30	2	47	29	13	9
9A	East	40	5	0	43	48	4
10A	Middle	50	4	0	51	40	5
25A	West	40	8	0	48	35	9
12C	West	30	15	0	45	32	8
12A	West	30	8	0	34	50	8
11C	West	20	8	0	36	51	5
11A	West	20	9	0	45	41	5
10C	West	10	10	0	43	37	10
8A	West	10	5	0	59	29	7
Transect Means			8	0	42	43	7
Standard Deviations:			±3		±10	±9	±3

TABLE VII-28

SEDIMENT CHARACTERIZATION
TRANSECT: 75ΔT

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
4B	East	10	42	50	8	Loam
5B	East	20	64	33	3	Sandy Loam
6B	East	30	55	41	4	" "
7B	East	40	58	37	5	" "
8B	Middle	50	52	41	7	" "
9B	West	40	54	40	6	" "
15C	West	30	58	35	7	" "
14C	West	20	56	36	8	" "
13C	West	10	57	36	7	" "

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
4B	East	10	7	0	39	47	7
5B	East	20	8	24	36	29	3
6B	East	30	13	0	46	36	3
7B	East	40	12	0	51	33	4
8B	Middle	50	19	0	42	33	6
9B	West	40	15	0	46	34	5
15C	West	30	19	0	47	28	6
14C	West	20	15	0	48	30	7
13C	West	10	16	0	48	30	6
Transect Means			14	3	45	33	5
Standard Deviation			± 4	± 8	± 4	± 5	± 1

TABLE VII-29

SEDIMENT CHARACTERIZATION
TRANSECT: INTERMEDIATE

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
10B	East	10	37	60	3	Silty Loam
11B	East	20	47	50	3	" "
12B	East	30	54	43	3	Sandy Loam
13B	East	40	41	53	6	Silty Loam
14B	Middle	50	48	47	5	Sandy Loam
15B	West	40	54	40	6	" "
16B	West	30	58	37	5	" "
17B	West	20	63	32	5	" "
18B	West	10	53	43	4	" "

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sands	% Silt	% Clay
10B	East	10	5	0	35	57	3
11B	East	20	5	1	43	48	3
12B	East	30	4	0	52	41	3
13B	East	40	9	0	38	48	5
14B	Middle	50	6	0	45	44	5
15B	West	40	9	0	49	38	5
16B	West	30	8	0	53	34	5
17B	West	20	9	4	54	29	4
18B	West	10	14	12	34	36	4
Transect Means:			8	2	45	41	4
Standard Deviations:			±3	±4	±8	±9	±1

in the deeper section of the river, allowing deposition to occur in the lee of the point.

The Danskammer Cove transect (Table VII-25) shows a trend similar to the Wappinger Creek transect, in that the percentage of silt is higher in the shallow (10 foot and 20 foot) areas and percentage of sand increases at the deeper (30, 40 and 50 foot), higher velocity stations. The cove is another example of a shallow, low velocity area which tends to accumulate silt due to increased settling. This transect has a relatively high percentage of clay in the shallow zone.

The Danskammer discharge transect (Table VII-26) data also show an increase in percentage of clay on the west side of the river, particularly in the shallow zone (10 foot depth). The variations of percent sand and silt on this transect do not show any lateral trend or any trend with depth.

The Max ΔT transect (Table VII-27) again shows the high silt in the shallow east zone, and increases in sand at the deeper stations.

The 75 ΔT transect (Table VII-28) also shows a higher silt content in the shallow eastern zone, with sand generally increasing to the west. This transect is located at the upstream end of a wide shallow zone on the eastern side of the river which extends south past the South Control transect. The 75 ΔT transect has a higher organic content across the transect (mean= 14%) than any other transect.

Table VII-29 shows that the Intermediate transect has a lateral increase of silt from west to east, with the shallow eastern station being the highest. This transect is in a section of river that has shallow water on the eastern third of the cross section.

The high sand content of the western stations of the South Control transect (Table VII-30) shows the effect of the channel on the west side of the river, by comparison to the high silt content of the shallow eastern stations. The western 40 foot sample has the highest organic content of any sample, and the eastern 20 foot sample had the highest organic content of any eastern station.

Table VII-31 summarizes the means by transect and Table VII-32 summarizes the means by depth of station. These two tables indicate that:

1. at all depths and at all transects western sediments are generally higher in organic content and usually lower in silt content than eastern sediments;

2. sand, silt, and clay fractions are similar for all depths for total samples; there is little difference between eastern and western sediments attributable to depth of station, except at the 10 foot depths where eastern sediments are comparatively high in silt and low in sand content;

3. there are more east/west differences attributable to transect than to depth; on a total station basis there is an apparent difference between transects;

4. North Control and South Control transects have the most extreme differences in sediment composition. North Control transect sediments are relatively high in silt and clay content and relatively low in sand and organic content (except western stations, which were high in organic content). South Control

TABLE VII-30

SEDIMENT CHARACTERIZATION
TRANSECT: SOUTH CONTROL

ROSETON/DANSKAMMER POINT VICINITY

Sample	Location	Depth (ft.)	% Sand	% Silt	% Clay	Classification
1B	East	10	53	43	4	Sandy Loam
2B	East	20	49	46	5	" "
3B	West	40	51	42	7	" "
7C	West	20	58	38	4	" "
6C	West	10	79	16	5	Loamy Sand

Sample	Location	Depth (ft.)	% Organic	% Stones	% Sand	% Silt	% Clay
1B	East	10	7	1	48	40	4
2B	East	20	13	0	43	40	4
3B	West	40	27	0	37	31	5
7C	West	20	9	0	53	34	4
6C	West	10	6	0	74	15	5
Transect Means:			13	0	51	32	4
Standard Deviations:			±9		±14	±10	±1

TABLE VII-31

SEDIMENT CHARACTERIZATION SUMMARY: ALL DEPTHS
ROSETON/DANSKAMMER POINT VICINITY

TRANSECT	NO. SAMPLES	% ORGANIC	% STONES	% SAND	% SILT	% CLAY
NORTH CONTROL						
East	5	6	0	27	58	8
West	4	13	0	41	40	6
Total	10	9	0	33	50	8
WAPPINGER						
Wap. Creek East	5	7	4	59	24	5
Danskammer Cove (West)	5	11	0	42	36	12
Total	10	9	2	50	40	8
DANSKAMMER DISCHARGE						
East	4	5	0	48	41	6
West	7	9	0	47	35	9
Total	11	8	0	47	37	8
Max. ΔT						
Max. ΔT East	3	6	0	35	51	8
Max. ΔT West	7	9	0	44	39	7
Max. ΔT Total	11	8	0	42	43	7
75 ΔT						
75 ΔT East	4	10	6	43	36	4
75 ΔT West	4	16	0	47	30	6
75 ΔT Total	9	14	3	45	33	5
INTERMEDIATE						
East	4	6	0	42	48	4
West	4	10	4	48	34	4
Total	9	8	2	45	42	4
SOUTH CONTROL						
East	2	10	0	46	40	4
West	3	14	0	55	27	5
Total	5	12	0	51	32	4
All Stations	65	9	1	44	39	7

TABLE VII-32

SEDIMENT CHARACTERIZATION SUMMARY: ALL STATIONS

ROSETON/DANSKAMMER POINT VICINITY

DEPTH (feet)	LOCATION	NO. SAMPLES	% ORGANIC	% STONES	% SAND	% SILT	% CLAY
10	East	7	8	0	34	51	7
	West	10	10	1	48	32	8
	Total	17	9	1	43	40	8
20	East	7	7	4	43	40	5
	West	7	10	1	45	38	7
	Total	14	8	2	44	39	6
30	East	6	7	3	44	42	5
	West	9	12	0	43	38	8
	Total	15	10	1	43	40	6
40	East	6	7	0	46	41	6
	West	7	12	0	45	36	7
	Total	13	10	0	45	38	6
50	Total	6	9	0	52	34	6
All	East	26	7	2	42	44	6
All	West	33	11	0	45	36	7
All	Total	65	9	1	44	39	7

transect stations were relatively low in silt and clay content and high in sand and organic content.

5. The relatively high organic content of western sediments may be correlated with relatively large particle sizes, since these sediments are generally higher in sand and lower in silt content than eastern sediments.

Table VII-33 summarizes sediment composition for seven separate areas of the Hudson River studied in 1973, including the Roseton/Danskammer Point area. There is a general increase in organic content from Kingston (mile point 96) to Hastings (mile point 22). The Roseton/Danskammer Point sediments fall into this pattern. Sand, silt, and clay content may be controlled more by local conditions than by river mile point. The North Control Transect means are very similar to means for all Hudson River samples.

The chemical analysis results are presented in Table VII-34 and are shown graphically in Figures VII-41 through 44. All of the detailed chemical data was obtained from western stations. The general trend appears to be that the South Control transect is lowest in concentration of most parameters, with the North control and the other transects being similiar. Also, for all parameters analyzed, the deeper stations have higher concentrations than the shallow 10-foot stations.

TABLE VII-33

HUDSON RIVER SEDIMENT CHARACTERIZATION

ROSETON/DANSKAMMER POINT VICINITY

LOCATION	MILE POINT	NO. SAMPLES	% ORGANIC	% STONES	% SAND	% SILT	% CLAY
Kingston	96	20	7	1	41	49	2
Poughkeepsie	75	48	9	1	18	67	5
Danskammer/ Point Roseton	65	65	9	1	44	39	7
Lovett	40	11	11	4	34	45	6
Bowline	37	24	11	0	27	58	4
Nyack	28	2	13	0	40	40	7
Hastings-on-Hudson	22	2	15	2	48	29	6
Mean			10	1	32	51	6
North Control Transect at Roseton/Danskammer Point			9	0	33	50	8

TABLE VII-34

SEDIMENT CHEMICAL ANALYSIS

ROSETON/DANSKAMMER POINT VICINITY

TRANSECT	DEPTH (FT.)	MOISTURE CONTENT (percent of wet wt.)	TVS (percent of wet wt.)	COD mg/100g DRY WT.	TP mg/100g DRY WT.	TKN mg/100g DRY WT.	Cd mg/100g DRY WT.	Cu mg/100g DRY WT.	Pb mg/100g DRY WT.	Zn mg/100g DRY WT.	SOLUI Cl mg/l
NCW	10	40.17		680.9	55.8	153.9	0.23	7.22	2.45	16.61	
NCW	20	56.62	2.85	8946	111.5	234.9	0.28	10.30	7.53	24.78	
NCW	30	50.42	8.93	7473	85.1	245.0	<D.L.	10.20	9.09	22.52	45
DANSK DISCH	10	47.32	4.01	8648	69.3	239.4	0.37	5.09	1.33	11.16	
DANSK DISCH	30	56.50	3.17	8872	114.8	267.8	0.44	3.21	<D.L.	14.37	
MAX ΔT WEST	10	38.02	3.67	4000	54.1	113.6	<D.L.	<D.L.	7.76	8.99	
MAX ΔT WEST	20	50.07	6.81	13032	96.1	260.8	2.72	7.80	8.80	39.41	
MAX ΔT WEST	30	51.65	3.54	12584	86.1	290.9	1.32	10.33	11.01	24.34	238
75 ΔT WEST	10	50.62	3.83	9194	84.7	243.6	2.13	8.40	8.63	30.30	
75 ΔT West	20	57.72	3.06	5742	112.3	231.3	2.38	7.44	11.27	25.34	
75 ΔT WEST	30	57.58	2.97	9258	112.4	180.1	2.46	6.27	14.01	25.06	
SCW	10	25.44	3.22	4857	49.8	94.9	<D.L.	3.45	7.06	11.45	
SCW	20	52.46	2.64	8092	40.0	227.8	<D.L.	<D.L.	<D.L.	0.27	
SCW	30	40.21	2.50	8204	47.5	130.1	<D.L.	1.66	<D.L.	0.89	442
NCE	30										57
SCE	30										188
MAX ΔT EAST	30										

NOTE: <D.L. = less than detection limit.

SEDIMENT CHEMICAL CHARACTERISTICS
COD AND TVS

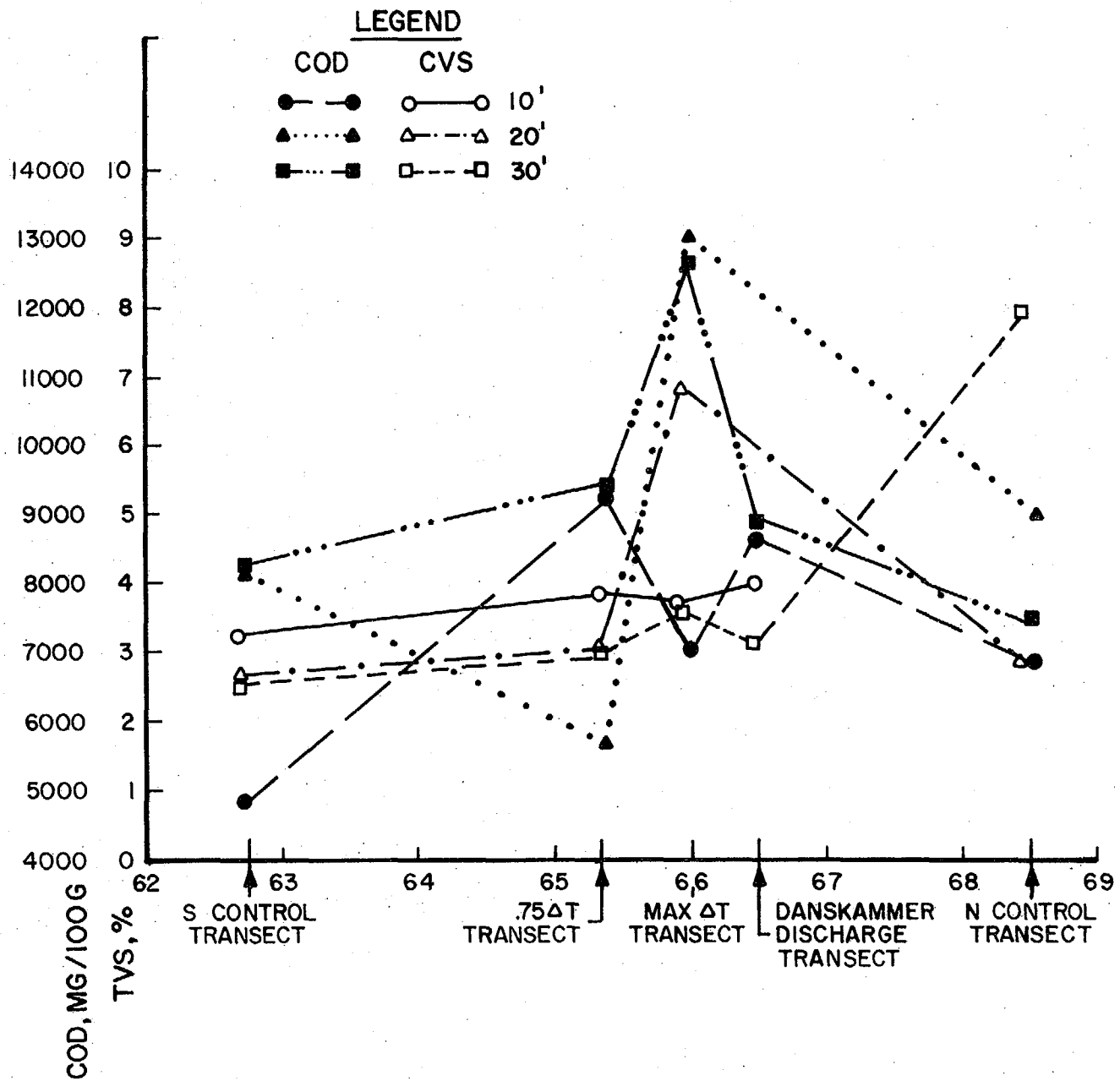


FIGURE VII-41

SEDIMENT CHEMICAL CHARACTERISTICS
TKN AND TP

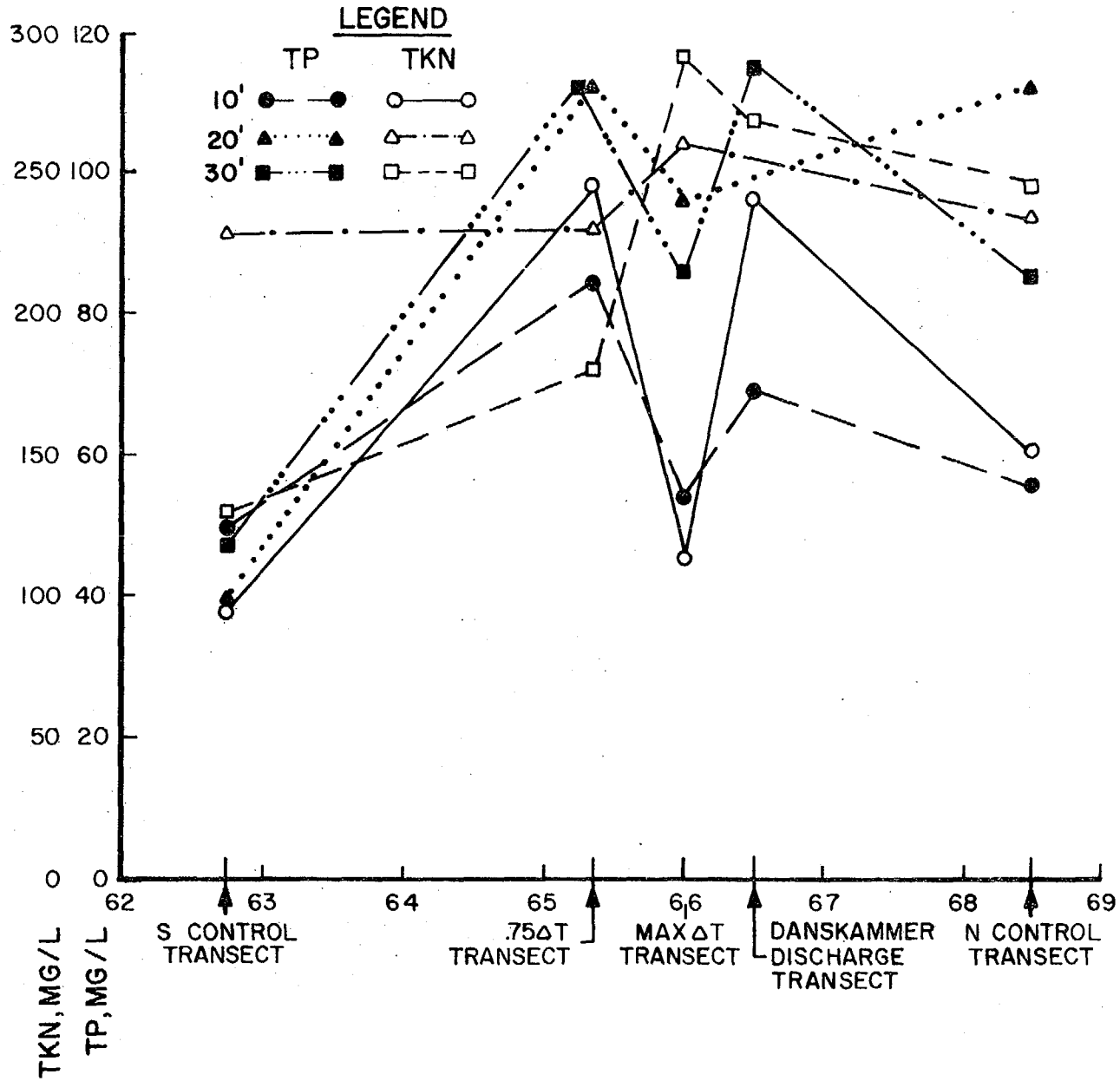


FIGURE VII-42

SEDIMENT CHEMICAL CHARACTERISTICS
Cu AND Cd

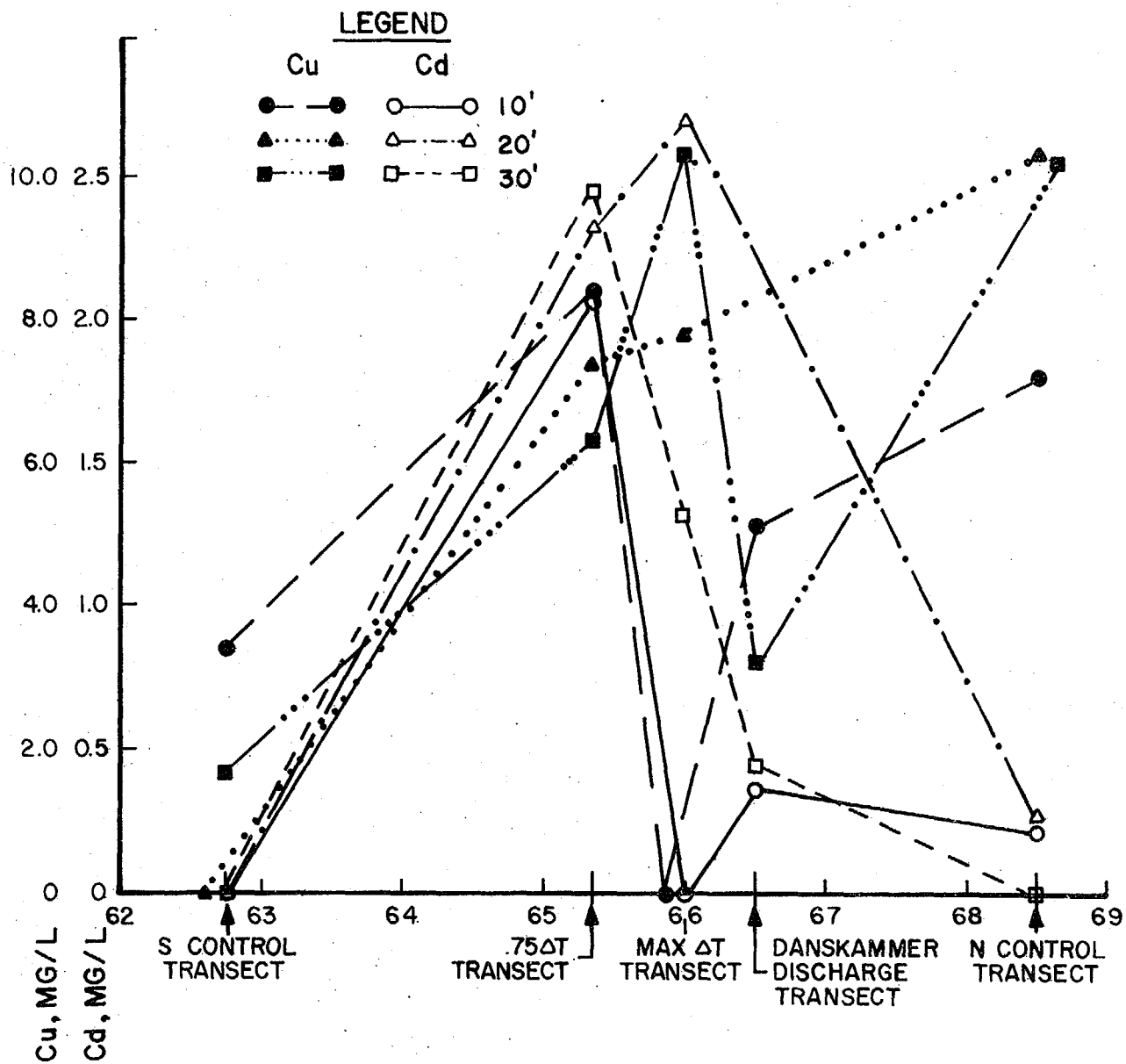


FIGURE VII-43

SEDIMENT CHEMICAL CHARACTERISTICS
Zn AND Pb

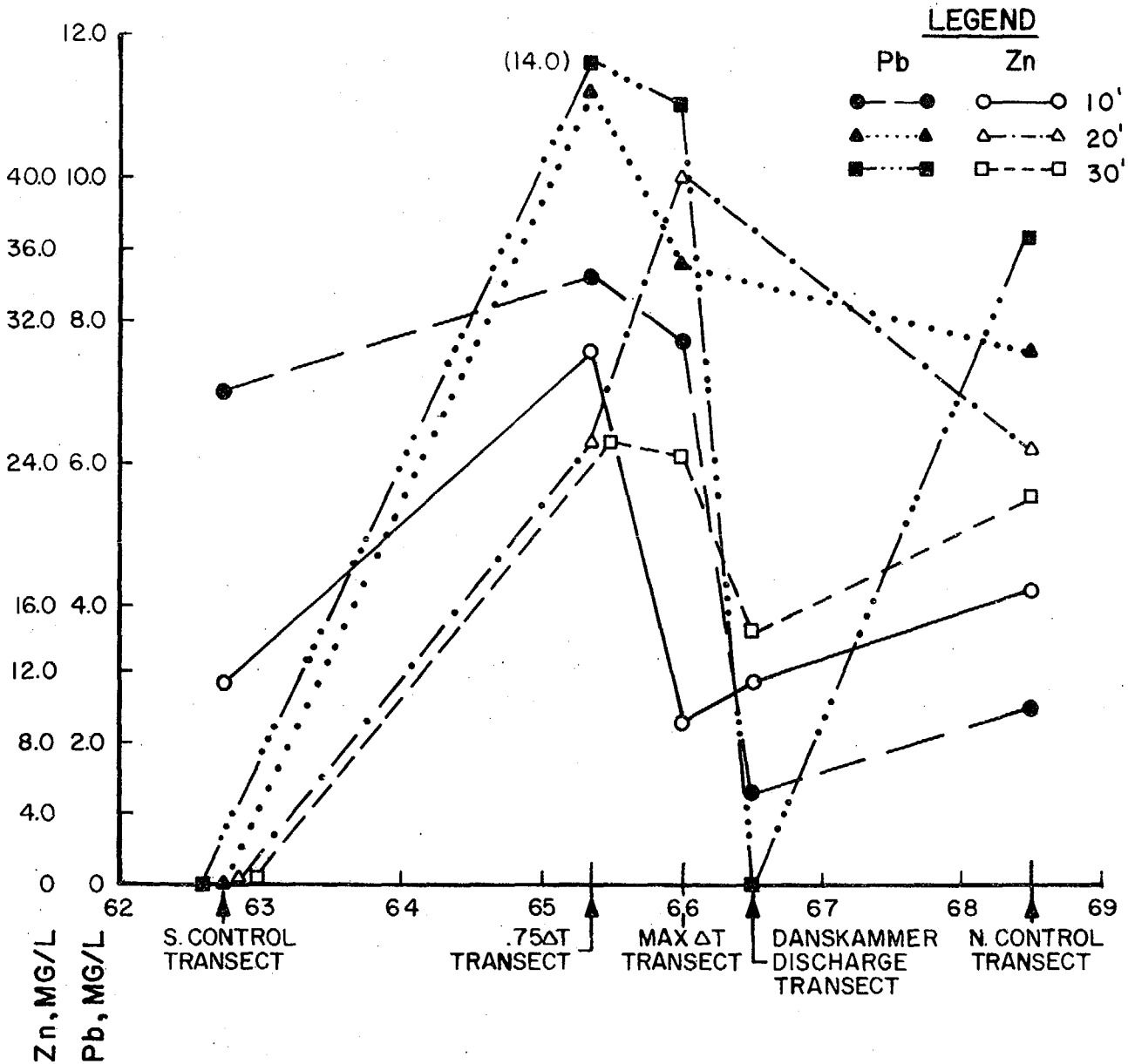


FIGURE VII-44

D. CONCLUSIONS

The objectives of water quality investigations conducted in the Roseton/Danskammer Point vicinity were to define temporal and spatial patterns in major water quality parameters in the study area in 1973, to compare these patterns with those found in previous years, to compare these patterns with those for other areas of the Hudson River in 1973, and to provide support for concurrent ecological studies. Samples or field measurements were taken monthly at six stations at specified depths; a total of thirteen samples were collected monthly. Additional field measurements for dissolved oxygen, specific conductivity, and temperature were taken approximately weekly to support various fish, benthos, and plankton studies. The results of these investigations indicate the following:

1. On the basis of NYSDEC and EPA studies conducted on the Hudson River between 1967 and 1973, there appear to be at least four patterns of yearly mean concentration for water quality parameters. These are:
   (a) concentrations not affected by location (NO_3, Fe, Mn, Hg).
   (b) concentration increases with proximity to New York City (Ca, K, Na, Mg, Cl, SO_4, TDS; i.e., parameters indicating degree of salt intrusion).
   (c) concentration increases with increasing proximity to Albany and, especially, to New York City (CO_2, F, MBAS, orthophosphate, total phosphorus, NH_3, NO_2, TKN, COD; i.e., generally, parameters which reflect municipal pollution).
   (d) concentrations reaching a maximum or minimum at a point between New York City and Albany (Cu and Pb, maximum at about mile point

25; suspended solids, maximum between mile points 70 and 80; Si, minimum between mile points 70 and 100).

2. The water quality in the study area (mile points 62 to 68) in 1973 was very similar to that expected from review of previous studies. Except for relatively low BOD and relatively high suspended solids values, the water quality of the study area in 1973 was not significantly different from that at both mile points 77 and 96. Several other parameters were relatively high or low compared to one or the other study area, but not both areas.

NH_3 was the only parameter measured which was significantly different in 1973 than in previous years. The values were approximately an order of magnitude less than previous values (0.02 mg/l vs. 0.2 mg/l).

Phenol was apparently higher than in previous years (0.03 mg/l vs. 0.01 mg/l) but values for phenol were highly variable, and insufficient data are available from previous studies to make definitive statements. Phenol was the only measured parameter with a mean value exceeding existing or proposed water quality standards or criteria; in particular the mean value of 0.03 mg/l exceeds the standard of 0.001 mg/l established for drinking water.

3. The major cause of variation in water quality in 1973 was salt intrusion. Based on freshwater flow at Green Island and on Cl and specific conductivity data at various points in the river in 1973, it is estimated that significant salt intrusion occurred approximately 10 to 15% of the time at mile point 62 and approximately 5% of the time at mile point 68. This intrusion, which occurred

mainly during October, was measured during a survey on October 24, 1973 in the study area and caused obvious peaks in concentrations of Cl, TDS, SO_4, TS, total hardness and possibly TVS.

4. Relatively minor increases in Cl, SO_4, TDS, and alkalinity were attributable to decreased flow from May through September.

5. The slight increase in pH from June through October may have reflected increased algal activity during this period.

6. Temperature and dissolved oxygen values exhibited expected annual patterns, with dissolved oxygen decreases reflecting temperature increases. On a monthly average basis percent saturation values varied from about 50 to 70% in the July through October period to about 80 to 90% during remaining periods. The ammonia pattern was similar to that for dissolved oxygen and was probably due to similar causes, i.e., the increased rate of oxidative processes in response to increased temperature.

7. Silica values decreased from January to August and remained low until early December, when the values again rose. This pattern also coincided with the freshwater flow pattern.

8. Total suspended solids values were somewhat higher for bottom samples than for surface samples and tended to increase for all depths late in the year, perhaps in response to increased freshwater flow.

9. Several parameters were highly variable, namely NH_3, TSS, Cl, phenol, Zn, and Cr. NH_3 and Cl variations were relatively smooth in response to natural hydrodynamic and biochemical phenomena. TSS, Zn and Cr had relatively low values during the September to November period followed by relatively high values, but generally it appeared to vary randomly. Phenol values varied within the study area in a manner suggesting a possible input from Wappinger Creek.

10. The mile point 37-42 area was relatively higher than all other 1973 study areas with respect to TKN, NH_3 and NO_3. Cr values decreased with increasing distance upstream. NH_3 values were lowest at the study area and higher both upstream and downstream. Concentrations in the mile point 37-42 area were much higher than in other 1973 study areas with respect to components reflecting salt intrusion directly, e.g., TS, TDS, TVS, SO_4, and Cl.

11. Statistical correlations indicated that during salt intrusion there were increases in BOD, COD, temperature, and TVS, and a slight decrease in pH attributable to the intruding waters.

12. Statistical correlations also indicated that the bottom sediment, when slightly disturbed, contributed relatively high values of COD BOD, TP, and TKN compared to normal values for the river.

13. A statistically significant negative correlation between pH and SO_4 was attributable to freshwater phenomena. It appears that sulfate variations in the study area during freshwater conditions may have caused relatively minor pH variations.

14. Analysis of variance techniques did not indicate any important main station effects (i.e., significant differences in parameter values attributable to station differences) based on the entire data record. Interaction effects involving station were largely attributable to salt intrusion. Most main depth effects were attributable to slight disturbance of bottom sediments during sampling for four samples. There was a main depth effect for dissolved oxygen which indicated that a mean dissolved oxygen value for surface samples 0.4 mg/l higher than that for bottom samples was significant. Main date effects were evident for most parameters, except for some of those associated with disturbance of sediment during sampling and for Zn and Cr. Variations in Zn and Cr were random in nature.

15. At all depths and at all transects western sediments were generally higher in organic content and lower in silt content than eastern sediments.

16. Sand, silt and clay fractions were similar for all depths for total samples; there was little difference between eastern and western sediments attributable to depth of station, except at the 10 foot depths where eastern sediments were comparatively high in silt and low in sand content.

17. North Control and South Control transects had the most extreme differences in sediment composition. North Control transect sediments were relatively high in silt and clay content and relatively low in sand and organic content (except western stations, which were high in organic content). South Control transect

stations were relatively low in silt and clay content and high in sand and organic content.

18. The relatively high organic content of wester sediments may have been correlated with relatively large particle sizes, since these sediments were generally higher in sand and lower in silt content than eastern sediments.

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VOLUME III

FISH

CHAPTER VI

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TABLE OF CONTENTS

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME III

TABLE OF CONTENTS

CHAPTER VI

VI. FISH

A. Introduction... ... ... VI-1
1. Previous Studies of Hudson River Fish 3
2. Present Study Objectives.. 7

B. Materials and Methods 9
1. Sampling Frequency... 9
2. Collection Techniques and Equipment. 9
3. Station Locations 13

C. Results and Discussion... 15
1. River Fish Collections: 1971-1973... 15
2. Total Collection by Collection Method: 1971-1973... ... 18
3. Population Location Preference Based on 1973 Collections 19
4. Collection Abundance and Biomass by Month: 1971-1973 ... 22
5. Ebb-Flood Comparison of Catches: 1973 26
6. Day/Night Collection Comparisons: 1973... 29
7. Index of Affinity 33
8. Community Structure by Diversity Index... 37
9. Age and Growth.. 47
(a) Introduction 47
(i) Length Frequency Analysis. 49
(ii) Scale Analysis.. 50
(b) Striped Bass 52
(i) Length Frequency 52
(ii) Body-Scale Relationship... 52
(iii) Time of Annulus Formation. 53
(iv) Age and Growth.. 54
(b) White Perch 55
(i) Length Frequency 55
(ii) Body-Scale Relationship... 57
(iii) Time of Annulus Formation. 58
(iv) Age and Growth.. 59
10. Reproduction 64
(a) Spawning Periodicity. 64
(i) White Perch 66
(b) Fecundity.. 67
(i) White Perch 68
(ii) Blueback Herring 69
(iii) Alewives... 70
(iv) Tomcod 71

VOLUME III

TABLE OF CONTENTS
(Continued)
CHAPTER VI
(Continued)

11. Stomach Content Analysis.. ... ...VI-72
(a) White Perch 74
(i) Spring 74
(ii) Fall.. 74
(b) Brown Bullhead.. 75
(i) Spring 75
(ii) Fall.. 76
(c) Pumpkinseed 76
(i) Spring 76
(ii) Fall.. 77
(d) Striped Bass 78
(i) Spring 78
(ii) Fall.. 78

D. Fish Impingement Studies.. 79
1. Introduction and Study Objectives... 79
2. Materials and Methods 80
(a) Plant Collections 80
(i) Roseton 80
(ii) Danskammer Point 80
(b) Laboratory Analysis.. 81
(c) Data Analysis... 81
3. Results and Discussion 82
(a) Species Composition.. 82
(b) Impingement Rates 83
(i) Monthly Impingement Rate Estimates.. 83
(c) Comparison of 1973 Impingement Rates for Danskammer Point Units 1 & 2 and Units 3 & 4.. ... 84
(d) Comparison of Danskammer Point Impingement Rates for Night and Day... 85
(e) Comparison of Impingement Rates during Ebb and Flood Tide... 89
(f) River and Plant Comparisons 89
(i) Relative Abundance... 89
a. White Perch. 91
b. River Herring 92
(ii) Relative Condition Factors 94
(iii)Species Diversity Comparison... 96
(iv) Length-Frequency Distribution.. 98

E. Conclusions 99

References Cited 108

VOLUME III

LIST OF FIGURES

Figure No.	CHAPTER VI	Preceding Page No.
VI-1	Fish Sampling Stations 1973	VI-13
VI-2	Localized Sampling Area	VI-14
VI-3	Catch per 10 Minute Trawl Effort Surface and Bottom Trawls, 1971-1973	VI-23
VI-4	Monthly Average Catch Per Effort, Beach Seines 1972-1973	VI-24
VI-5	Biomass Per Effort, Seines and Trawls 1973	VI-25
VI-6	Monthly Catch Per Effort, Seines, 1973 Danskammer Cove North	VI-27
VI-7	Monthly Catch Per Effort, Seines, 1973 Danskammer Cove South	VI-27
VI-8	Monthly Catch Per Effort, Seines, 1973 Danskammer Discharge	VI-27
VI-9	Day-Night, Surface Trawl-Bottom Trawl Transect Comparison	VI-29
VI-10	Day-Night, Surface Trawl-Bottom Trawl Transect Comparison	VI-29
VI-11	Day-Night, Surface Trawl-Bottom Trawl Transect Comparison	VI-29
VI-12	Day-Night, Surface Trawl-Bottom Trawl Transect Comparison	VI-29
VI-13	Affinity Index Values, 1973 Affinity Index for Numbers of Fish Species	VI-34
VI-14	Affinity Index Values, 1973 Affinity Index for Biomass of Fish	VI-35
VI-15	Affinity Index Values, Seines, 1973 Affinity Index for Numbers Collected	VI-35

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER VI (Continued)	Preceding Page No.
VI-16	Affinity Index Values, Trawls, 1973: Affinity Index for Numbers Collected Affinity Index for Biomass	VI-35
VI-17	Monthly Species Number, Mean Diversity, and Average Abundance, Seines, 1973	VI-37
VI-18	Monthly Species Number, Mean Diversity, and Average Abundance, Surface and Bottom Trawls, 1973	VI-37
VI-19	Mean Monthly Biomass Diversity for Seines and Trawls, 1973	VI-39
VI-20	Surface Trawl, DC-10, Ebb and Flood	VI-41
VI-21	Surface Trawl vs Bottom Trawl, DC-20	VI-41
VI-22	Surface Trawl vs Bottom Trawl, DC-30	VI-41
VI-23	Surface Trawl vs Bottom Trawl, DD-20	VI-41
VI-24	Surface Trawl vs Bottom Trawl, DD-30	VI-41
VI-25	Length Distribution: Striped Bass	VI-52
VI-26	Scale Radius-Total Length Relationship for 44 Male and Female Striped Bass Collected at Roseton During 1973	VI-53
VI-27	Length Distribution: White Perch	VI-55
VI-28	Scale Radius- Total Length Relationship for 126 Young White Perch Collected at Roseton and Bowline	VI-57
VI-29	Weighted Mean Total Length and Increment in Length Attained by 226 Male and 279 Female Hudson River White Perch at the End of Each Year of Life	VI-59
VI-30	Calculated Growth of Year Classes of 505 Male and Female White Perch Collected from the Hudson River at Roseton during 1971, 1972 and 1973	VI-60

LIST OF FIGURES
(Continued)

Figure No.	CHAPTER VI (Continued)	Preceding Page No.
VI-31	White Perch Reproductive Cycle at Roseton and Danskammer During 1971-1973 Spawning Seasons	VI-66
VI-32	Relationship Between Log Number of Eggs Body Weight and Log Number of Eggs Body Length in a Sample of 37 Hudson River Tomcod	VI-72
VI-33	Roseton/Danskammer Point River Ecological Studies, White Perch, Danskammer 1972	VI-91
VI-34	Roseton/Danskammer Point River Ecological Studies, White Perch, Danskammer 1973	VI-91
VI-35	Roseton/Danskammer Point River Ecological Studies, White Perch, Roseton 1973	VI-91
VI-36	Roseton/Danskammer Point River Ecological Studies, Alewife, Danskammer 1973	VI-92
VI-37	Roseton/Danskammer Point River Ecological Studies, Alewife, Roseton 1973	VI-92
VI-38	Roseton/Danskammer Point River Ecological Studies, Blueback Herring, Danskammer 1973	VI-92
VI-39	Roseton/Danskammer Point River Ecological Studies, Blueback Herring, Roseton 1973	VI-92
VI-40	Roseton/Danskammer Point River Ecological Studies, Alewife, Danskammer 1972	VI-92
VI-41	Roseton/Danskammer Point River Ecological Studies, Blueback Herring, Danskammer 1972	VI-92
VI-42	1973 Species Diversity Comparison for River Catches and Plant Collections	VI-97

LIST OF TABLES

LIST OF TABLES

Table No.	CHAPTER VI	Preceding Page No.
VI-1	Family, Common and Scientific Names of Fishes Collected: 1971-1973	VI-15
VI-2	River Fish Collections and Percent Total Catch: 1971-1973	VI-15
VI-3	Fish Collection by Method, 1971	VI-18
VI-4	Fish Collection by Method, 1972	VI-18
VI-5	Fish Collection by Method, 1973	VI-18
VI-6	Monthly Average Trawl Catch Per 10 Minute Effort: 1971-1973	VI-23
VI-7	Monthly Average Beach Seine Catch Per Effort for: 1972-1973	VI-24
VI-8	Biomass Per Effort Seines and Trawls: 1973	VI-25
VI-9	Monthly Average Biomass per Fish: 1973 Seine Collections	VI-25
VI-10	Monthly Average Biomass per Fish: 1973 Trawl Collections	VI-25
VI-11	Ebb-Flood Comparisons: 1973 Trawls and Seines	VI-27
VI-12	Day-Night Comparison: 1973 Trawls and Seines	VI-29
VI-13	Rank Sum Test For Day-Night Comparison of Seines and Trawls	VI-31
VI-14	Station Comparison of Diversity Index Values By Collection Technique	VI-31
VI-15	Day-Night Station Comparisons	VI-33
VI-16	Surface and Bottom Trawl Comparison	VI-33
VI-17	Standard Deviation and Standard Error for Average Calculated Growth (MM) of Striped Bass Year Classes 1969-1972 Collected During 1973	VI-54

LIST OF TABLES
(Continued)

CHAPTER VI
(Continued)

Table No.		Preceding Page No.
VI-18	Mean Calculated Fork Lengths (MM) at Annulus Formation for Striped Bass Based on Several Studies	VI-54
VI-19	Standard Deviation and Standard Error for Average Calculated Growth (MM) of Male and Female White Perch Year Classes 1964-1972 Collected in the Vicinity of Roseton/Danskammer Point 1971-1973	VI-59
VI-20	Mean Calculated Standard Lengths (MM) At Annulus Formation for White Perch Based on Several Studies	VI-61
VI-21	Fecundity Estimates: White Perch, Blueback Herring and Alewife	VI-68
VI-22	Fecundity Estimates: Tomcod	VI-71
VI-23	Stomach Content Analysis: White Perch - Spring 1973	VI-74
VI-24	Stomach Contents Analysis: White Perch - Fall 1973	VI-74
VI-25	Stomach Content Analysis: Brown Bullhead - Spring 1973	VI-75
VI-26	Stomach Contents Analysis: Pumpkinseed - Spring 1973	VI-76
VI-27	Stomach Content Analysis: Striped Bass - Spring 1973	VI-78
VI-28	Stomach Content Analysis: Striped Bass - Fall 1973	VI-78
VI-29	Roseton Impingement Collections, 1973 - Monthly Average Species Composition	VI-82
VI-30	1973 Monthly Average Species Composition - Danskammer Point Impingement Collections	VI-82

LIST OF TABLES
(Continued)

CHAPTER VI
(Continued)

Table No.		Preceding Page No.
VI-31	Fish and Invertebrate Impingement Collection at Danskammer Point Generating Station, 1973	VI-82
VI-32	Dominant Species, Danskammer Point Impingement Collections, 1972 and 1973	VI-82
VI-33	Estimated Monthly Impingement Rates, Danskammer Point Generating Station, 1973	VI-83
VI-34	Estimated Monthly Impingement Rates, Danskammer Point Generating Station, 1972	VI-83
VI-35	Estimated Monthly Impingement Rates - 1973 Roseton Generating Station, 1973	VI-83
VI-36	Statistical Examination of 1973 Impingement Rates at Units 1 & 2 and Units 3 ¢ 4, Danskammer Point Generating Station	VI-85
VI-37	Analysis of Night and Day Impingement Rates for Selected Species, Roseton and Danskammer Point Generating Stations	VI-86
VI-38	Statistical Examination of Impingement Rates During Ebb and Flood Tides, Roseton/Danskammer Point Generating Stations	VI-89
VI-39	Statistical Examination of Day-Night Bottom Trawl and Surface Trawl Catches for Alewife and Blueback Herring	VI-93
VI-40	Weighted Mean Condition Factors - 1973 Roseton and Danskammer Point Generating Stations	VI-96
VI-41	Comparison of Mean Lengths of Bottom Trawl, Seine and Impingement Collections of White Perch at Danskammer Point on May 30-31, 1973 and at Roseton on August 21, 1973	VI-98

CHAPTER VI

VI. FISH

A. INTRODUCTION

The presence and persistence of a stable fish community is essential to the functioning of any estuarine system. Fishes are unique among aquatic organisms in that various species, or the life history stages of species, function at many levels of energy exchange: primary consumers, secondary consumers, top carnivores, and detritus feeders. Thus, the addition or loss of fishes to an aquatic system can influence the stability of the system by altering its nutrient cycling and energy flow characteristics.

Fish, particularly coastal fishery populations, depend upon estuaries for important parts of their life cycles (Clark et al., 1969). Estuarine and near-shore coastal areas function as major spawning and nursery locales for marine fishes. Young fish congregate in these areas in order to benefit from the availability of food and protection from predators (Gunter, 1938; Lobell, 1939, Warfel and Merriman, 1944; Massman et al., 1952; Reid, 1954; June and Reintjes, 1957; Arnold et al., 1960).

Recent studies, including those described in this report (Jerome et al., 1965; Fisk, 1966; Texas Instruments, 1972a, 1972b, 1973a, 1973b; Quirk, Lawler & Matusky Engineers, 1969, 1973a, 1973b; Raytheon, 1971), have

been designed to view estuarine areas as functional units encompassing all trophic levels. This approach is based on the interrelationship of trophic levels and species within an estuary. The impact of a change in an estuary, either natural or manmade, may be directly experienced by a single trophic level or species, but the effect of that change can be reflected throughout the entire system. Because fish are able to function at various trophic levels, changes in fish populations provide a good scale against which to measure environmental change (Grimes, 1971; Tsai, 1968, 1973; McErlean et al., 1973).

Environmental change produced by natural or cultural causes must be evaluated against a data base which is comprehensive enough to permit characterization of normal variation. This is especially true in the case of estuarine fish communities which normally experience greater seasonal changes during the migration of adults to spawning areas and the emigration of juveniles (McErlean et al., 1973). The data base must describe the community changes in order to be useful for future studies.

Biological measures of environmental change fall into several categories. Those applicable to fish communities include condition indices, population dynamics, community structure, and community metabolism. Condition factors of fish species are based on the relationship between length and weight of individuals within the species and measure the physiological state or health of the individuals.

Population dynamics of a fish species are determined by the relative abundance and distribution of the species, as well as age distribution, growth rate, age at maturity,and fecundity. Criteria based on community structure generally take the form of mathematically calculated diversity indices which relate the composition of the fish community and the relative abundance of species.

Community metabolism is determined by the fixation and transfer of energy within fish populations and is measured in terms of biomass and food webs or predator-prey relationships. Each of these biological criteria of environmental change, when related to fishes, must be interpreted in comparison with all other criteria as well as with descriptive baseline data on other trophic levels. Careful evaluation of fish communities makes it possible to provide unique information on changes within the Hudson River estuary.

1. Previous Studies of Hudson River Fish

Ideally, baseline information about a given environment is obtained through long-term studies of three or more years using identical sampling stations and standardized laboratory and field procedures. Unfortunately, few studies of any estuarine system have been extended beyond a single year. Exceptions include work by Massman et al. (1952) on the Rappahannock River and by McErlean et al.(1973) on the Patuxent River. In the absence of unified long-term data pertaining to the Hudson River, it is necessary to evaluate the data presented by this report in terms of previous studies.

The characterization of Hudson River fishes can be expected to vary correspondingly with the sampling locations and the sampling procedure employed or with the relative efficiency of the various types of gear used. Comparisons of dominant species, life-history parameters of selected species, and diversity of specific fish communities can be made, since each of these parameters is relatively independent of gear selectivity.

The first major work in recent times to supply information concerning fish populations of the lower Hudson watershed was carried out by the New York Conservation Department in 1937 (Moore et al., 1937). This work provided background information on Hudson River fish species and their parasites.

During the 1950's several studies were directed toward analysis of the mechanisms involved in determining shad abundance. Fecundity, or the productivity of the individual female shad measured by egg counts, was studied in an effort to determine the reproductive potential of the Hudson River shad population (Lehman, 1953). From 1954 to 1958, three papers appeared in which the possible factors associated with fluctuations in shad abundance were discussed; the general consensus was that commercial over-fishing rather than environmental degradation was the main cause of fluctuating abundance (Burdick, 1954; Talbot, 1954; Nichols, 1958).

At approximately the same time, attention was focused on the striped bass, another commercially important fish species found in the Hudson.

Migratory and racial studies indicated that the reaches of the Hudson River north of Croton Point produced a race of striped bass morphologically distinct from that found in Chesapeake Bay and other, more southern areas of striped bass population (Raney, 1952).

In addition, tagging studies demonstrated that the Hudson River is important in supplying the striped bass needed for the valuable sport fishery located in the western quarter of Long Island Sound (Raney and deSylva, 1953). During 1955, the spawning grounds of the striped bass in the Hudson River were defined to include the area from Bear Mountain upriver to Cruger Island, with the most intense spawning occurring in the vicinity of West Point. The most important juvenile nursery ground for striped bass lay in the brackish water portion between Newburgh and the George Washington Bridge (Rathjen and Miller, 1957).

Results of striped bass tagging studies along the northeast Atlantic Coast from 1959 to 1963 were published in 1968, and the Hudson River was defined as a major spawning river and source of recruitment for striped bass populations of Long Island Sound and the New York Bight (Clark, 1968).

In 1966, the first of three Hudson River symposia took place. Although this symposium emphasized the chemical and physical aspects of the Hudson, two papers were presented on fish and fish egg distribution (Grim, 1966;

Perlmutter et al., 1966); one paper on fish stomach analysis and invertebrate distribution in the Hudson was presented (Hirschfield and Rachlin, 1966).

The life histories of the migrating anadromous fish such as shad, sturgeon, and striped bass were described (Clark and Smith, 1969) and information was presented on larval fish and eggs in relation to a proposed pump storage plant at Cornwall (Carlson and McCann, 1969). Papers on fluctuations in fish populations on a diurnal and a seasonal basis include those by Heller and Hermo (1969) and Perlmutter et al. (1969).

Research on the Hudson from 1969 through the early 1970's was characterized by comprehensive studies sponsored by representatives of the power generation industry. Most of these studies took an ecosystem approach; that is, they evaluated each trophic level, plankton, benthos, and fish as an integral portion of a dynamic, multi-faceted estuarine system.

In 1969 studies were undertaken by Quirk, Lawler & Matusky Engineers and Oceanographic Analysts, Inc. (1969a) to assess the effect of the cooling water discharge from the Roseton Generating Station on the temperature distribution and ecology of the Hudson River. Similar studies of fish distribution in this area of the Hudson River were conducted in 1971 and 1972 (Quirk, Lawler & Matusky Engineers, 1973a), in relation to the operation of the Roseton and Danskammer Point plants.

Additionally, ecosystem studies of other areas of the Hudson River have been conducted since 1969 in conjunction with the operation of power plants (see Quirk, Lawler & Matusky Engineers, 1971, 1973b, 1974; Raytheon Co., 1971; Texas Instruments, Inc., 1973a, 1973b). These studies are concerned with quantitative evaluation of the impact on the aquatic environment resulting from the operation of the Bowline, Lovett and Indian Point plants and a pre-siting study in the Kingston vicinity.

2. Present Study Objectives

Fish represent the upper levels of the trophic structure and are the most visible members of the aquatic ecosystem. In this capacity they can be used to evaluate the aquatic environment and to monitor any changes that occur within the aquatic system. The use of fish as a criterion for environmental monitoring necessitates an understanding of the community structure and its normal changes with time. This chapter considers the fish community in the vicinity of Roseton/ Danskammer Point and the changes in this community over the three year study period 1971 through 1973.

The objective of the studies conducted in 1973 was to provide base-line, preoperational data against which it would be possible to assess the impact on the Hudson River of operation of the Roseton Generating Station. The fish sampling program was specifically designed to evaluate:

- The seasonal variation in species abundance of fishes, and diversity
- The annual variation in species, abundance, and diversity
- The population dynamics of selected species, including age and growth, spawning periodicity and mortality
- The condition of selected species, including length-weight relationships and condition factors
- The trophic relationships through stomach content analyses of selected species

Implicit in the study objectives is the intent of combining information from the Roseton/Danskammer Point region of the Hudson with information collected in conjunction with similar studies in the Lovett, Bowline and Kingston regions, as well as with information prepared by other organizations.

The discussion herein reflects the results of the studies conducted in 1971, 1972 and 1973. Details and results of the studies conducted in 1971 and 1972 have been reported (Quirk, Lawler & Matusky Engineers, 1973a) and, except where appropriate, are not included in this report.

B. MATERIALS AND METHODS

1. Sampling Frequency

A comprehensive sampling program, in terms of both numbers of samples collected and stations sampled, was conducted in 1973. The 1973 program was divided into two programs conducted on an alternating week schedule. One program was designed for collection of fish near the plant sites simultaneous with impinged fish collection and the second for fish distribution and community structure comparison at areas upstream and downstream of the plant sites.

The 1973 river sampling program was initiated in March and continued through December. Weather conditions limited the sampling program to once per month in March, April and December. In addition, special programs to collect fish specimens for stomach analysis and fecundity were conducted on a seasonal basis.

2. Collection Techniques and Equipment

Throughout the course of the ecological surveys in the Roseton/Danskammer Point vicinity several types of sampling apparatus were employed. Selectivity and sampling location necessitate more than one type of sampling gear to obtain an accurate assessment of the fish community (Powell, Bowden and Hagen, 1971; Pope, 1966; Lagler, 1971).

Sampling gear used fell into two broad categories: active and passive. Active methods involve fishing with a fabric mesh moved through the water, contrasted with passive methods where netting is left stationary (Lagler, 1971). Gear of the active type used in this study were the otter trawl and the beach seine.

The otter trawl had a mouth opening of 30 feet and was 5 feet deep. The body of the net was 2 inch square mesh and the cod end was of 1-1/2 inch mesh with a 1/4 inch square mesh liner. In addition, two beach (bag) seines, each with 1/4 inch square mesh, were used to sample the near shore community; the first was 50 feet long by 5 feet deep, and the second was 100 feet long by 8 feet deep.

The otter trawl was used for both bottom trawls and surface trawls, for which floats were attached to the otter boards or vanes. Tow lines 200 feet long were used for the surface trawls and 150-foot lines for all bottom trawls. For each sampling, nets were towed at a constant boat speed against the tidal current or, if at slack tide, against the next expected tidal influence. Trawls during 1973 were based on time, approximately 10 minutes, within the distance limits of an established station. In 1971-1972 time varied, but distance covered was held more or less constant.

At each beach seine deployment station, width boundaries were marked on permanent shore structures. The seine was set from the front of a shallow draft boat by the following procedure:

(a) One end of the net was held at the shoreline at one boundary mark.

(b) The net was set perpendicular to shore to the extent of the net.

(c) The free end of the net was brought to shore in an arc to the other boundary mark.

(d) With lead line on the bottom, the net was pulled to shore, thus concentrating the collection as in a bag.

The approximate distance of the seine haul along the beach was one half the length of the net. The approximate area sampled by the 50 foot seine was 300 ft^2 (25 m^2) and for the 100 foot seine 1000 ft^2 (90m^2).

Passive collection techniques rely on entanglement or entrapment in the fabric mesh (Lagler, 1971; Weber, 1973). Passive methods are more selective than active methods, and therefore do not necessarily yield a representative sample of the fish community. The greater selectivity of passive techniques was exploited to sample for specific fish populations as opposed to the more general community sampling of the active sampling methods.

Gill nets, fyke nets, and frame nets were the passive collection methods employed. Several types of gill nets were used during the study period. Standard gill nets, with 1-1/2 inch and 2-1/2 inch square mesh and 300 feet long, were set primarily to capture adult fish during spawning migrations. Mesh size used in each net determined the size of fish collected, thus rendering this method highly selective. Standard gill

nets were of the surface and bottom types, and drift sampling was the technique primarily employed in the Roseton/Danskammer Point area. The 1-1/2 inch square mesh nets were 8 feet deep and the 2-1/2 inch square mesh nets were 10 feet deep.

In order to determine the fish community more accurately and reduce the selectivity of the gill nets, experimental type gill nets were also used. These nets were made of separate panels each of a different mesh size. The variability in mesh size, though each is selective for a certain size range, has an overall effect of lessening selectivity on the sampled community.

Two different experimental gill nets were used: one 125 feet by 6 feet deep having five 25-foot panels with square mesh sizes ½, 1, 1½, 2 and 2½ inches; the second 300 feet by 12 feet having six 50-foot panels of square mesh sizes 3/8, ½, 3/4, 1, 1½ and 2 inches. The experimental gill nets were of the surface and bottom type and were fished by two different methods: one technique was to anchor the net and the other technique was to drift the nets with the current.

Two entrapment devices were used in the Roseton/Danskammer Point area, to sample the near shore community. A fyke net and a frame net, both with ¼ inch square mesh, were fished at several locations in the study area. The fyke net had a 2½-foot hoop with a 50-foot lead and wings attached and was set perpendicular to the shore with the lead between the shore and the hoop. The fyke net was developed for fishery surveys where fish movements are random such as in an estuary (Weber, 1973).

The frame net (or trap net) was used due to its similarity to the fyke net and applicability to slightly deeper water areas. The frame net was 3 feet by 5 feet with four hoops and a 40-foot by 3-foot lead. Fishing was performed by placing the net in water deep enough to cover the frame at low tide, with the lead either toward or away from the shore.

3. Station Locations

Sampling stations established for the 1973 studies were an expansion of stations established in studies conducted previously at this site (Quirk, Lawler & Matusky Engineers, 1973a). Location of the 1973 stations is shown in Figure VI-1. In addition, a localized seine and trawl collection program was conducted in the immediate vicinity of the Danskammer Point plant. These stations are shown in Figure VI-2.

Data in 1973 were recorded at all 1971 and 1972 sampling stations plus an additional trawl station near each of the two existing plants on the east side of the river; two new east and west stations north of the Newburgh-Beacon Bridge were also used to collect fish in areas south of the plants.

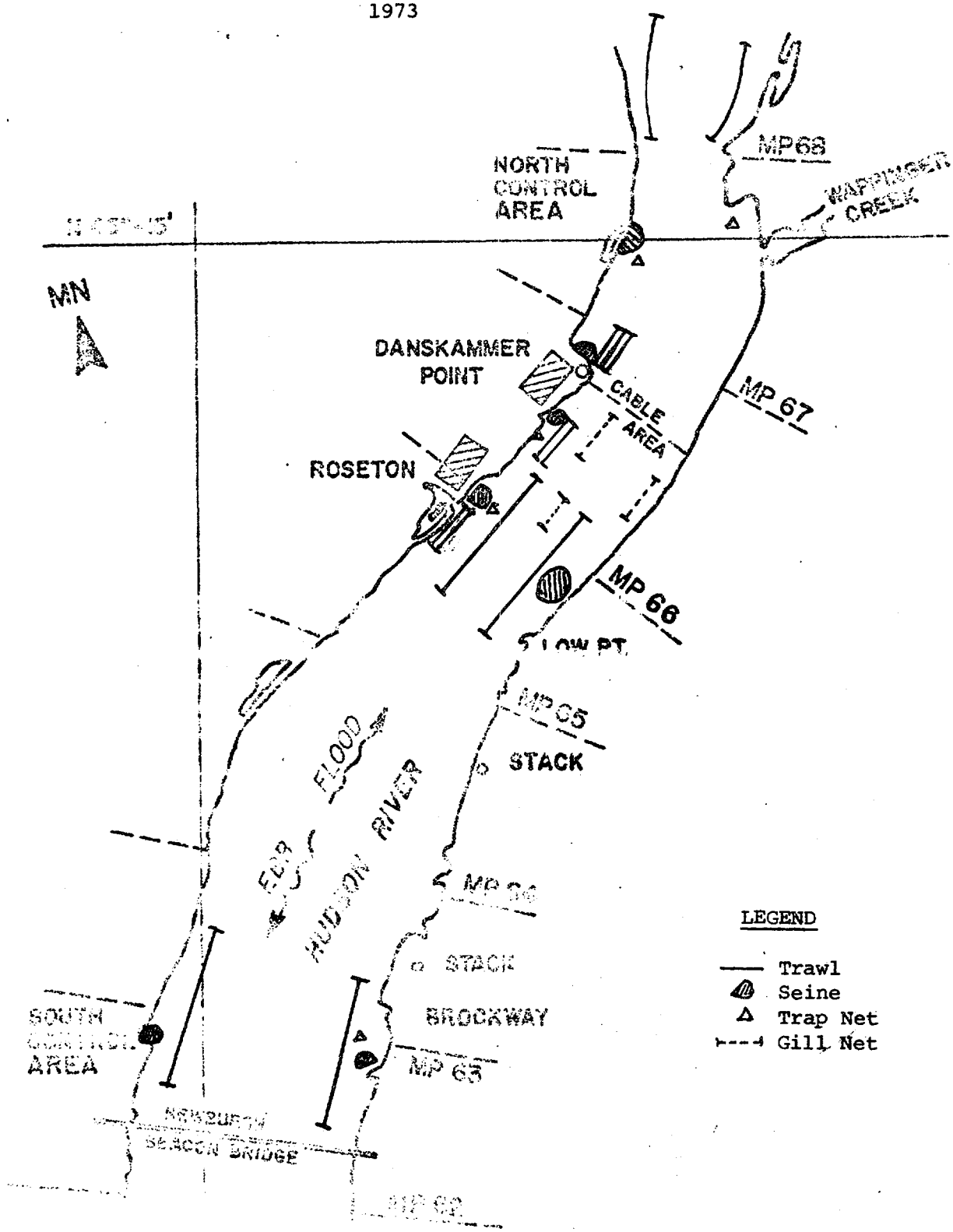
Due to the river bottom contour across from the Roseton plant, frequent problems with bottom trawls resulted in sporadic collections at this depth and station.

Along with the expanded trawl stations for open water fish collections, the seine program was also increased for the shallow water near shore community. The additional seine sites were:

FIGURE VI-1

CENTRAL HUDSON GAS AND ELECTRIC
ROSETON GENERATING STATION

FISH SAMPLING STATIONS
1973



(a) Southern area of the cove north of Danskammer Point.

(b) In the vicinity of the Roseton Discharge.

(c) On the east side of the river across from Roseton and north of the Chelsea Yacht Club.

(d) Small cove area on the west side of the river, north of the Newburgh-Beacon Bridge.

(e) Cove area on the east side of the river north of Newburgh-Beacon Bridge and south of abandoned brickyard.

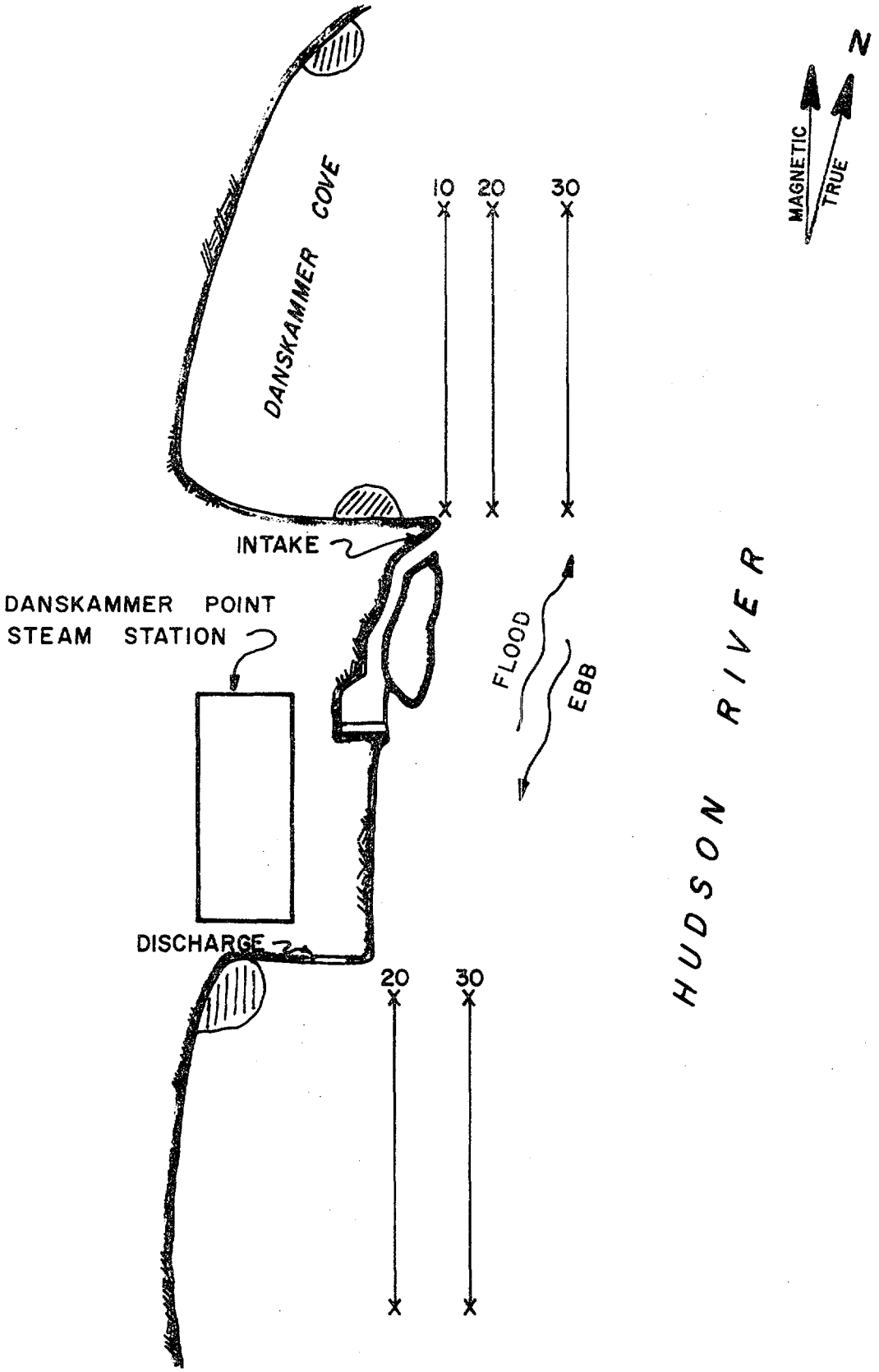
Frame net locations were designed to augment the seine data. Locations were in the cove area north of Danskammer Point, south of the Danskammer Point discharge, near the Roseton discharge, near the mouth of Wappinger Creek, and at the south seine area on the eastern shore. The gill nets were drift-fished at the two trawl stations directly in front of the Roseton plant.

The localized program consisted of five trawl stations established in the vicinity of the Danskammer Point plant (Figure VI-2), three in the cove area just north of the plant intake, and two in the discharge area. The stations were established along 10, 20 and 30 foot depth contours. Surface and bottom trawls were conducted at the 20 and 30-foot stations and a surface trawl at the 10-foot station. The trawls were of five minute duration with one set conducted on ebb tide and a second set on flood tide. A third set of trawl stations and a seine station were added in the vicinity of the Roseton discharge area toward the end of the study period.

FIGURE VI-2

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

LOCALIZED SAMPLING AREA



Seine stations at Danskammer Point were sampled at slack water after each tidal cycle; three seine stations in all were sampled for ebb-flood comparison.

C. RESULTS AND DISCUSSION

1. River Fish Collections: 1971-1973

The primary emphasis of the river fish ecological survey was to obtain baseline data on the species present and to assess their distribution by time and location. The species list of fish collected in the Roseton/Danskammer Point vicinity during the 1971-1973 study period is presented in Table VI-1. Annual collections and percent composition for each species for seine and trawl collections are presented in Table VI-2 in rank order based on 1973 collections.

Seines and trawls were used in all three years, so that these data are comparable between years. The table also lists each species in the Roseton/Danskammer Point vicinity which utilizes the estuary.

Sampling efforts increased from 1971 to 1973; therefore, comparison of the total numbers of fish collected is not valid. However, sampling did encompass the same study area, seasons, and sampling techniques. The fish collected are therefore representative of the community, and consequently percent composition values can be used as a reliable method of relating a population to the total community.

TABLE VI-1

FAMILY, COMMON AND SCIENTIFIC NAMES OF FISHES COLLECTED : 1971-1973
ROSETON/DANSKAMMER POINT VICINITY

FAMILY	COMMON NAME	SCIENTIFIC NAME *
Acipenseridae	Atlantic sturgeon	Acipenser oxyrhynchus
	Shortnose sturgeon	Acipenser brevirostrum
Anguillidae	American eel	Anguilla rostrata
Belonidae	Atlantic needlefish	Strongylura marina
Carangidae	Crevalle jack	Caranx hippos
Catostomidae	White sucker	Catostomus commersoni
Centrarchidae	Black crappie	Pomoxis nigromaculatus
	Bluegill sunfish	Lepomis macrochirus
	Largemouth bass	Micropterus salmoides
	Pumpkinseed sunfish	Lepomis gibbosus
	Redbreasted sunfish	Lepomis auritus
	Smallmouth bass	Micropterus dolomieui
	White crappie	Pomoxis annularis
Clupeidae	Alewife	Alosa pseudoharengus
	American shad	Alosa sapidissima
	Atlantic menhaden	Brevoortia tyrannus
	Blueback herring	Alosa aestivalis
	Gizzard shad	Dorosoma cepedianum
Cyprinidae	Carp	Cyprinus carpio
	Emerald shiner	Notropis atherinoides
	Golden shiner	Notemigonus crysoleucas
	Goldfish	Carassius auratus
	Silvery minnow	Hybognathus nuchalis
	Spottail shiner	Notropis hudsonius
Cyprinodontidae	Banded killifish	Fundulus diaphanus
Engravlidae	Bay anchovy	Anchoa mitchilli
Gadidne	Atlantic tomcod	Microgadus tomcod
Gasterosteidae	Fourspine stickleback	Apeltes quadracus

TABLE VI-1 (con't)

FAMILY	COMMON NAME	SCIENTIFIC NAME
Ictaluridae	Brown bullhead	*Ictalurus nebulosus*
	White catfish	*Ictalurus catus*
	Yellow bullhead	*Ictalurus natalis*
Mugilidae	White mullet	*Mugil curema*
Osmeridae	American smelt	*Osmerus mordax*
Percichthyidae	Striped bass	*Morone saxatilis*
	White perch	*Morone americana*
Percidae	Tesselated darter	*Etheostoma olmstedi*
	Yellow perch	*Perca flavescens*
Pomatomidae	Bluefish	*Pomatomus saltatrix*
Soleidae	Hogchoker	*Trinectes maculatus*

* Scientific names from American Fisheries Society, Special Publication No. 6

TABLE VI-2

RIVER FISH COLLECTIONS AND PERCENT TOTAL CATCH: 1971-1973
ROSETON/DANSKAMMER POINT VICINITY

Species - Rank Order 1973		Number of Specimens Collected and Percent of Total Catch (Yearly)						Utilization of Estuary at Roseton		
		1973		1972		1971				
Common Name	Scientific Name	Number	Percent	Number	Percent	Number	Percent	Resident	Spawning	Nursery
Blueback herring	Alosa aestivalis	6669	31.21	918	9.31	550	42.67		X	X
White perch	Morone americana	6102	28.56	2831	28.72	373	28.94	X	X	X
Spottail shiner	Notropis hudsonius	2035	9.52	609	6.18	33	2.56	X	X	X
Striped bass	Morone saxatilis	1058	4.95	176	1.79	59	4.58	X	X	X
Alewife	Alosa pseudoharengus	967	4.53	181	1.84	157	12.18		X	X
Alosa sp.	Alosa sp.	966	4.52	-	-	-	-		X	X
Atlantic tomcod	Microgadus tomcod	699	3.27	3357	34.05	39	3.03	X	X	X
Brown bullhead	Ictalurus nebulosus	487	2.28	38	0.39	7	0.54	X	X	X
American shad	Alosa sapidissima	425	1.99	101	1.02	8	0.62		X	X
Golden shiner	Notemigonus crysoleucas	321	1.50	46	0.47	-	-	X	X	X
Hogchoker	Trinectes masculatus	196	0.92	136	1.38	16	1.24	X	X	X
Goldfish	Carassius auratus	191	0.89	57	0.59	2	0.15	X	X	X
Pumpkinseed	Lepomis gibbosus	179	0.84	143	1.45	-	-	X	X	X
Bay anchovy	Anchoa mitchilli	165	0.77	974	9.88	4	0.31		X	
Bluegill sunfish	Lepomis macrochirus	162	0.76	10	0.10	1	0.08	X	X	X
Tessellated darter	Etheostoma olmstedi	140	0.66	63	0.64	3	0.23	X	X	X
Banded killifish	Fundulus diaphanus	126	0.59	14	0.14	-	-	X	X	X
White catfish	Ictalurus catus	97	0.45	99	1.00	2	0.15	X	X	X
American eel	Anguilla rostrata	68	0.32	24	0.24	4	0.31	X		X
Gizzard shad	Dorosoma cepedianum	47	0.22	20	0.20	-	-	X	X	X
Atlantic sturgeon	Acipenser oxyrhenchus	40	0.19	10	0.10	5	0.39	X	X	X
Notropis sp.	Notropis sp.	39	0.18	17	0.17	-	-			
Morone sp.	Morone sp.	38	0.18	-	-	-	-			
Carp	Cyprinus carpio	36	0.17	8	0.08	-	-	X	X	X
Largemouth bass	Micropterus salmoides	22	0.10	2	0.02	-	-	X	X	X
Rainbow smelt	Osmerus mordax	18	0.08	5	0.05	25	1.94			X

TABLE VI-2 (cont'd)

Common Name	Scientific Name	Number	Percent	Number	Percent	Number	Percent	Resident	Spawning	Nurse
Silvery minnow	Hybognathus nuchalis	17	0.08	-	-	-	-	X	X	X
Redbrested sunfish	Lepomis auritus	13	0.06	3	0.03	-	-	X	X	X
White sucker	Catostomus commersoni	9	0.04	2	0.02	-	-	X	X	X
Black crappie	Pomoxis nigromaculatus	9	0.04	2	0.02	1	0.08	X	X	X
Crevalle jack	Caranx hippos	6	0.03	-	-	-	-			
White mullet	Mugil curema	6	0.03	-	-	-	-			
Shortnose sturgeon	Acipenser brevirostrum	4	0.02	-	-	-	-	X	X	X
Yellow perch	Perca flavescens	2	0.01	5	0.05	-	-	X	X	X
Atlantic menhaden	Brevoortia tyrannus	2	0.01	3	0.03	-	-			
Smallmouth bass	Micropterus dolomieni	2	0.01	-	-	-	-	X	X	X
White crappie	Pomoxis annularis	1	0.004	-	-	-	-	X	X	X
Four-Spined Stickleback	Apeltes quadracus	1	0.004	2	0.02	-	-	X	X	X
Cyprinid	Cyprinidae	1	0.004	-	-	-	-			
Emerald shiner	Notropis atherinoides	-	-	-	-	-	-			
Yellow bullhead	Ictalurus natalis	-	-	-	-	-	-			
Bluefish	Pomatomus saltatrix	-	-	1	0.01	-	-			
Atlantic needlefish	Strongylura marina	-	-	1	0.01	-	-			
Unidentified		3	0.01	-	-	-	-			
	TOTAL	21369		9958		1289				

NOTE:
Numbers based on seine and trawl collections.

Approximately 60 percent of the total catch in 1973 was composed of blueback herring and white perch. During three years of sampling the percent composition of white perch ranged from 28.5 to 28.9% averaging 28.7% of the total. The most efficient collecting technique for white perch was found to be the otter trawl. The constant yearly percentage value, viewed with relation to the large number of fish collected, is a strong indication of a stable population.

Blueback herring and white perch had a combined composition of 71.7%, thus dominating the 1971 fish collection. In 1972 their combined total was 38%, with white perch making up 28.7% of the total . A trend of decreased percent composition in 1972 compared with 1971 and 1973 was also noted for two other prevalent species: alewife and striped bass. All three of these species are known to migrate up the Hudson River to spawn in the spring (Perlmutter, 1938; Carlson and McCann, 1969).

The record freshwater flow of the Hudson River in 1972, as measured at Green Island (see Chapter VII), could have had an effect on the location of spawning activity, consequently decreasing the population in the study area.

The American shad, another anadromous species, represented a small proportion of the total catch over the three years. The general decline in abundance of this species in the Hudson (Curran and Ries, 1936) limits statements about the abundance of this species.

Spottail shiner was the third most abundant species collected in 1973 composing 9.5% of the total catch. The percent composition for this species increased over the years from 2.6% (1971) to 6.2% (1972) to 9.5% (1973). Greatest numbers of the spottail shiners were caught by beach seine in the late fall and early winter periods. In the successive years of the study the number of seine collections increased from 1 to 35 to 98. This increase in seine collection activity could account for the increase in spottail shiner percentage composition.

Atlantic tomcod composed 34.05% of the 1972 collection and approximately 3% for each of the other two years. Of the 3,357 specimens collected in 1972, 2,630 were collected on December 28, 1972. The last date that weather permitted sampling in 1971 was December 8, and in 1973, December 12. Tomcod spawn during late January to early March and the later date of sampling in 1972 could have collected the spawning run not encountered in the previous two years.

Bay anchovy had a composition of 9.9% in 1972 compared to an average of 0.5% in the other two study years. Bay anchovy were also reported in large numbers as far north as Kingston (Quirk, Lawler & Matusky Engineers, 1973b) in 1972. The bay anchovy is a late spring-summer spawner (Hildebrand and Schroeder, 1971) and would not have been affected by the spring run-off as would the species which spawn in the early spring. The large numbers of bay anchovies collected in 1972 may have been representative of an extremely large year class which had not been sampled in previous years.

All other species made up a very small percentage of the total collection. The increased numbers of species and individuals reflect the increase fishing activity over the three year period.

2. Total Collection by Collection Method: 1971-1973

Accurate assessment of the biological community requires the use of several different collection methods in a well-designed sampling program. Different types of sampling gear are needed because of the selectivity of the gear and specific locations the gear is designated to sample (Lagler, 1966; Barkley, 1972; Weber, 1973). The nature of the community sampled, various sizes and locations of different life stages, mobility and recruitment necessitate a long range program to ensure collection of all, or a majority of the fish species present, in a given river segment.

Monthly summaries of the total number of each species caught by gill nets, seines and trawls is presented in Tables VI-3, VI-4, and VI-5 for 1971, 1972 and 1973, respectively. Actual values for each sample are presented in Appendix VI-B.

During 1971, the majority of the spring sampling efforts were directed toward collection of migratory and spawning species in gill nets (Table VI-3). Experimental gill nets were employed at several sites with marginal results.

The spring spawning species (American shad, alewife, and striped bass) were not collected by any of the gill nets and only 2% of all blueback

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herring collected were captured using this gear. Problems associated with the use of gill nets in an estuary, such as tidal currents, fishing time in relation to tidal cycles, and methods, whether stationary or drifting, were probably factors in the success of this method (Weber, 1973).

During 1972, assessment of the nearshore habitat was conducted by the use of both seines and fyke nets. All species collected by the fyke net were also collected by seines; however, the difference in species collected each month demonstrated the necessity for varied gear types to evaluate the fish community structure.

In 1973 frame nets were used in conjunction with seine collections in several near shore areas. Two species, emerald shiner and yellow bullhead, were collected by this method alone during 1973. The 1973 monthly collection data show that on several occasions seines and frame nets collected different populations from the same zone, indicating that efficiency of collection varies seasonally.

A total of 23,341 fish representing 44 species were collected in 1973 by all techniques. Trawls and seines accounted for 44.2% and 47.3% of the total catch, respectively. Gill net collections accounted for 2.4% and frame nets 6%.

3. Population Location Preference Based on 1973 Collections

The 1973 sampling program was designed to determine the distribution and composition of the fish in the Roseton/Danskammer Point vicinity.

Qualitative information about the locational preferences of a population can be obtained from the results of various collection techniques.

Approximately 80% of the 7,260 blueback herring collected during 1973 were taken in seines (Table VI-5); of these 96% were taken during July, August, September and October. In addition trawls collected 1,330 herring; 82% of these were collected in July, 99.8% by surface trawls. From July through October primarily young-of-the-year fish were collected indicating a large number of small fish moving in the surface waters near shore.

Many schools were noted along the shore during the fall, pointing to the possible use of this area by young herring as a nursery before making their run to the sea. Several age group I specimens (10cm total length) were collected during May (along with mature alewives on their spawning run), suggesting that some of the organisms spawned in the previous year remain in the lower Hudson through the first year of life, moving to sea in their second year.

White perch were collected during every month of the study, indicating that one phase of the life cycle was resident in the study area at all times. Of the 5,388 white perch collected, 72.5% were collected by trawls. Bottom trawls were the most efficient of the two types, yielding 83% of the white perch.

During the spring, the majority of the white perch collected were from age groups I through IV; however only a small number were sexually

mature. The first juvenile white perch were collected in July with peak abundance noted in September and October. Approximately 27% were collected in near shore areas. Young white perch are known to move into shallow water areas to feed on fry of other species (Bigelow and Schroeder, 1953). The large numbers of larval herring available in 1973 may have provided an ample food source for juvenile white perch.

The third most abundant species, the spottail shiner, was collected mainly in the near shore area by seines or by bottom trawls at the more shallow stations. The species is reported to be found almost exclusively in quiet, shallow areas, where they feed on insects and are themselves used as a food source by other fish (Hildebrand and Schroeder, 1971).

Striped bass collected in 1973 were primarily young-of-the-year taken during the fall and winter months in the near shore area by seines. The absence of fish in the spring and the sharp decline in bass abundance during the winter indicate that the fish move from the study area to more southerly nursery grounds during the colder months.

Alewives were collected by gill nets and seines in the spring. Very few were caught in trawl collections. During the summer and fall, the young-of-the-year alewives were collected as they migrated through the study area.

The Atlantic tomcod spawns during the winter months. During the study period, one or more of its life stages was present in the study area, although weather conditions precluded river sampling during much of the time when adult forms were in the river. A total of 788 of the 966 tomcod (79%) were collected by bottom trawls. This species is a benthic feeder which explains the bottom trawl abundance (Bigelow and Schroeder, 1953).

Species such as the hogchoker, brown bullhead, Atlantic sturgeon, shortnose sturgeon and carp were collected primarily by bottom trawls. Several species, such as the fourspine stickleback, emerald shiner, white and black crappie, silvery minnow, pumpkinseed, and redbreasted sunfish,are the primary littoral fauna as evidenced by their collection almost exclusively by seines and frame nets.

Fishes commonly associated with more saline waters, such as crevalle jack, mullet, needlefish,and bluefish,were collected only occasionally. The occurrence of these species in the upper estuary was generally during late summer and fall in the Roseton/Danskammer Point vicinity.

4. Collection Abundance and Biomass by Month: 1971-1973

The fish community changes structure on a temporal basis. Such changes are associated with population migrations, recruitment and presence or absence of different life stages of the community members.

Seasonal and daily movements of fishes from shallow water to deep water have been noted for several species (Wells, 1968; Hildebrand and Schroeder, 1971; Mansueti and Hardy, 1967).

Table VI-6 and Figure VI-3 present, for surface and bottom trawls, monthly average fish collected per 10 minutes trawl time for 1971, 1972 and 1973.

In each year a midsummer peak is indicated in numbers of fish per 10 minutes for surface trawls. The peaks occurred during August during 1971 and 1972 and during July in 1973. The 1971 and 1973 peaks were the result of large catches of young-of-the-year blueback herring, whereas the peak for 1972 represented an 87% bay anchovy composition in the August collections.

Bottom trawls collected the greatest number of species and individuals in the Roseton/Danskammer Point area. This is attributable to the preference of local fish species for a demersal existence and/or greater efficiency of this gear compared to surface trawls.

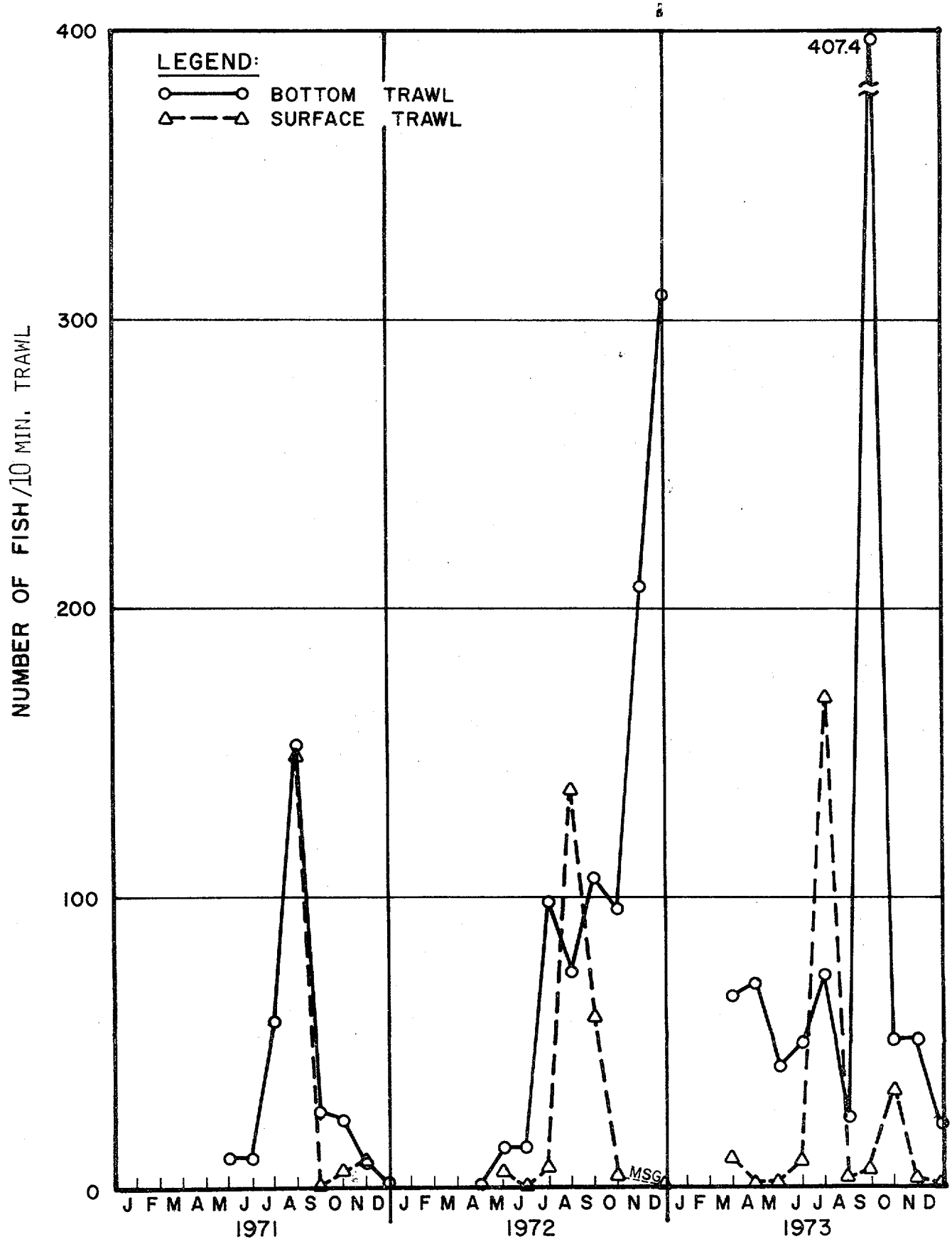
The bottom trawl trend observed from 1971 and 1973 produced small spring-early summer catches which increased in the fall and then decreased in late fall-early winter. In 1972 no winter decline was observed. In November 1972 sampling was conducted in the more southern areas of Newburgh Bay and not at the established stations. At these stations, spottail shiner (27%) and white perch (40%) were found in greater concentrations than in the Roseton/Danskammer Point area.

TABLE VI-6

MONTHLY AVERAGE TRAWL CATCH PER 10 MINUTE EFFORT: 1971-1973
ROSETON/DANSKAMMER POINT VICINITY

Month	Number of Efforts		Number of Fish		Fish per 10 minutes effort	
	Surface Trawl	Bottom Trawl	Surface Trawl	Bottom Trawl	Surface Trawl	Bottom Trawl
1971						
May	-	4	-	58	-	9.7
June	-	6	-	107	-	9.7
July	-	1	-	86	-	57.3
August	2	3	425	248	149.6	152.7
September	2	2	2	72	0.8	26.0
October	2	2	30	52	6.0	23.4
November	4	4	89	80	8.9	8.2
December	2	2	4	34	0.8	2.0
1972						
April	-	1	-	2	-	1.5
May	3	4	32	66	5.3	14.7
June	2	4	0	100	0	14.0
July	2	2	30	295	7.5	98.4
August	4	4	1129	519	136.6	74.8
September	2	2	352	374	58.7	107.4
October	3	10	26	2799	4.6	95.8
November	-	2	-	470	-	207.9
December	2	13	0	2978	0	308.2
1973						
March	3	3	32	140	10.7	65.6
April	2	4	3	149	2.1	70.1
May	18	17	36	561	2.0	41.3
June	19	18	121	504	9.7	49.3
July	21	23	1762	1171	169.2	73.2
August	17	18	60	369	3.7	24.0
September	11	11	33	2356	5.9	407.4
October	26	29	540	788	33.6	50.9
November	29	26	72	815	3.1	51.7
December	15	15	2	203	0.2	22.9

CATCH PER 10 MINUTE TRAWL EFFORT
SURFACE AND BOTTOM TRAWLS
1971-1973



The 1972 December results would have been lower, corresponding to the 1971 and 1973 values, except for sampling results on December 28 when a large number of Atlantic tomcod were collected. The fall peak in all three years was composed of young-of-the-year white perch.

Seine efforts were initiated in June 1972 on a monthly basis. Table VI-7 presents the number of seine efforts conducted per month, number of fish collected and the catch per seine effort through December 1973. The monthly catch per seine effort is shown graphically in Figure VI-4. Spring-early summer and fall values exhibited the same general trend for the two years. August collections differed greatly with few organisms/effort collected in 1972 compared to very large numbers in 1973.

The August high for 1973 was due to a very large number (3,576) of juvenile blueback herring (82% of monthly seine catch). Blueback herring composition was similar in 1972 and 1973, 72% and 82%, respectively; total number of fish (130), however, was much less.

The movement of blueback herring fry into the more productive and protected zone in the near shore area is the cause of the peak values during late summer. As the fish mature and the littoral zone environment becomes harsher with the approach of winter (Ruttner, 1963; Wells, 1968) fish moved to deeper waters, causing the decline noted in fall and winter.

Biomass is a measure of the living organic matter existing in an area (Ruttner, 1963; Odum, 1971). All fish collected in 1973 were counted and weighed prior to specific analysis of length and sex.

TABLE VI-7

MONTHLY AVERAGE BEACH SEINE CATCH PER EFFORT FOR: 1972-1973
ROSETON/DANSKAMMER POINT VICINITY

Month	Number of Seine Efforts	Number of Fish Collected	Average Number Collected per Effort
1972			
April	-	-	-
May	-	-	-
June	3	38	12.7
July	5	57	11.4
August	6	130	21.7
September	3	269	89.7
October	5	366	73.2
November	2	28	14.0
December	11	47	4.0
1973			
March	4	154	38.5
April	2	49	24.5
May	11	690	62.7
June	15	386	25.8
July	15	499	33.3
August	15	4345	289.6
September	11	1300	118.2
October	29	3063	105.6
November	18	457	25.4
December	11	98	8.9

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY AVERAGE CATCH PER EFFORT, BEACH SEINES
1972-1973

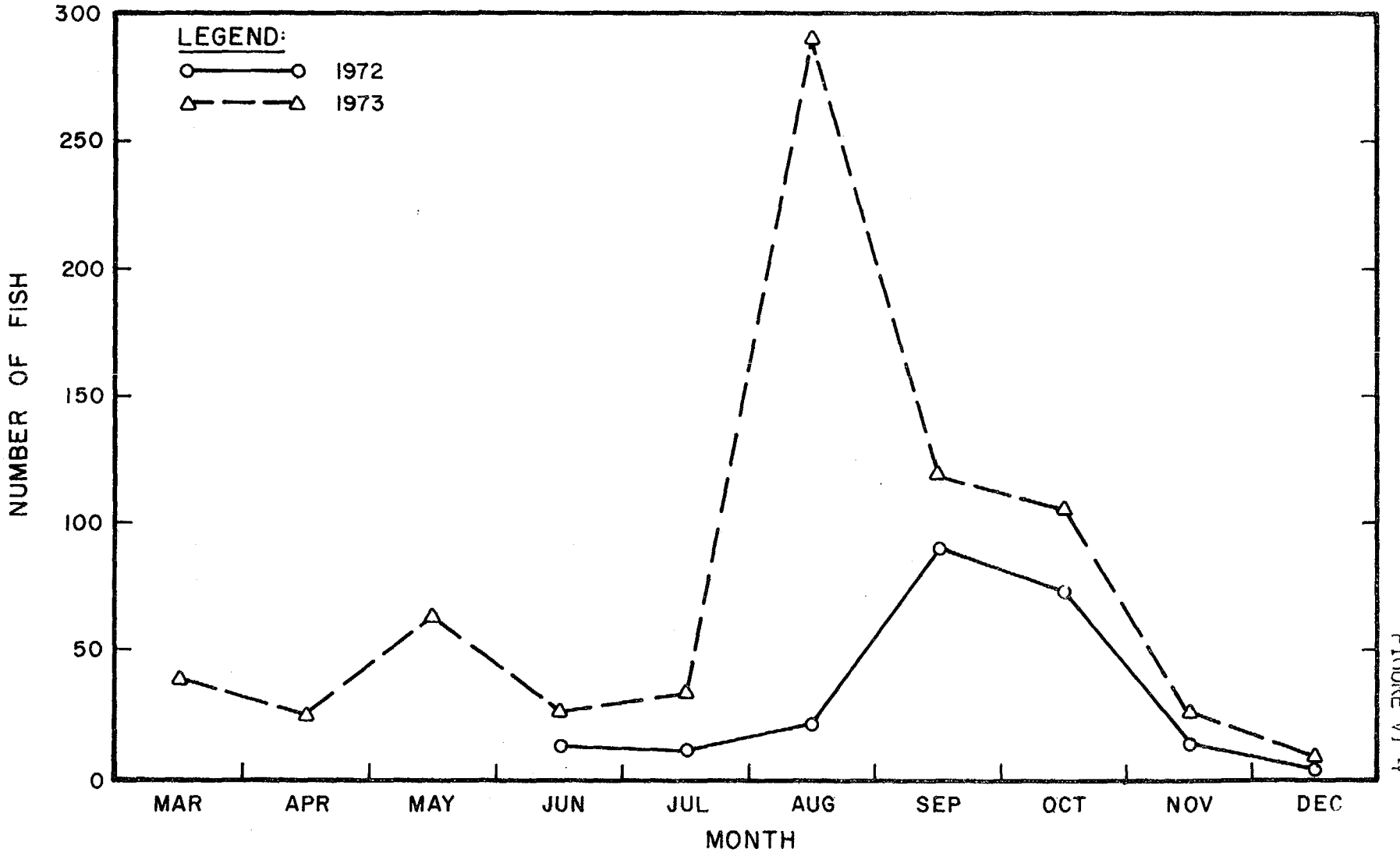


FIGURE VI-4

Analysis of the weight of collections enables one to estimate the community on a stored energy level basis (Russell-Hunter, 1970). The average weight of fish collected by seine and trawl and the total biomass per collecting effort by month in 1973 is presented in Table VI-8 and Figure VI-5.

The greatest fish biomass was noted in the spring, due primarily to the goldfish and golden shiner populations in the nearshore area. The biomass per effort value fell to approximately 0.75 kg and maintained this level through the summer and fall months.

The biomass per effort as shown in Figure VI-5 demonstrates the greater weight per fish (indicating adults) in the spring, shifting to much smaller young-of-the-year fish during the fall.

The monthly average biomass (weight) was calculated for the dominant species collected in 1973. Tables VI-9 and VI-10 present these values for seines and trawls, respectively.

For seine collections, August (the period when the greatest numbers were collected by seine) showed the lowest average biomass for most species. The average weight for goldfish, golden shiner and brown bullhead varied very slightly over the year. The temporal variation of average biomass for each collection method reflects the movement of the different life stages into and out of the study area. In addition, the movement or lack of movement from deep waters to the more shallow areas is reflected by comparison between the collection methods.

TABLE VI-8

BIOMASS PER EFFORT SEINES AND TRAWLS : 1973
ROSETON/DANSKAMMER POINT VICINITY

MONTH	NUMBER OF EFFORTS		BIOMASS PER EFFORT (kg)		TOTAL BIOMASS PER EFFORT (kg)
	SEINE	TRAWL	SEINE	TRAWL	
March	4	6	5.94	0.383	2.606
April	2	6	0.204	1.711	1.335
May	11	35	2.44	0.494	0.961
June	15	36	1.20	0.711	0.856
July	15	42	0.270	1.114	0.779
August	15	34	0.785	0.777	0.779
September	11	23	0.584	1.11	0.724
October	29	70	0.612	0.686	0.665
November	18	56	0.723	0.316	0.415
December	11	30	0.258	0.119	0.156

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BIOMASS PER EFFORT, SEINES AND TRAWLS
1973

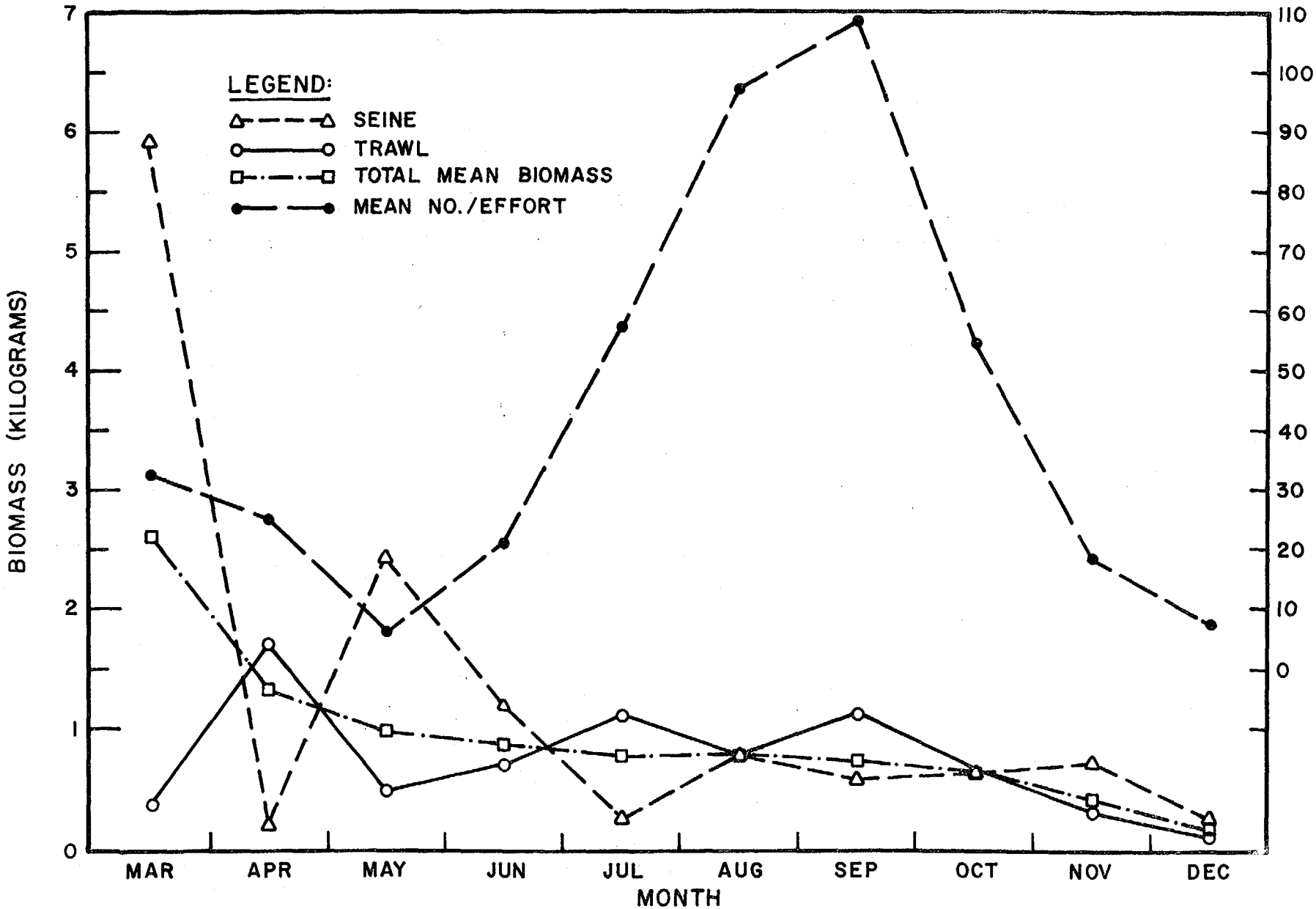


FIGURE VI-5

TABLE VI-9

MONTHLY AVERAGE BIOMASS PER FISH: 1973 SEINE COLLECTIONS
ROSETON/DANSKAMMER POINT VICINITY

	SPECIES										
MONTH	Blueback Herring	White Perch	Spottail Shiner	Striped Bass	Alewife	Atlantic Tomcod	Brown Bullhead	American Shad	Golden Shiner	Hogchoker	Goldfish
March	-	255.2	6.1	-	-	-	-	-	58.4	-	294.9
April	-	-	6.9	-	-	-	-	-	-	-	-
May	8.8	42.6	8.6	59.7	130.6	1.1	42.5	-	70.7	-	-
June	12.7	35.2	10.2	39.5	46.2	-	117.9	-	46.6	-	390.0
July	0.7	11.5	8.2	0.9	0.8	-	118.9	0.7	19.2	1.5	539.3
August	0.8	2.6	1.9	2.6	1.2	-	-	2.2	54.5	4.5	231.4
September	1.4	7.6	4.6	7.4	3.3	-	54.3	4.2	39.2	-	-
October	1.8	8.1	7.4	9.9	4.0	-	206.1	5.9	61.7	1.7	414.7
November	1.7	28.6	5.3	47.4	6.0	-	131.8	8.1	51.0	-	561.1
December	-	8.9	3.8	50.6	-	-	-	-	53.1	-	-

NOTE:
Biomass in grams

TABLE VI-10

MONTHLY AVERAGE BIOMASS PER FISH: 1973 TRAWL COLLECTIONS
ROSETON/DANSKAMMER POINT VICINITY

	SPECIES										
MONTH	Blueback Herring	White Perch	Spottail Shiner	Striped Bass	Alewife	Atlantic Tomcod	Brown Bullhead	American Shad	Golden Shiner	Hogchoker	Goldfish
March	-	49.8	8.3	-	-	16.4	-	-	50.7	-	-
April	-	72.2	9.5	-	206.8	29.5	-	-	-	-	-
May	14.5	80.9	11.1	-	54.9	3.1	72.5	-	-	12.3	-
June	-	67.4	12.9	9.9	19.9	5.5	66.7	-	-	9.0	358.3
July	0.9	40.9	7.5	46.9	3.9	6.5	99.7	-	96.4	1.9	598.1
August	1.3	56.5	4.8	30.9	4.4	4.3	103.5	2.4	-	15.8	331.5
September	1.6	6.6	2.3	6.4	5.3	5.7	115.7	7.8	59.0	6.9	358.1
October	2.3	17.7	3.3	10.9	6.9	32.5	129.1	8.3	90.7	15.9	418.5
November	1.9	15.3	5.9	11.3	5.5	52.1	109.6	8.7	60.1	14.7	-
December	-	9.5	4.4	6.8	-	62.5	153.4	-	84.6	-	-

NOTE:
Biomass in grams

5. Ebb-Flood Comparison of Catches: 1973

Tidal conditions affect the fish community in many ways. Resident species, in order to maintain the same geographical position, must constantly orientate to the shifting currents and varying tidal velocities. Spawning fish can either move with a favorable current or expend energy and move against the current. After spawning, when physical condition of the fish population is poor, the situation may be critical (Weatherly, 1972). Larval fish are at the mercy of the tidal currents for the first days after hatching.

The fish collected over the study period fall into several categories with varying life stages. The effect of tidal currents is therefore essential in understanding life cycles and distribution.

Tidal cycle effects on the fish community were discussed by Boyle (1969), who indicated that the striped bass and other fish species were more likely to be caught on an ebb tide than on a flood tide and attributed this to a greater likelihood of food for fish being washed into the main flow from streams and marshes on an ebb tide.

The results of collections at the localized sampling stations shown in Figure VI-2 were used for comparison of ebb and flood catches. Data analysis consisted of combining the monthly ebb collection data for trawls and seines and comparing these to the combined monthly flood collection data using the Student's Paired t-test for numbers of

organisms and numbers of species, after first testing for homogeneity of variance by Bartlett's test. These results are presented in Table VI-11. Ebb-flood comparisons for seine collections are shown in Figures VI-6, VI-7 and VI-8.

For the dates having sufficient data points for comparison, there was no significant difference in the number of individuals or the number of species collected by trawls on ebb or flood tide. Similarly, the seine data showed no significant difference between ebb-flood collections.

The seine data peaks shown in Figures VI-6, VI-7 and VI-8, though not significantly different from other data, are ecologically important because these peaks indicate the cyclic movements of fish species and their location preferences.

The peaks for the Danskammer discharge station on ebb tide in May and for all three stations on ebb tide in September were caused by an influx of large numbers of blueback herring. The peak in October at the north cove station was due to juvenile herring, while the peak at the discharge station was due to young-of-the-year white perch and striped bass.

Additional comparisons were made among the dominant species to determine whether there were tidal fluctuations in abundance due to variable life styles.The Wilcoxon Test was used to test both trawl and seine collection data. Species tested were blueback herring, striped bass, spottail shiner, alewife, brown bullhead, American shad, golden shiner, hogchoker, white perch, Atlantic tomcod, and Alosa spp.(juvenile blueback herring and alewife).

TABLE VI-11

EBB-FLOOD COMPARISONS: 1973 TRAWLS AND SEINES
ROSETON/DANSKAMMER POINT VINICITY

Date	Degree of Freedom	t Calculated	Probability
A. TRAWL			
1. Number of Species			
3/21	1	-1.000	p = .5
8/7	1	-0.6084	p<.5
9/4	2	-1.3979	.2<p>.4
10/3	4	-0.3469	p>.5
10/31	3	-0.1265	p>.5
11/28	5	0.7181	p>.5
2. Number of Fish			
3/21	1	-0.0910	p>.5
8/7	1	-0.1328	p>.5
9/4	2	0.3749	p>.5
10/3	4	2.0928	.1 <p>.2
10/31	3	-0.1246	p>.5
11/28	5	-0.0081	p>.5
B. SEINE			
1. Number of Species			
3/21	1	-1.1647	.4<p>.5
8/7	1	3.8176	.1<p>.2
10/3	2	2.3018	.1<p>.2
10/31	2	0.7838	p>.5

TABLE VI-11 (continued)

Date	Degree of Freedom	t Calculated	Probability
2. Number of Fish			
3/21	1	-2.1215	.2<p>.4
8/7	1	1.8171	.2<p>.4
10/3	2	-0.0317	p>.5
10/31	2	-1.1027	.2<p>.4
11/28	3	1.4478	.2<p>.4

* Denotes Significant Difference

ROSETON /DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY CATCH PER EFFORT, SEINES

1973

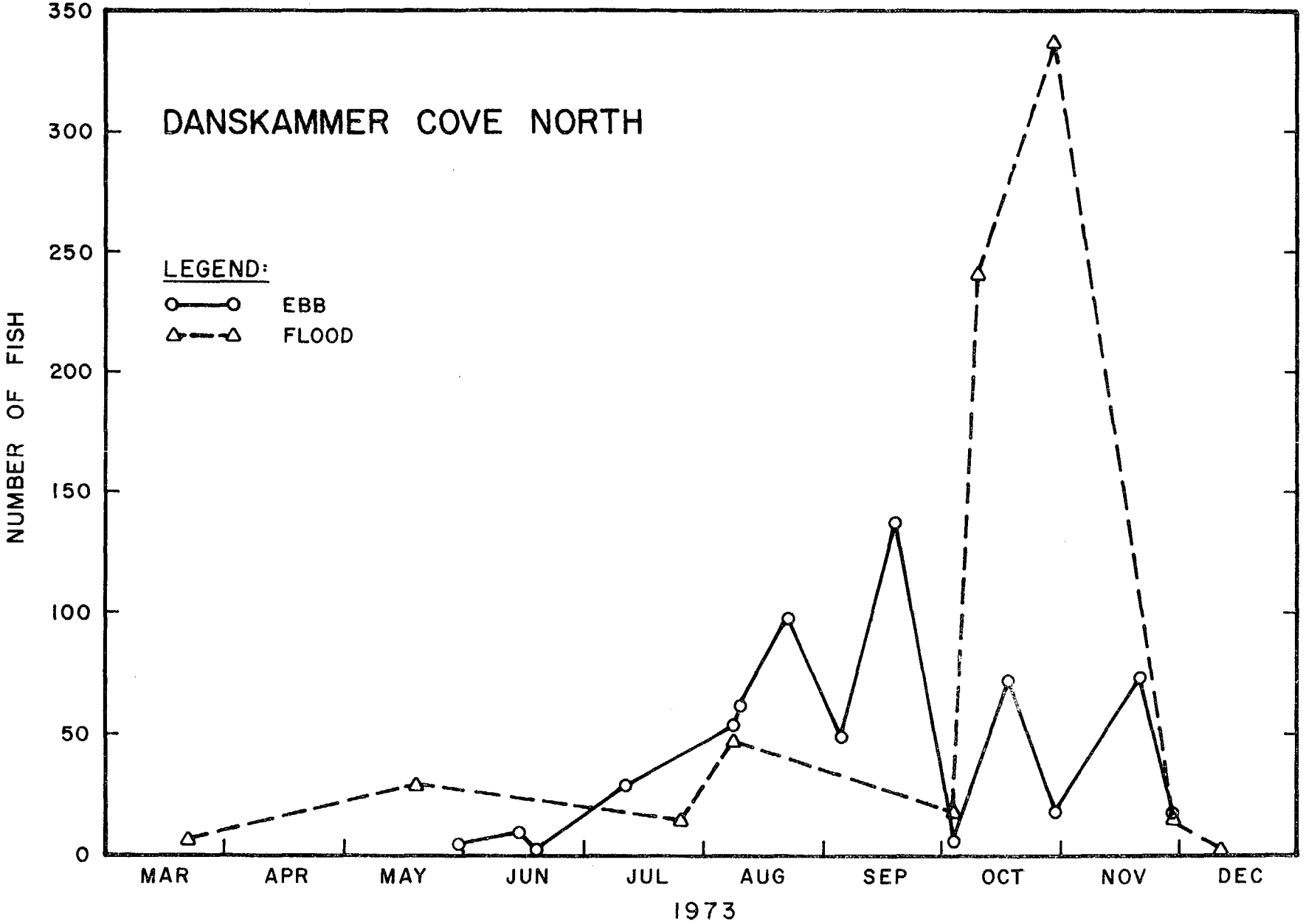


FIGURE VI-6

ROSETON/ DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY CATCH PER EFFORT, SEINES
1973

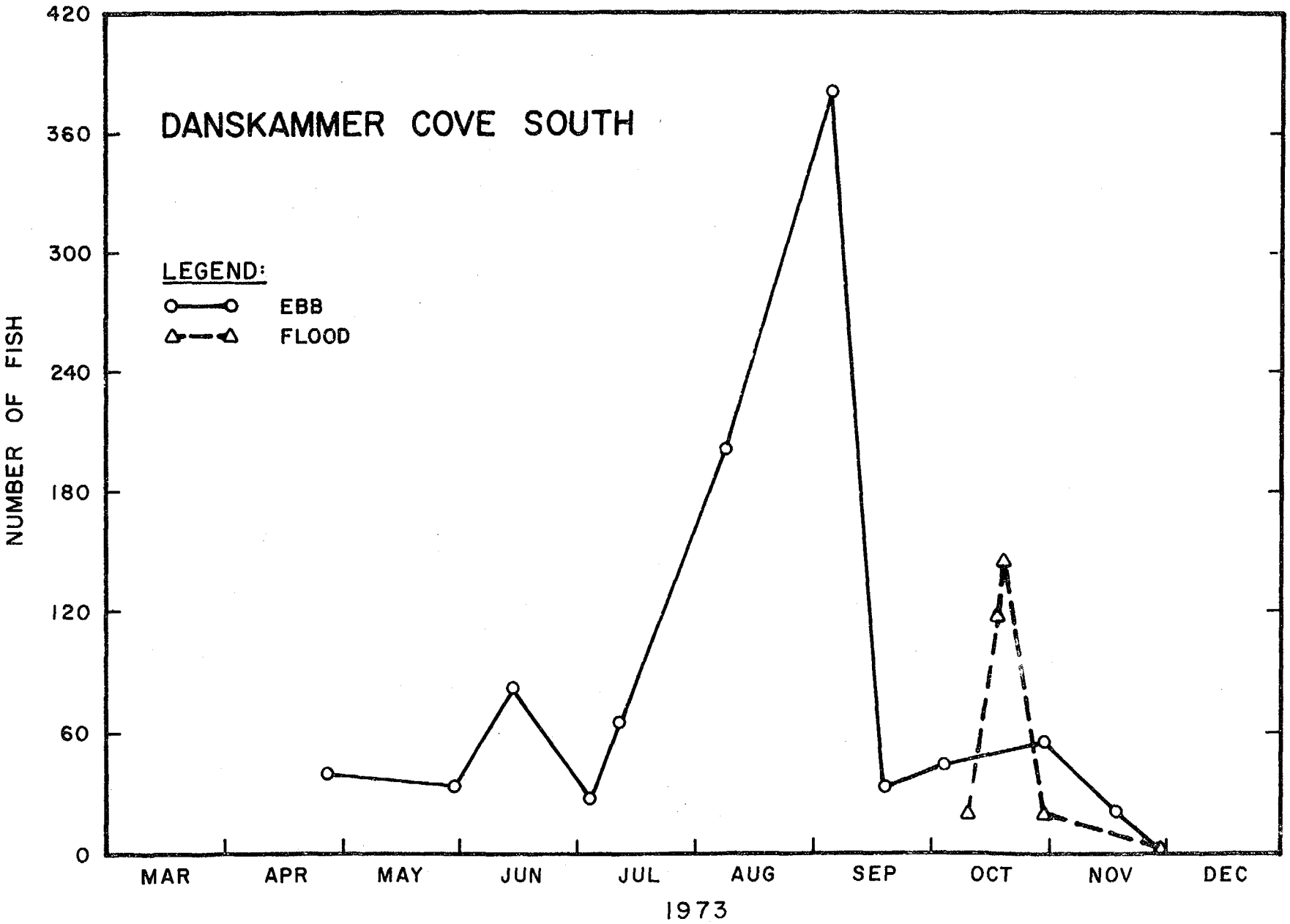


FIGURE VI-7

ROSETON / DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY CATCH PER EFFORT, SEINES
1973

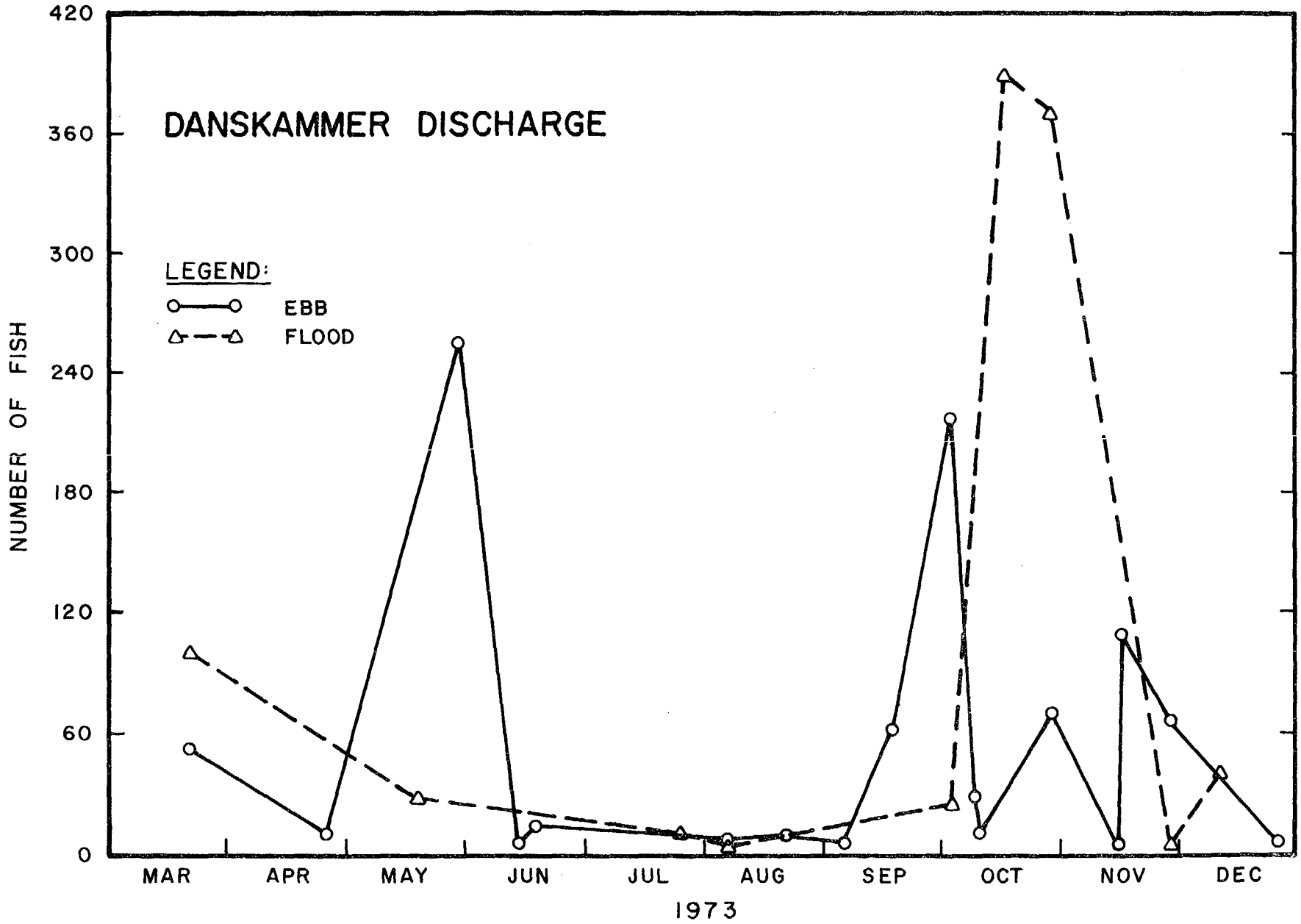


FIGURE VI-8

Except for the trawl and/or seine catches of the spottail shiner, there was no significant difference between ebb and flood catches of any species tested. Greater numbers of spottail shiner were collected by seine of slack water after ebb tide. This species is a resident of the shore areas (Hildebrand and Schroeder, 1971) and the possible concentration of this population in the shallow areas could have contributed to the larger catches of this species after ebb tide.

The numbers of species and abundance of organisms were compared for surface and bottom trawls using the t-test. The first comparison was for number and species collected at the five stations on the same tide by surface trawl versus bottom trawl. On both ebb and flood tides, bottom trawls yielded significantly higher numbers of organisms and species compared to surface trawls.

In addition, the influence of tidal cycle on catches by similar trawls was tested, e.g., bottom trawls conducted on ebb tide compared to bottom trawls conducted on flood tide. Significantly higher numbers of fish and species were collected when surface trawls were conducted on ebb tide as opposed to flood tide. There was no significant difference between ebb and flood tide collections for bottom trawls.

These tests indicate that the majority of the fish community in the Roseton/Danskammer Point area are bottom or deeper water species not affected by changing tidal conditions. The pelagic species collected in surface trawls were predominantly young-of-the-year Clupeidae.

The greater number collected on the ebb tide would indicate that these fish are using the favorable tidal current in their movements to more southern nursery areas or marine waters.

6. Day/Night Collection Comparisons: 1973

The dynamics of the fish populations are influenced by environmental conditions such as temperature, sunlight, and chemical constituents of the water. The photic cycle has been reported to have an influence on the movements and relationships within the fish community (Nikolsky, 1963; Odum, 1971). Many organisms are adapted to a sedentary existence, relying on currents to bring the necessary food materials within reach; other organisms are more active. However the organism obtains its requirements for growth and reproduction, periods of activity and inactivity usually assume a twenty-four hour cycle.

Evaluation of the day/night differences in the fish community was conducted at the eight trawl stations shown in Figures VI-1 and VI-2. All stations (trawl and seine) were sampled during daylight hours and all trawl stations and selected seine stations were sampled at night. The results of the trawl efforts are shown in Figures VI-9 through VI-12.

Day/night differences in abundance and species numbers were tested for all trawls and seines. The data were tested first for homogeneity of variance using Bartlett's method. Homogeneous data were then tested by Student's Paired t-test. If homogeneity of variance was not found the non-parametric Wilcoxon-Signed Rank test was used for the analysis. The t-statistic results are presented in Table VI-12 for seines and trawls.

DAY-NIGHT, SURFACE TRAWL-BOTTOM TRAWL TRANSECT COMPARISON

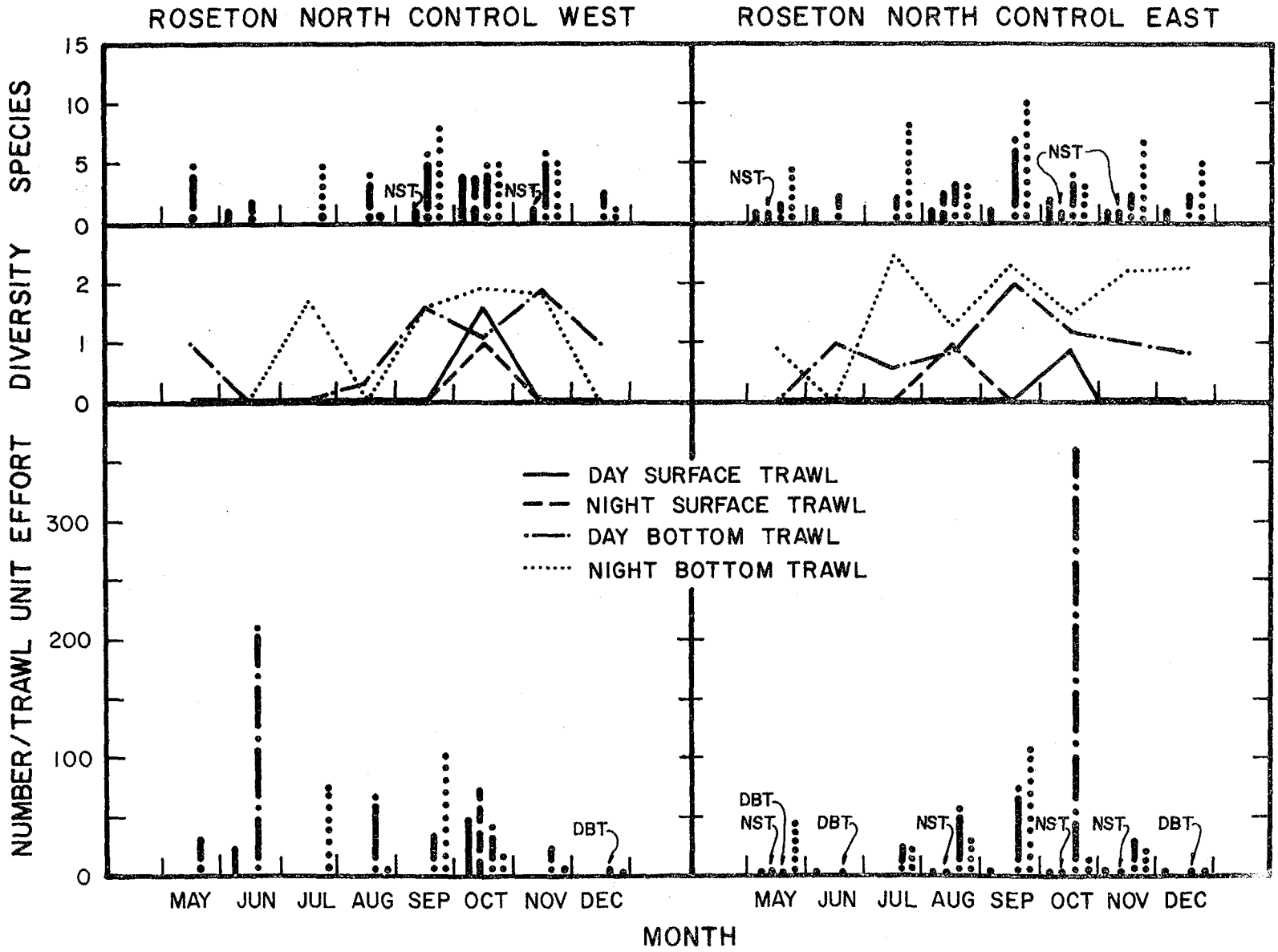


FIGURE VI-9

DAY-NIGHT, SURFACE TRAWL-BOTTOM TRAWL TRANSECT COMPARISON

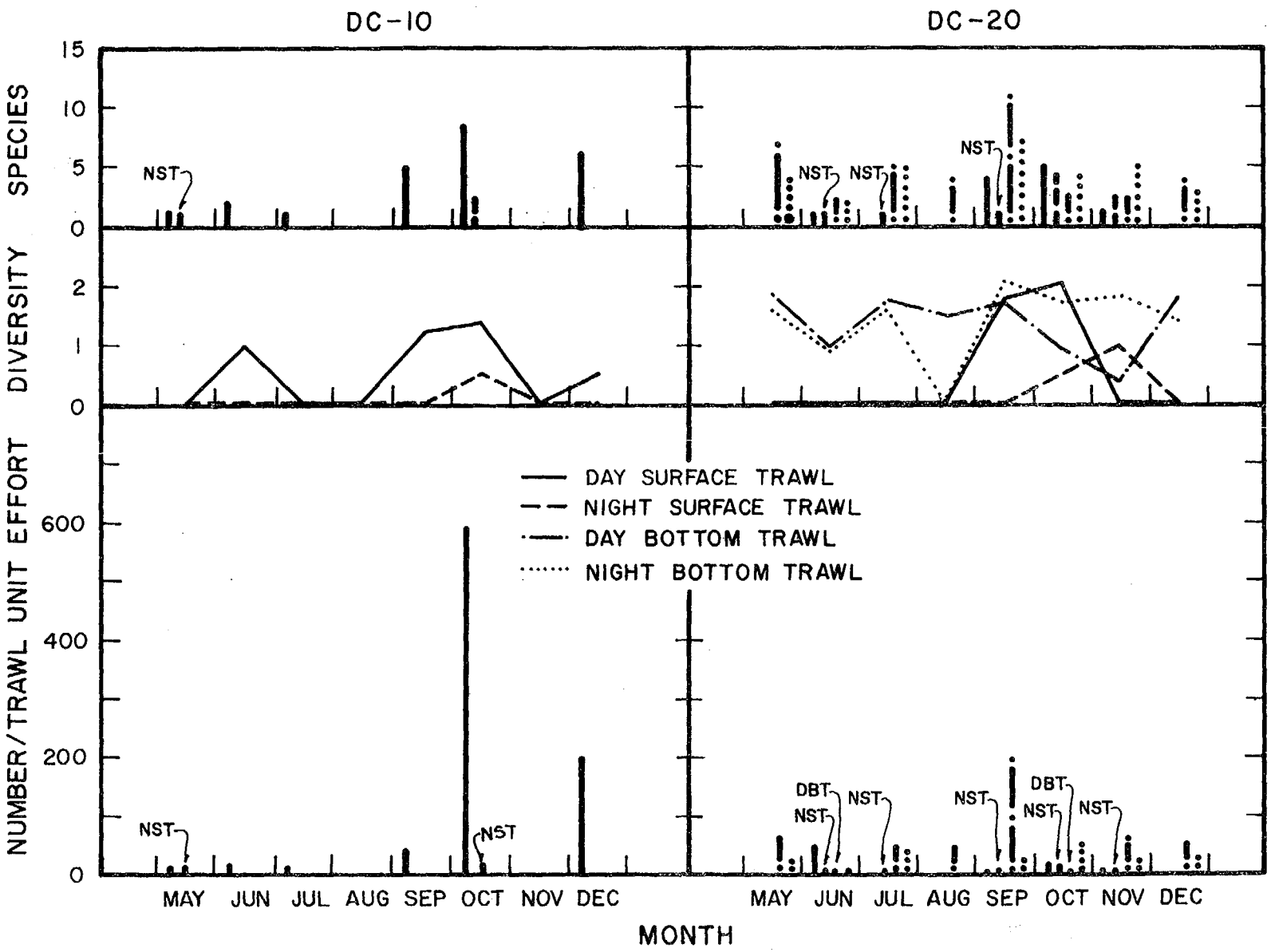


FIGURE VI-10

DAY-NIGHT, SURFACE TRAWL-BOTTOM TRAWL TRANSECT COMPARISON

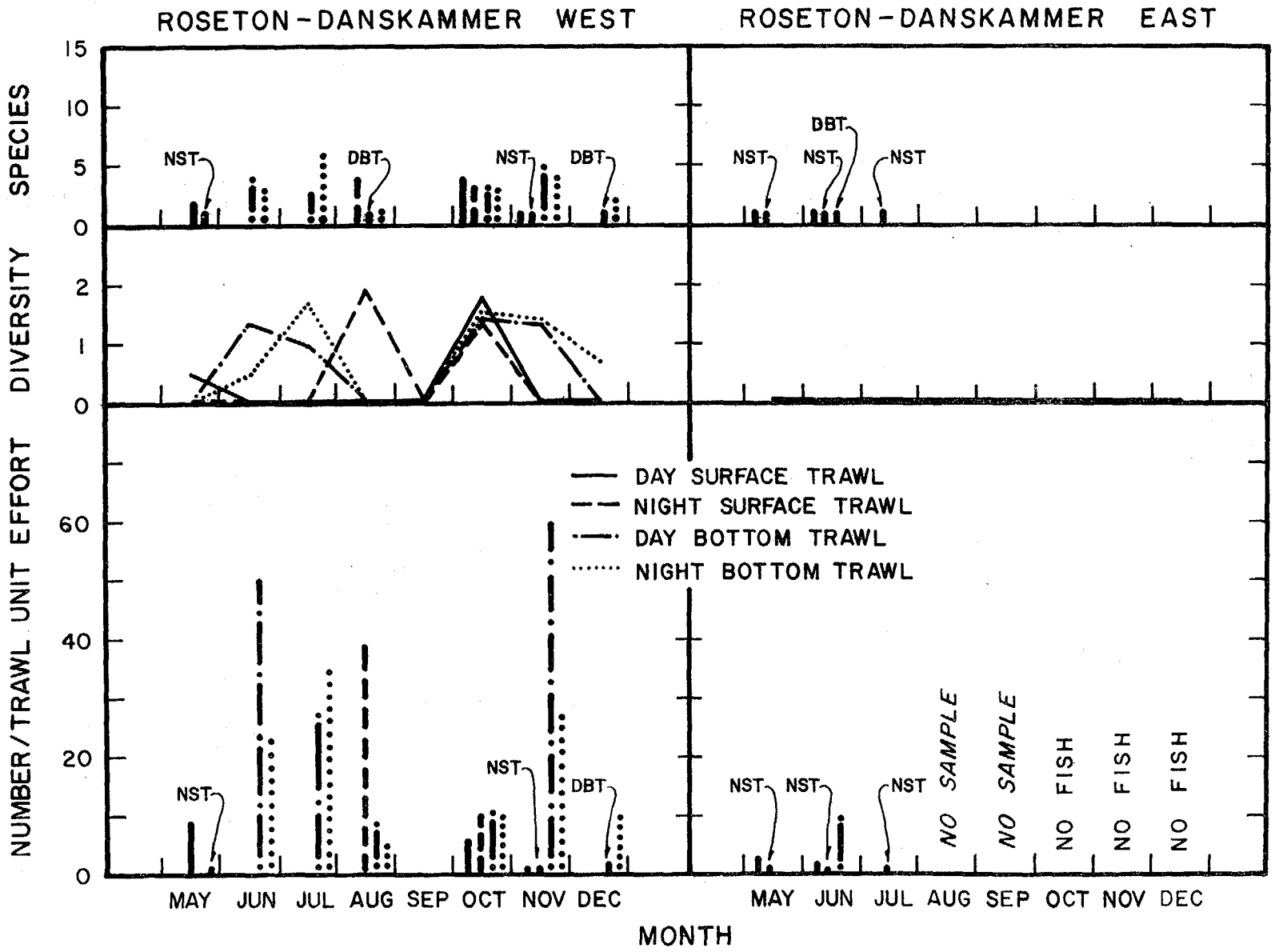


FIGURE VI-11

DAY-NIGHT, SURFACE TRAWL-BOTTOM TRAWL TRANSECT COMPARISON

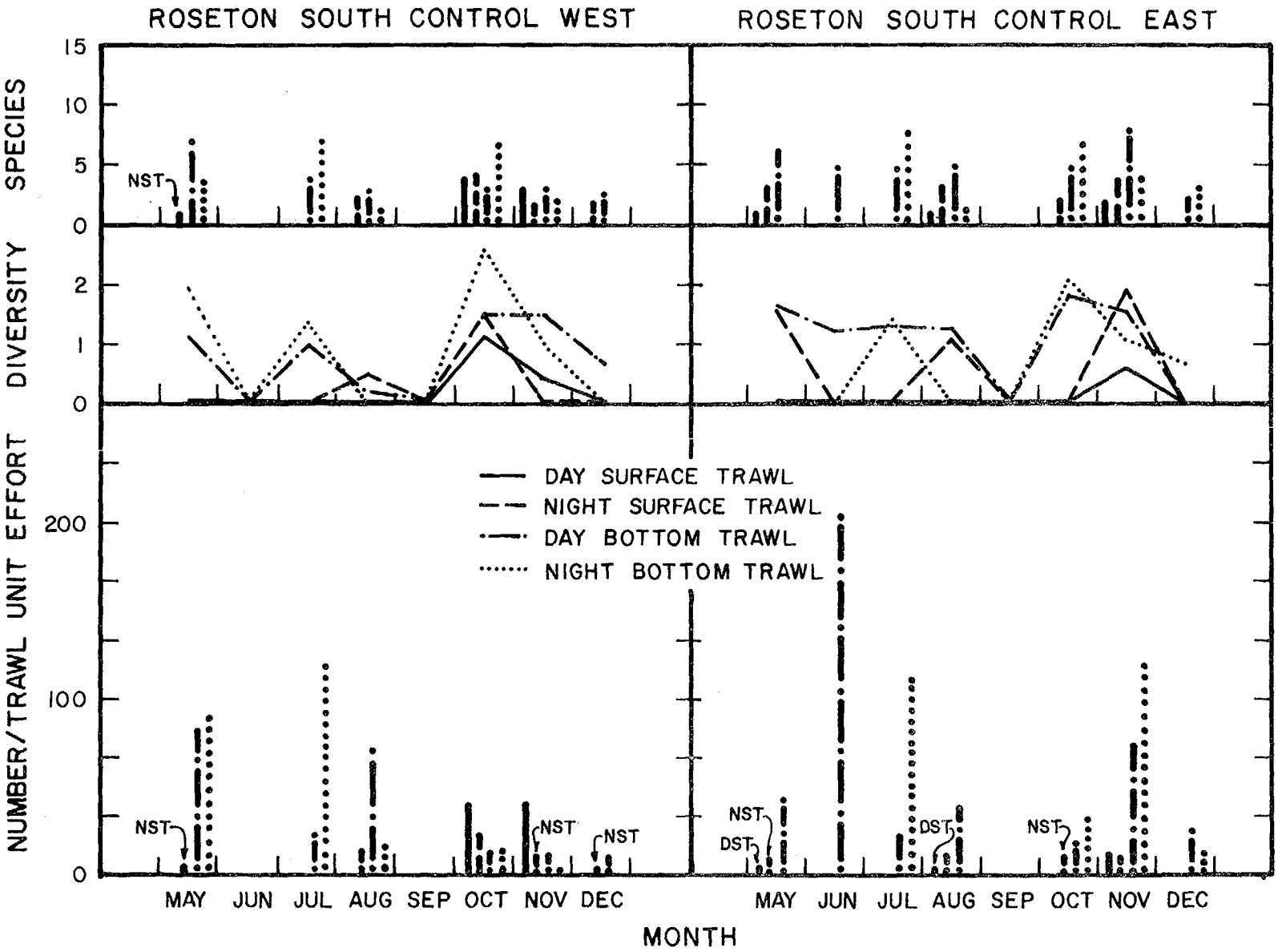


FIGURE VI-12

TABLE VI-12

DAY-NIGHT COMPARISON: 1973 TRAWLS AND SEINES
ROSETON/DANSKAMMER POINT VICINITY

Date	Degrees of Freedom	t Calculated	Probability
A. TRAWLS			
1. Number of Species			
5/30-31	7	0.809	.4>p>.5
6/26-27	4	1.875	.1<p<.2
8/11-22	5	0.722	p<.5
9/18-19	2	-0.110	p<.5
10/17-18	7	1.137	.2>p>.4
11/15-16	7	-0.522	p>.5
12/15-16	7	0.465	p<.5
2. Number of Fish			
5/30-31	7	1.065	.2<p<.4
6/26-27	4	1.739	.1<p<.2
8/21-22	5	1.826	.1<p<.2
9/18-19	2	0.283	p>.5
10/17-18	7	1.422	.1<p<.2
11/15-16	7	1.583	.1<p<.2
12/11-12	7	1.204	.2 p .4

TABLE VI-12 (continued)

Date	Degrees of Freedom	t Calculated	Probability
B. SEINES			
1. Number of Species			
8/21/-22	3	0.087	$p>.5$
10/17-18	2	0.095	$p>.5$
11/15-16	2	0.549	$p>.5$
12/11-12	3	-4.944	$.01<p<.025$
2. Number of Fish			
8/21-22	3	1.237	$.2<p<.4$
10/17-18	2	1.038	$.4<p<.5$
11/15-16	2	0.917	$.4<p<.5$
12/11-12	3	-1.489	$.2<p<.4$

No significant differences in number of fish between day and night seining collections were found. Species numbers were found to be significantly different only for the December 11-12 collection date when more were collected during the night hours (9) than during the day hours (4).

The trawl dates having homogeneity of variance and tested by the Student t-test were found not to be significantly different for day and night. Data from July 26-27 did not have homogeneity of variance and was tested using the non-parametric method. On this date both the number of organisms and species numbers were significantly higher for the day collection than for the night collection.

A diversity index (Shannon-Weaver) was calculated for each collection using information theory. The diversity index assigns a numerical value to the faunal composition of a community. If all communities are sampled equally, then the index values can be compared to show environmental effects on the species and their numerical contribution to the aggregate.

The resultant diversity index values were used to evaluate the day/night influence on the community structure for each month in an analysis of day/night differences by the Wilcoxon Rank Sum Test for Unpaired Measurements (Snedecor and Cochran, 1967). A second comparison was made at each sampling station and for each individual day/night collection using the Wilcoxon Paired Signed Rank Test (Snedecor and Cochran, 1967).

For the monthly comparison the totals for seines and trawls were first added together with the diversity index based on organisms per effort. The test showed that July had a higher mean diversity index for day collections and December had a higher index at night. All other months showed no statistical differences.

Seines and trawls sample different portions of the fish community; therefore diversity indices were compared for each method on a monthly basis. Night seines were not initiated until August, so comparisons are possible only for the last five months of 1973. The near shore community was found to be significantly more diverse during the daylight hours in November; other months did not exhibit day/night differences.

Trawls conducted during the night in December had a mean diversity value higher than trawls conducted during the day. All other monthly collections had similar mean diversity values for both day and night collections.

The Rank Sum Test was used to compare the data in two ways. The data for both trawls and seines were pooled and the day diversity value compared to the night diversity value at each station. The results of this test are presented in Table VI-13. A significantly higher diversity index was found for day efforts in June and for night efforts in December; July was significant because only one comparison was made. In other months there was no significant difference in diversity values during either of the photic periods.

The second use of the Rank Sum Test was for individual comparison of trawls and seines. These results are presented in Table VI-14.

TABLE VI-13

RANK SUM TEST FOR DAY-NIGHT
COMPARISON OF SEINES AND TRAWLS
ROSETON/DANSKAMMER POINT VICINITY

Date	Sum of the Negative And Positive Ranks Σ T-	Σ T+	Number of Comparisons	Critical Range and Alpha Value	
5/30-3	9	12	6	1<T<20	α = 0.062
6/26-27	0	3	2	0<T<3	α = 0.50
7/24-25	0	1	1	0<T<1	α = 1.00
8/21-22	31	14	9	6<T<39	α = 0.054
9/18-19	5	5	4	0<T<6	α = 0.124
10/17-18	27	28	10	8<T<47	α = 0.048
11/15-16	29	16	9	6<T<39	α = 0.054
12/11-12	34	2	8	4<T<32	α = 0.054

TABLE VI-14

STATION COMPARISON OF DIVERSITY INDEX VALUES
BY COLLECTION TECHNIQUE

ROSETON/DANSKAMMER POINT VICINITY

A. TRAWLS

Month	Sum of the Negative And Positive Ranks Σ T-	Σ T+	Number of Comparisons	Critical Range And Alpha Value	
May	9	12	6	1<T<20	α = 0.065
June	0	3	2	0<T<3	α = 0.50
August	13	2	5	0<T<15	α = 0.065
September	5	1	3	0<T<6	α = 0.25
October	13	15	7	2<T<26	α = 0.046
November	14	7	6	1<T<20	α = 0.062
December	13	2	5	0<T<15	α = 0.062

B. SEINES

August	5	5	4	0<T<10	α = 0.124
September	0	1	1	0<T<1	α = 1.00
October	4	2	3	0<T<6	α = 0.25
November	3	3	3	0<T<6	α = 0.25
December	6	0	3	0<T<6	α = 0.25

The June trawl stations had a significantly higher diversity index for the daylight hours. Only December showed a difference between day and night seine collections; a significantly higher diversity value was found for night collections.

Species most abundant in 1973 studies were compared for day/night differences by seines and trawls. Species tested were the spottail shiner, striped bass, alewife, Alosa spp. (juvenile alewife and blueback herring), brown bullhead, American shad, golden shiner, hogchoker, white perch, Atlantic tomcod and blueback herring. These eleven species composed 93.25% of all fish collected in 1973. The Wilcoxon Rank Sum Test was used for the comparison.

The spottail shiner was the only species showing a significant difference between day and night seine collections; a greater number were collected during the day than at night. The spottail shiner population is a primary food source for other fish species and is a normal resident of the shore community (Hildebrand and Schroeder, 1972; Wells, 1968).

Two species (spottail shiner and white perch) exhibited a significant difference between day and night trawl collections. For both species a greater number were collected during the daylight hours. This difference could be attributed to feeding patterns dependent on visual location of food.

Statistical analysis using the Paired t-test was used to test for differences in abundance and number of species for surface and bottom trawls collected during the two time periods. The evaluation was first

conducted on surface trawl/bottom trawl comparisons at the same station and then comparing all surface trawls and all bottom trawls for the two time periods. The results for the station day/night comparisons are presented in Tables VI-15 and VI-16.

A significantly higher number of organisms and species were collected with bottom trawls than with surface trawls during the daylight hours (Table VI-15). No significant differences between day and night in numbers of fish and species were found, indicating that surface and bottom fish populations had approximately the same composition during daylight and night hours.

7. Index of Affinity

For a given set of environmental conditions one community of organisms grows and functions, while another community may or may not exist, or may function more or less efficiently (Odum, 1971; Nikolsky, 1963). As environmental conditions change with time or location, the community structure changes. This alteration usually involves a shift in species dominance, size, or exclusion of some species and inclusion of others.

Community structure in the Roseton/Danskammer Point study area was determined by use of an affinity index. The analysis was computed by the dominance affinity method of Renkonen (see Kontkanen, 1957) for numbers of species and biomass by month. This method bases affinity on the sum of the lowest dominance values of every species common to compared samples.

TABLE VI-15

DAY-NIGHT STATION COMPARISONS

ROSETON/DANSKAMMER POINT VICINITY

A. DAY

	Degrees of Freedom	t calculated	Probability
Abundance	40	7.236	$p<0.001$
Number of Species	40	7.578	$p<0.001$

B. NIGHT

Abundance	36	5.841	$p<0.001$
Number of Species	36	5.626	$p<0.001$

TABLE VI-16

SURFACE AND BOTTOM TRAWL COMPARISON
ROSETON/DANSKAMMER POINT VICINITY

A. SURFACE TRAWLS

	Degrees of Freedom	t calculated	Probability
Abundance	45	-1.749	$0.05<p<0.1$
Number of Species	45	-0.462	$p>0.5$

B. BOTTOM TRAWLS

Abundance	38	-1.822	$0.05<p<0.1$
Number of Species	38	-0.122	$p>0.5$

Calculations involved computing the percent composition for each species in a sample and then summing the lowest common value for that species between the two samples being compared. The index values indicating the similarity of the samples were then combined for the year using a trellis diagram (MacFayden, 1963) which enabled a visual representation of the comparisons.

Percent similarities were computed on 20% intervals between the highest affinity and lowest affinity values, and shown graphically on the same trellis diagram. The comparison values that fell into the highest percent interval (80-100%) were considered to be similar, reflecting the same basic community structure. The values in the lower percent interval indicated a dissimilar community structure, and the intermediate intervals were considered transitional, indicating a community structure change. These results are shown in Figure VI-13 for species numbers.

The months exhibiting the greatest affinity were found to be:

(a) March and December

(b) April, September, November and December

(c) July and August

(d) September, October and November

(e) October and November

(f) November and December

The successive months from July through December are similar, but only the months September, October, and November compare as a block.

ROSETON/DANSKAMMER POINT ECOLOGICAL STUDIES
AFFINITY INDEX VALUES
1973

AFFINITY INDEX FOR NUMBERS OF FISH SPECIES*

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	43.6									
MAY	26.4	34.2								
JUNE	19.8	47.8	55.7							
JULY	11.2	23.4	52.6	38.0						
AUGUST	11.8	16.8	40.4	21.4	66.1					
SEPT.	15.8	62.0	55.6	51.3	56.6	48.7				
OCT.	21.1	43.9	49.8	60.5	47.5	31.7	66.8			
NOV.	36.7	63.7	52.9	60.0	35.0	26.0	57.1	65.1		
DEC.	68.1	62.4	48.9	44.6	27.0	19.0	36.6	41.9	63.0	

INDEX RANGE

11.2-22.6

22.7-34.0

34.1-45.4

45.5-56.8

56.9-68.2

*Trawls and Seines Only.

The community during this time of the year was dominated by blueback herring, white perch, and spottail shiners. The majority of the blueback herrings and white perch collected from June through December were young-of-the-year.

The percent composition of the two dominant species, blueback herring and white perch, in great part, explains the high affinity between the later months of the year. In July and August the percent composition of blueback herring was 39% and 72%, respectively; and for white perch, 21% and 11%, respectively. Comparison gave a high index value of 50.

In September the percent composition of bluebacks dropped to 25% and white perch increased to 48%, yielding an index of 36. September also had fewer species present compared to August and October, again showing a low index value.

The affinity index for the community structure based on biomass is shown in Figure VI-14. The months June through October had a very high affinity with all months having a similar weight value per species collected. At this time of the year the greatest numbers were observed and rapid development of fish takes place. Before and after these months the number of species is less and growth is usually slower.

Affinity values for seines and trawls are presented in Figures VI-15 and VI-16, respectively. Near-shore communities in July, August and September were quite similar. During this period large numbers of young-of-the-year fish, primarily Clupeids, were collected by seine. Fish of this family are normally spring-early summer spawners, and have planktivorous larvae. The shallow, more protected waters offered a safe

ROSETON/DANSKAMMER POINT ECOLOGICAL STUDIES
AFFINITY INDEX VALUES
1973

AFFINITY INDEX FOR BIOMASS OF FISH*

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	12.1									
MAY	18.7	50.9								
JUNE	28.8	53.0	52.5							
JULY	34.2	52.0	53.8	76.9						
AUGUST	22.3	47.0	56.8	70.2	70.6					
SEPT.	29.2	46.9	55.7	85.2	72.0	71.4				
OCT.	27.5	34.8	42.2	70.6	55.3	54.5	74.6			
NOV.	17.0	36.6	47.0	55.0	49.3	48.8	55.4	58.3		
DEC.	21.4	18.8	58.0	30.3	24.0	25.3	32.6	34.2	52.8	

INDEX RANGE

12.1-26.7

26.8-41.3

41.4-55.9

56.0-70.5

70.6-85.2

* TRAWLS AND SEINES ONLY

FIGURE VI-15

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES
AFFINITY INDEX VALUES
SEINES
1973

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	18.2									
MAY	31.4	20.6								
JUNE	24.3	22.6	49.8							
JULY	10.5	8.2	61.1	34.5						
AUGUST	7.0	4.5	44.4	14.4	68.0					
SEPT.	8.6	6.7	51.7	24.5	78.7	83.6				
OCT.	19.9	20.4	53.0	50.8	44.1	29.5	41.7			
NOV.	22.7	49.6	42.2	49.4	27.3	15.2	22.5	55.1		
DEC.	44.8	33.7	46.7	34.4	24.5	12.4	19.1	38.9	55.2	

AFFINITY INDEX FOR NUMBERS COLLECTED

INDEX RANGE

4.5-20.3

20.4-36.2

36.3-52.1

52.2-68.0

68.1-83.9

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	1.2									
MAY	13.4	5.1								
JUNE	32.9	4.3	41.9							
JULY	32.9	7.4	34.7	53.0						
AUGUST	23.9	3.7	47.6	38.7	44.0					
SEPT.	14.9	18.5	35.1	45.9	36.2	47.5				
OCT.	63.9	22.7	44.4	49.3	45.6	37.8	55.7			
NOV.	11.9	9.2	33.7	43.4	39.5	26.0	36.7	58.9		
DEC.	11.7	5.1	34.4	12.8	16.3	33.3	23.8	27.6	30.5	

AFFINITY INDEX FOR BIOMASS

INDEX RANGE

1.2-13.8

13.9-26.3

26.4-38.8

38.9-51.4

51.5-63.9

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

AFFINITY INDEX VALUES
TRAWLS
1973

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	31.3									
MAY	16.7	32.5								
JUNE	16.2	48.6	57.3							
JULY	13.9	29.0	32.0	37.2						
AUGUST	11.4	77.1	32.0	50.9	31.6					
SEPTEMBER	20.4	84.5	35.0	47.4	31.7	87.7				
OCTOBER	17.2	60.2	33.1	63.0	39.7	68.2	68.4			
NOVEMBER	26.5	61.2	54.0	62.2	35.8	55.7	61.3	60.6		
DECEMBER	67.1	53.0	40.4	47.1	26.6	32.4	41.5	38.6	57.2	

AFFINITY INDEX FOR NUMBERS COLLECTED

INDEX RANGE

11.4-26.6

26.7-41.9

42.0-57.2

57.3-72.5

72.6-87.8

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
MARCH										
APRIL	43.2									
MAY	42.9	67.8								
JUNE	42.3	62.1	71.3							
JULY	42.2	55.1	62.1	67.8						
AUGUST	39.0	58.5	63.7	75.8	68.2					
SEPT.	45.3	50.9	58.2	82.8	77.0	68.0				
OCTOBER	24.7	29.3	34.8	61.3	55.3	47.8	69.9			
NOV.	38.9	38.4	52.4	55.0	48.4	44.0	54.2	29.9		
DEC.	41.0	22.8	28.5	25.6	25.2	21.3	28.0	25.0	56.7	

AFFINITY INDEX FOR BIOMASS

INDEX RANGE

21.3-33.6

33.7-45.9

46.0-58.2

58.3-70.5

70.6-82.8

area where these young fish found refuge and food. All other months showed a great deal of variability in the near-shore community based on this collection technique.

Community composition by weight for seine efforts was similar during September, October, and November. The community structure showed great variability during the spring months when shore conditions were less stable than open water conditions and migratory species were prevalent in the area. Through the summer and early fall, spawning fish left the area and the monthly biomass for young-of-the-year tended to stabilize as these fish migrated from the near-shore area to more open waters or moved further down river.

The affinity index value for numbers of organisms collected by trawl (Figure VI-16) was highly variable. This is due in part to the lumping of surface and bottom trawl figures and also to the change in community composition in the more open water areas. The months of April, August and September had high affinity index values because white perch composed 71.1 to 74.2% of the collections during these months.

Earlier months had a low index value, primarily because the influx of migratory spawners altered community structure. The numbers of individuals per species became more stable in August when the young-of-the-year, mainly white perch, were in the study area. The fall community structure varied as fish emigrated from the study area, leaving only a small resident population.

Biomass affinity index showed that the community, as expressed by weight of organisms collected, was similar from April to October. It was during this time that the greatest numbers of individuals and species were collected. As the numbers of organisms in the study area declined in the fall, the community structure exhibited low biomass affinity.

8. Community Structure by Diversity Index

In recent years the diversity index has been increasingly used to evaluate fish populations (Bechtel and Copeland, 1970; Dahlberg and Odum, 1970; Swartz, 1972). Bechtel and Copeland (1970) found that the diversity index showed station-to-station and seasonal differences indicating changes in the fish community that could also be interpreted in terms of water quality. Dahlberg and Odum (1970) concluded that diversity indices could be used to summarize the structure of a fish community.

A low diversity index number indicates that the majority of individuals present are members of one or a few populations (species), while a high value represents a more even distribution of the organisms among species. Usually the more species present, the more stable the community. As more of the available niches are filled, however, the stability is altered if more members of one species are present than the niche can maintain (Roughgarden, 1971). The diversity index combines these variables as a numerical value for comparison.

The number of species, average number of fish collected, and mean diversity by month in 1973 for seines and trawls is presented in Figures VI-17 and VI-18, respectively.

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY SPECIES NUMBER, MEAN DIVERSITY, AND AVERAGE ABUNDANCE SEINES, 1973

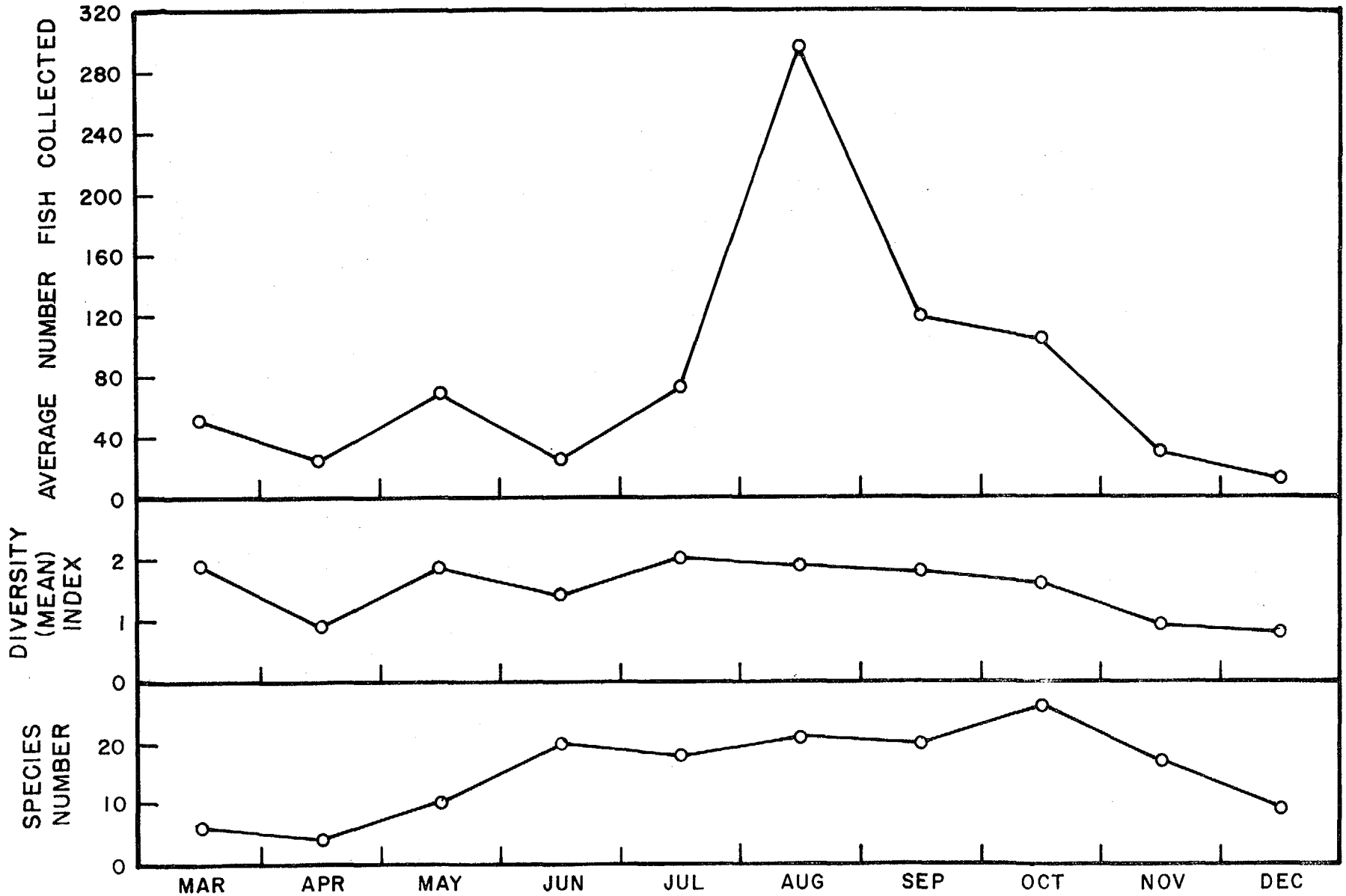


FIGURE VI-17

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MONTHLY SPECIES NUMBER, MEAN DIVERSITY, AND AVERAGE ABUNDANCE SURFACE AND BOTTOM TRAWLS, 1973

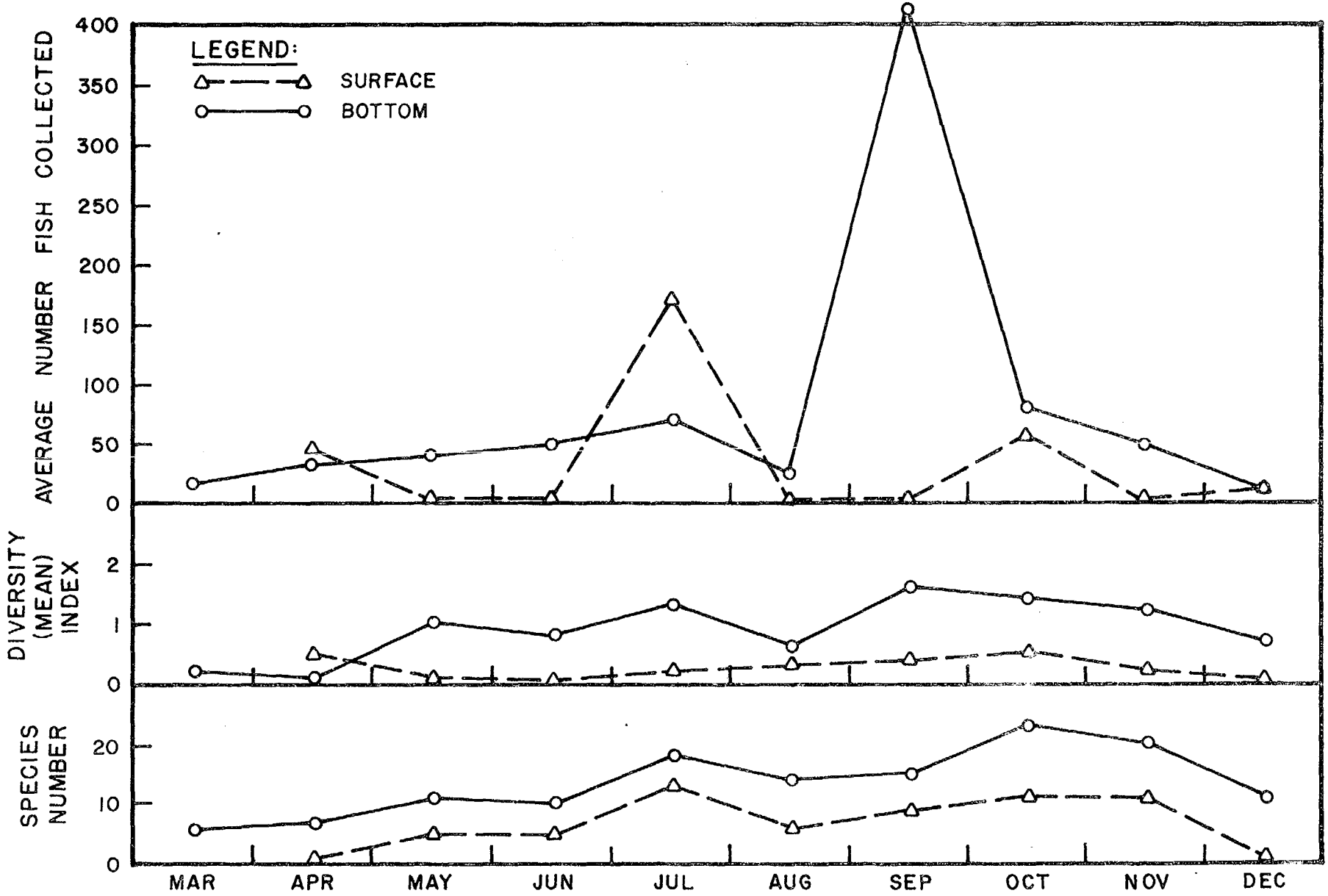


FIGURE VI-13

During the spring, summer and winter months the abundance of organisms was comparatively low. A sharp increase was observed in August and abundance gradually decreased through the fall months. The shore catch was composed of few species in the spring; the number of species increased in the early summer, remained high through the summer and fall, and declined in the winter months.

The mean diversity index was high in March and dropped off in April, probably due to movement of some species to deeper water. The value increased in May and assumed a fairly constant value until the species number and abundance fell in the winter. These values indicated a fairly stable community during the summer and fall months.

As shown in Figure VI-18 the number of species composing the surface fish catch was consistently less than the demersal catch yielded by bottom trawls. The same trends were observed for composite surface and bottom trawls.

The average number of organisms collected by surface trawl and bottom trawl indicate a very small spring fish population in the Roseton/ Danskammer Point area. The number of fish collected by surface trawls declined through May and June and increased sharply to a July peak, after which the catch declined through August and September. A second increase noted in October, due primarily to abundance of post-larval Alosa spp., declined in November and December.

Bottom trawls showed a gradual increase in numbers collected through July. A slight decrease in the abundance of demersal fish was noted for August followed by a sharp increase in September. The September peak was due to the presence of young-of-the-year white perch.

The low value in March for bottom trawls was similar to the December yield. As neither month reflects large numbers of spawning fish or young-of-the-year, the March values probably represent the winter population in this area of the river.

The diversity index for surface trawls was very low throughout the year. There was a gradual increase to a value of 0.5 in October and then a decline to values found in other months.

The mean diversity index for bottom trawls was much greater than for surface trawls. There was a spring low due to the collection of few species and small numbers of fish. The diversity index increased in May to approximately 1.0 and did not vary greatly until the winter months, when it declined gradually to approximately 0.7.

Of the three communities sampled, near-shore, open water surface and open water bottom, the most diverse community was found near shore. The variety of habitats available, such as weeds, rocks, and open bottom, represent various niches absent from the deeper waters. The same seasonal trends were found by McErlean et al. (1973) in a long term study in the Patuxent Estuary.

The diversity index based on biomass for seines and trawls is presented in Figure VI-19. When evaluating the upper trophic levels, Bechtel and Copeland (1970) found the differences in diversity based on numerical catch and diversity based on biomass to be significant in establishing differences in the community. A diversity index based on numbers gives as much emphasis to a carp weighing several kilograms as to a tesselated darter weighing a few grams. This relationship, as pointed out by Wilhm (1968), yields an erroneous picture of the community when considered alone.

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

MEAN MONTHLY BIOMASS DIVERSITY FOR SEINES AND TRAWLS 1973

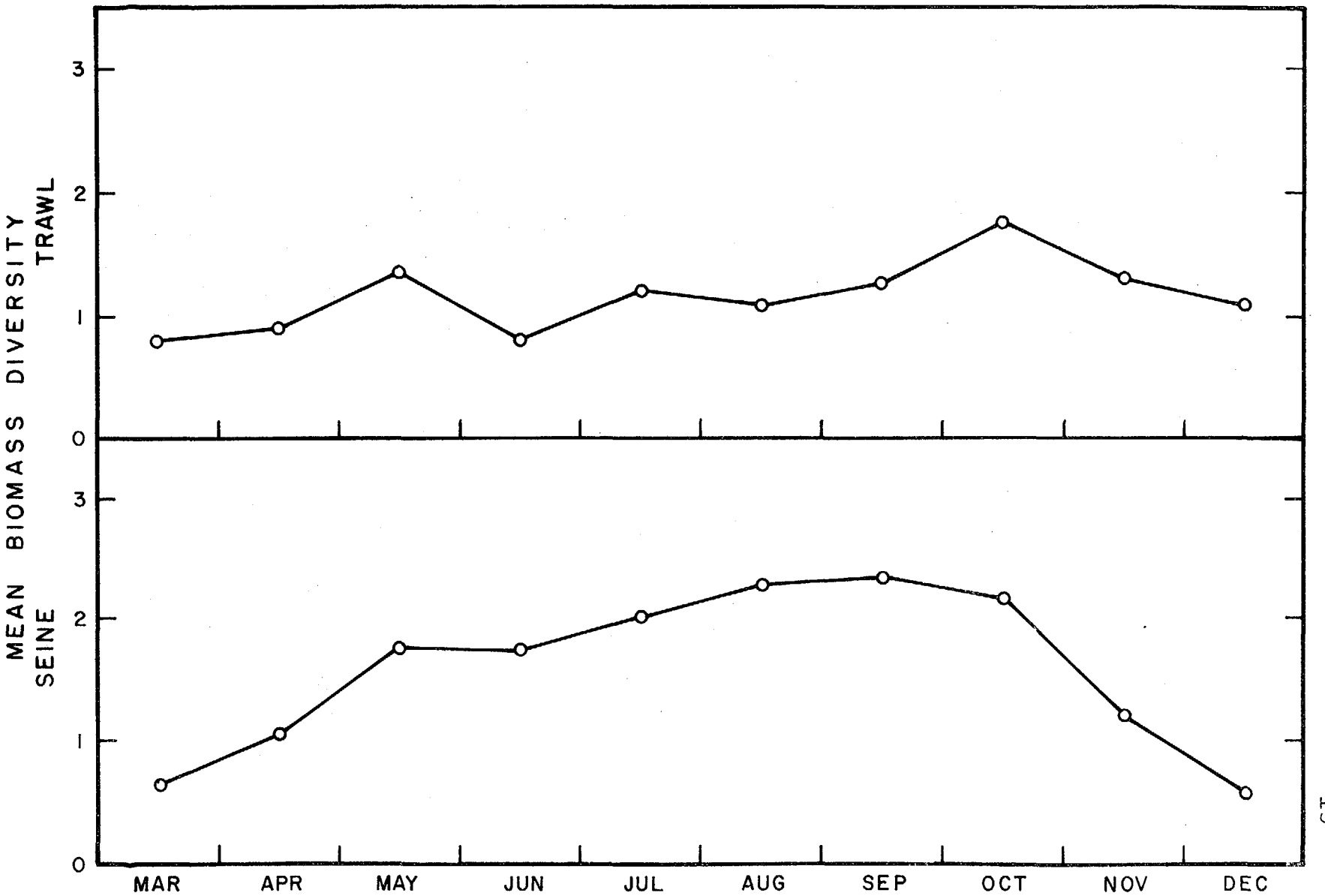


FIGURE VI-19

The seine biomass mean monthly diversity showed a gradual increase from March through September, peaking at approximately 2.5 and gradually dropping to a December index value similar to that of March, approximately 0.6. The near shore area is populated by resident species and the young-of-the-year of both area residents and non-residents. The increase in diversity in the spring was due to the movement into the area of spawners and resident forms that had been over-wintering in deeper waters or other areas of the estuary.

Between the spring spawners (May) and the appearance of young-of-the-year a slight decrease is found in the diversity value. The relative value was maintained by the growth of the resident fauna. With the use of the shallow water by fry, growth proceeded rapidly and the diversity index reflects the growth. By late fall the young-of-the-year fish are moving from the area to either marine or southern estuary nursery grounds.

The biomass index closely follows the index based on numbers (Figure VI-16). When the diversity index at a station was lower for biomass than for numbers, Bechtel and Copeland (1970) concluded that environmental stress was the cause. Of the monthly values only the March biomass value was much lower than the number value. At this time of the year the colder water and lack of food could have been the general cause for the lower biomass number.

The trawl mean monthly biomass diversity (surface and bottom combined) shows a very slight increase through October, when it peaked at 2.75, and then a

gradual decline. The value is less than the seine biomass diversity indicating a smaller population size due to fewer available niches. The relative consistency of the diversity value between 1.00 and 1.50 suggests a fairly stable open water community.

The species numbers, diversity index (Shannon-Weaver), and number fish per ten-minute trawl effort for each collection date are presented graphically in Figures VI-20 through VI-24. These figures relate to the stations near Danskammer Point used for ebb-flood comparisons. Similar information is presented in Figures VI-9 through VI-12 for the east-west transect stations sampled for day/night differences.

The ten and twenty-foot stations in the cove north of Danskammer Point were used for both studies, permitting a degree of comparability for the total numbers collected. The near field stations sampled more shallower, near-shore areas. These stations were also very close to the intake and discharge of the Danskammer Point Steam Station.

On the north cove transect (Figure VI-20 through VI-22) very few organisms, representing only a few species, were collected by surface trawls over the study period, as evidenced by the low diversity index. The time period for the collections was also restricted to the late summer months. The greatest numbers were collected on flood tide, with the diversity index dropping from the shallower ten-foot transect to the thirty-foot transect. The fish collected by the surface trawls were primarily young-of-the-year herring.

ROSETON / DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

SURFACE TRAWL
DC-10

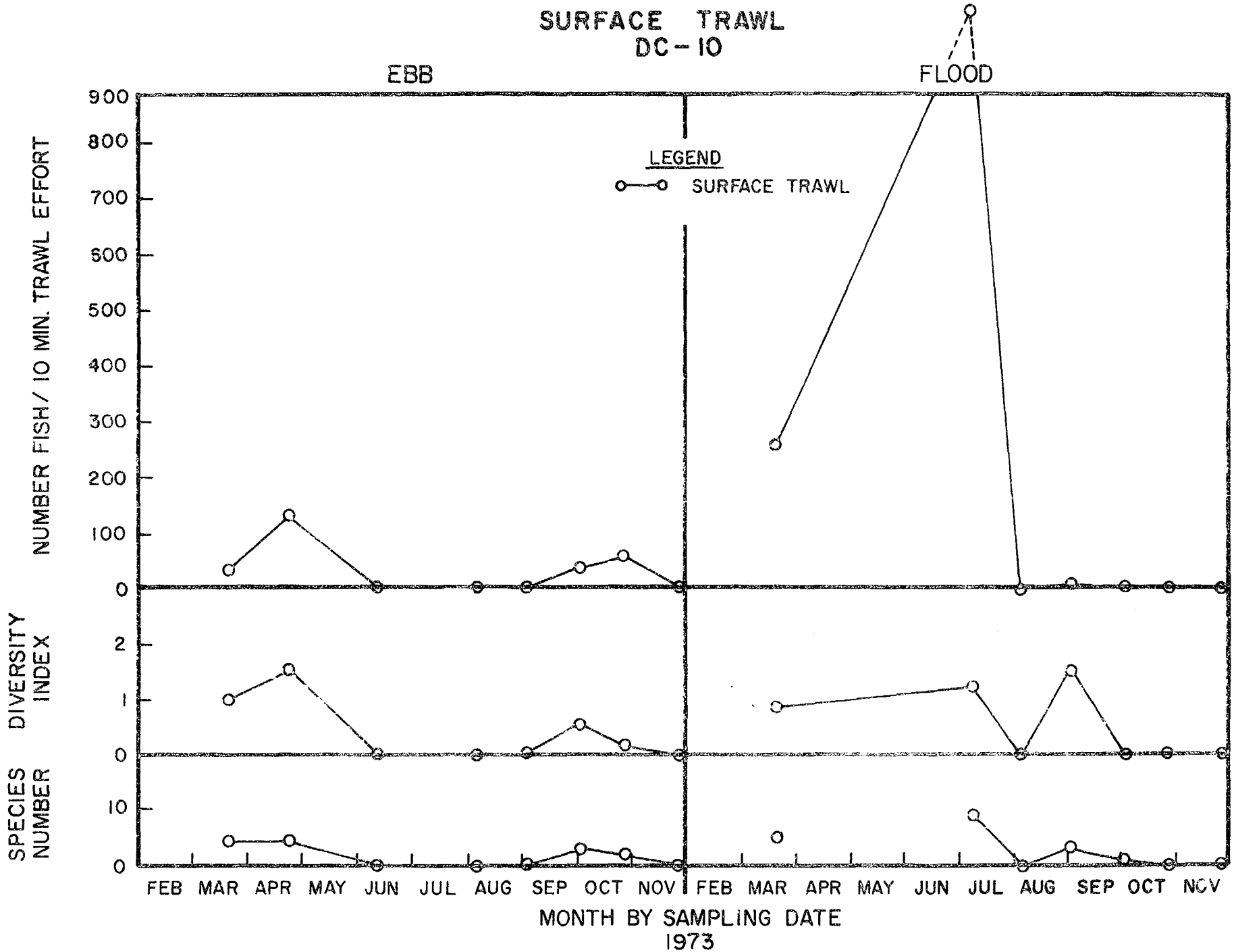


FIGURE VI-20

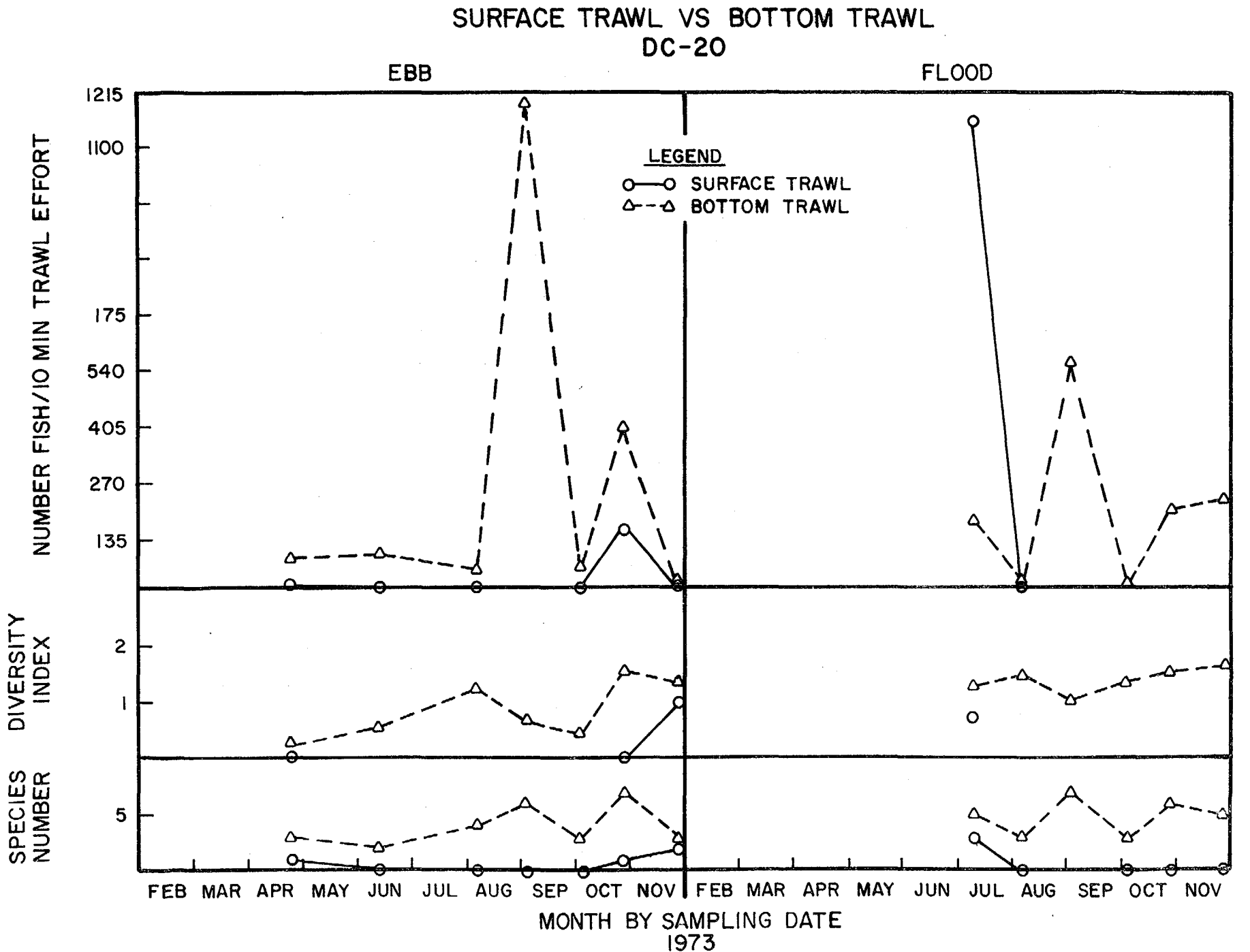

SURFACE TRAWL VS BOTTOM TRAWL
DC-20
EBB
FLOOD
LEGEND
SURFACE TRAWL
BOTTOM TRAWL
NUMBER FISH/10 MIN TRAWL EFFORT
1215
1100
175
540
405
270
135
DIVERSITY INDEX
2
1
SPECIES NUMBER
5
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
MONTH BY SAMPLING DATE
1973

FIGURE VI-21

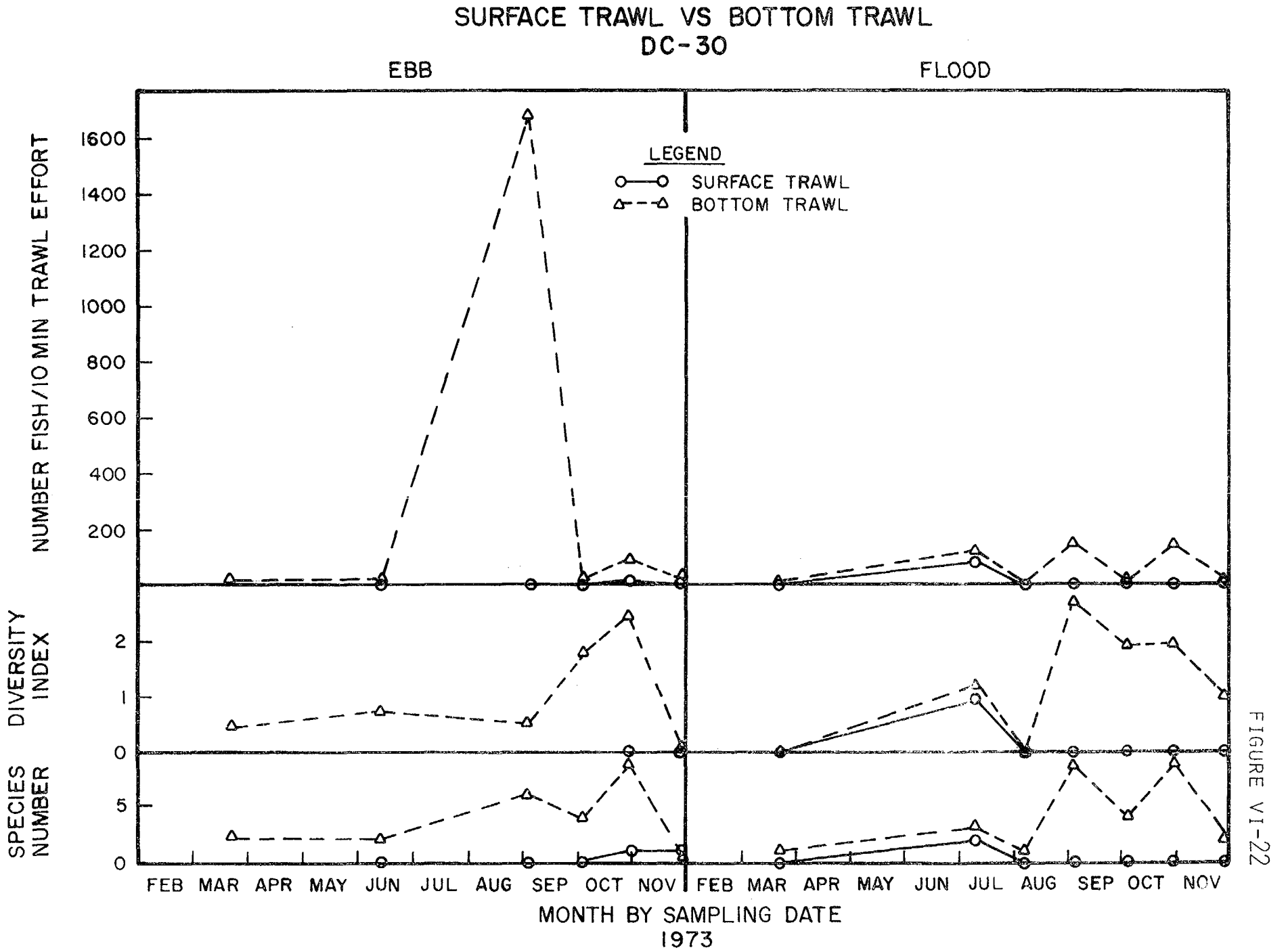

SURFACE TRAWL VS BOTTOM TRAWL
DC-30
EBB
FLOOD
LEGEND
SURFACE TRAWL
BOTTOM TRAWL
NUMBER FISH/10 MIN TRAWL EFFORT
1600
1400
1200
1000
800
600
400
200
DIVERSITY INDEX
2
1
0
SPECIES NUMBER
5
0
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV FEB MAR APR MAY JUN JUL AUG SEP OCT NOV
MONTH BY SAMPLING DATE
1973

FIGURE VI-22

ROSETON / DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

SURFACE TRAWL VS BOTTOM TRAWL

DD-20

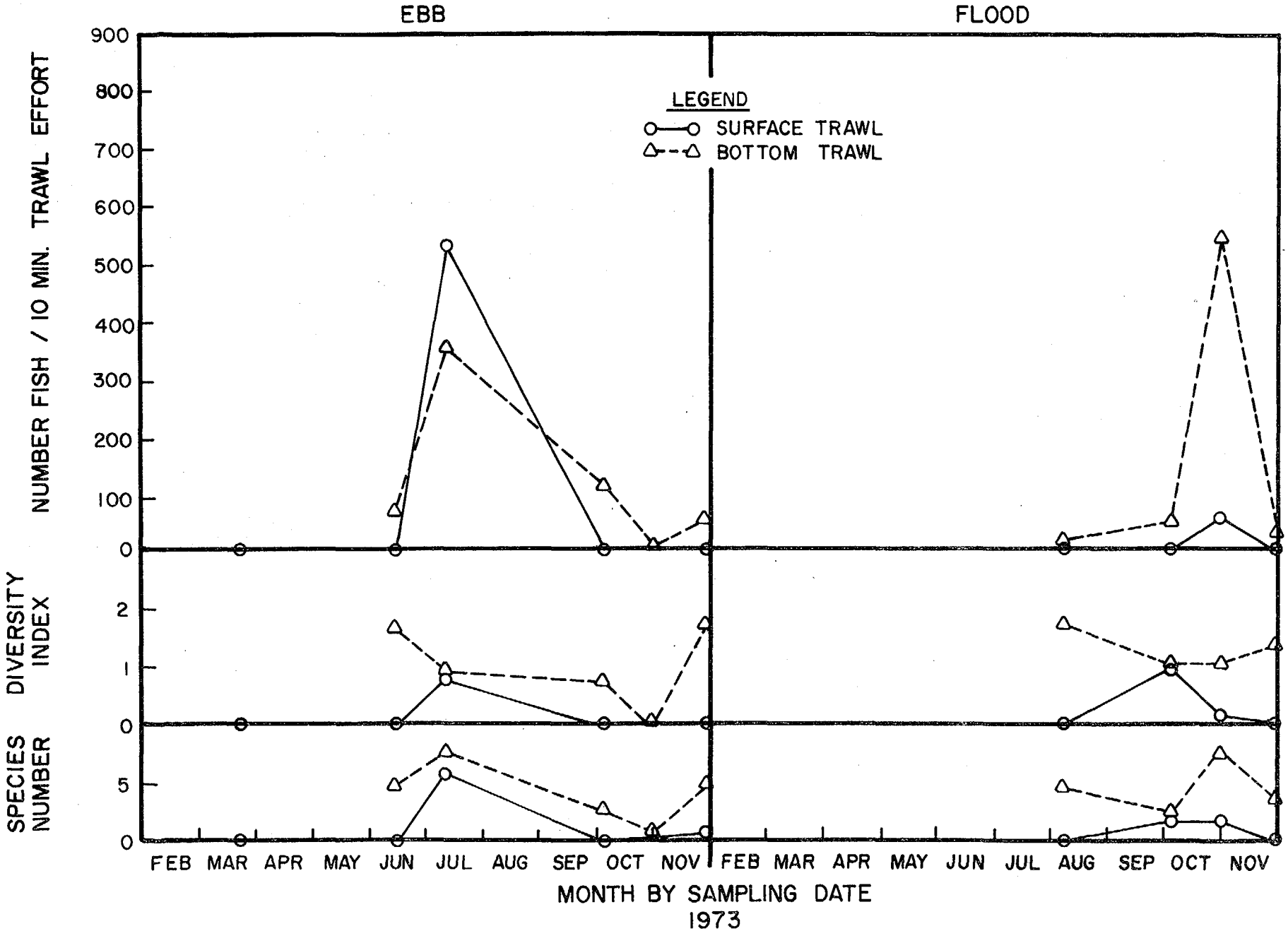


FIGURE VI-23

ROSETON / DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

SURFACE TRAWL VS BOTTOM TRAWL
DD-30

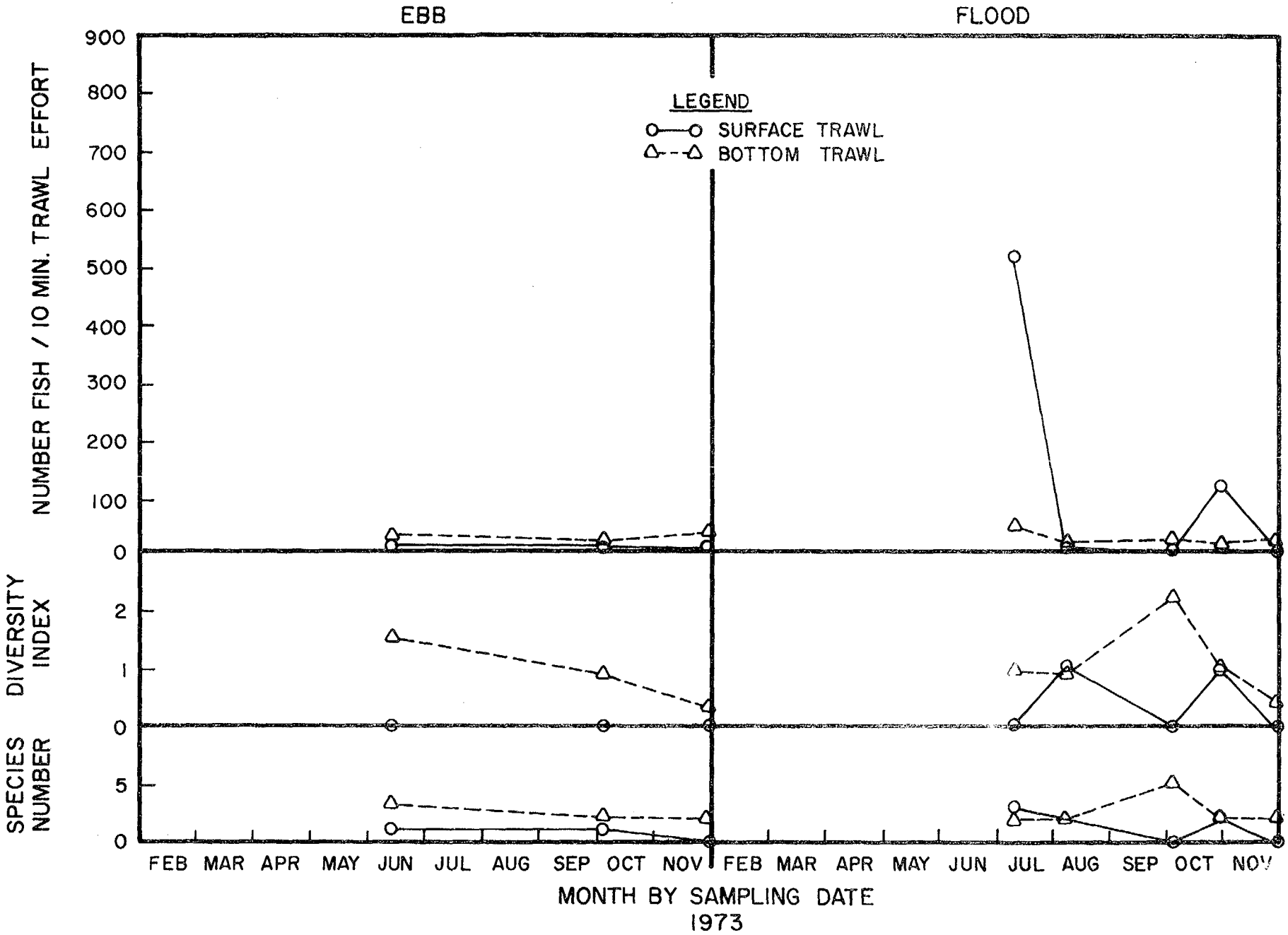


FIGURE VI-24

Tidal influence was not very pronounced in the bottom trawl collections. The yields increased during early September and late October for both surface and bottom trawls, resulting in both cases from the presence of young-of-the-year white perch. The ebb tide collection was of greater magnitude than the flood collection. For the peak collections by bottom trawl the diversity index was lower for the ebb collection at each transect.

The flood collection during the peak was lowest at the twenty-foot station and highest at the thirty-foot station. The bottom community in the cove area had a relatively low diversity during the spring and summer months and increased during the fall. The greatest diversity values were found at the thirty-foot transect whereas fewer species dominated at the near-shore station.

An interesting note is the increase in diversity and numbers on flood tide at the twenty-foot transect. This may have been caused by the beginning of the Atlantic tomcod spawning run, because flood tide is the most favorable for this migration, and Bigelow and Schroeder (1953) state that this species moves at a depth of around twenty feet.

Surface trawls in the Danskammer Point discharge area (Figures VI-23 and VI-24) collected few or no fish on most sampling dates. However, in July the twenty-foot ebb and thirty-foot flood collections yielded large numbers of fish, mainly blueback herring and some alewives. The numbers collected at the thirty-foot transect were of smaller size than the twenty-foot transect and were not identified to species.

These smaller organisms are distributed in patches and their occurrence in this area may have been due to tidal influence.

Very few fish were collected at the thirty-foot transect by bottom trawls. A summer (July) peak was experienced at the twenty-foot transect on ebb and during October for flood. Both collections were almost exclusively young-of-the-year white perch. Those collected in July were post-larval forms while the October collection included well developed juveniles. The diversity value for the twenty-foot transect increased during November and decreased for the thirty-foot transect, possibly due to the movement of fish populations into warmer waters.

Because of few collections at the Roseton discharge transect, trends could not be established for comparative purposes.

Very few fish and species were collected by surface trawls at the north control transect (Figure VI-9). Several anadromous species, namely blueback herring, American shad, and bay anchovy, were collected during October on the west side of the river. Both the day and night collections were made within two hours of each other and encompassed high slack to ebb water currents. A greater number of bay anchovy were collected during the night hours. The most fish were collected on the east side throughout the study; however, the diversity index shows that all fish belonged to one species or that the total number was evenly distributed among two species.

Bottom trawls on the west side yielded greater collections in the summer and lower catches in the fall and winter. The diversity index was low in the summer, increasing in the fall, and maintaining a fairly high value through December except for the December night collections; however, these latter values for December were based on only two species collected.

The reverse trend is true for the east side station. Very few fish were collected in the summer, but abundance increased in the fall and decreased in the winter. The high value in October was due to occurrence of brown bullhead and white perch. The diversity index was high throughout most of the study period, pointing to a more stable community structure.

The east side of the river at this point is shallower with many rooted aquatic plants. This area was probably used for feeding purposes during the late summer-fall period. Several of the fish collected were young-of-the-year, indicating an area of quieter, more sheltered waters, as required by these young fish.

Due to the shallowness of the ten-foot transect only surface trawls are comparable for the cove stations (Figure VI-10). At both the ten-foot and twenty-foot transects very few organisms were collected by night surface trawls. In October large numbers of white perch were collected, along with several Clupeidae and bay anchovy. The December value is due almost exclusively to spottail shiner. The twenty-foot transect had a more diverse community structure, but only in the fall. The spring-summer collections were mono specific

with juvenile Alosa spp. taken during the day trawls in June and white perch from the June and July night trawls. Bottom trawls at the twenty-foot transect had a high diversity value throughout the study.

After June, only surface trawls were conducted on the east side of the river across from Roseton (Figure VI-11). In the summer all trawls pointed to a very sparse population; all surface trawls conducted after July during daylight and night hours failed to collect any fish.

A great deal of fluctuation in the community structure was noted at the west station. Very few fish were collected by trawling, although bottom trawls yielded the greater catches. In June and July the catch by bottom trawl consisted mainly of young-of-the-year Atlantic tomcod and white perch. In the fall months, the number of tomcod decreased, and the bottom population was mainly young-of-the-year white perch. The collections in November and December showed an increase in adult tomcod, but were still dominated by white perch.

Surface trawls at the west station collected mainly Clupeidae, mostly blueback herring young, but also shad and alewife, especially in October. The diversity index was fairly high for surface trawls in late summer-fall due to the Clupeidae. The demersal community appeared to be quite diverse decreasing during the winter.

The South Control stations (Figure VI-12) were located just north of the Newburgh-Beacon Bridge. Depth at the west side station was approximately 50 feet and the east station was shallow, approximately 30 feet, and situated near a very large shallow area of the river.

No fish were collected from the surface waters during spring sampling. Young-of-the-year Atlantic tomcod were abundant in bottom trawl collections. The bottom community was composed mainly of adult white perch through the fall, becoming quite diverse although with fewer organisms in the late fall-winter period.

Diversity index was low in the summer and increased in the fall and winter, when it included several species and low numbers.

Few adult alewife and blueback herring were collected during the spring by surface trawl on the east side of the river. In the late summer-early fall, few young-of-the-year Clupeidae were collected. For the most part the surface fauna was sparse in this area. The greatest diversity was recorded in November for surface trawls.

In May and June large numbers of young-of-the-year Atlantic tomcod were collected by bottom trawls. Adult white perch, in addition to the tomcod, were found in June. The number of tomcod decreased in July and tomcod was not collected again until November. The white perch population shifted to young-of-the-year in August, after which very few adults were collected.

The general trend indicated from comparison of north and south transect data was a spring migration in the channel on the west side of the river, mainly in the surface waters. In summer, the population shifted to young-of-the-year Clupeidae along the shore in the surface waters and white perch young-of-the-year in the bottom waters. In the north, movement to the shallower east side for feeding was observed.

At the southern transect greater numbers of young-of-the-year tomcod were found, especially at the eastern station. Since this area is approximately 30 feet deep, the preference by tomcod for intermediate depths could account for their higher incidence.

White perch were the dominant species in the deeper waters at all times of the year. Adult tomcod were found in the spring and young-of-the-year in the late summer months. Since few adults were collected after July these fish must leave the immediate areas sampled and possibly move into the deeper main channel.

9. Age and Growth

(a) Introduction. Age is one of the most important parameters in a study of the population dynamics of fish. The age composition of the stock, the relative strengths of the different age groups, and the maximum life span are, within certain limits, a species characteristic. Fish with a short life cycle and a population consisting of only a few age groups, such as the anchovy and the river herring, are adapted to living under conditions of high and variable mortality. Their population dynamics ensure a rapid replacement of the stock.

On the other hand, species such as sturgeon, in which the population contains age groups spanning several decades, are best adapted to living under conditions of a relatively stable food supply and negligible annual fluctuations in the mortality of mature individuals. If a substantial part of this population should die, replacement would be slow (Nikolsky, 1963).

Knowledge of the age of fish can act as an identifying factor by which the migrations of certain year classes can be followed and chapters in their life history pieced together. Striped bass do not ordinarily travel far until they are two years old. This was determined when young fish of the enormous year classes of 1934 and 1942 in Chesapeake Bay did not appear in New England waters until two years later (Bigelow and Schroeder, 1953).

Fish scale analysis can be used to determine the age group of a fish as well as to obtain much of the historical information necessary to determine growth patterns. Age determination can be accomplished by counting the annuli, which are yearly growth marks on the scales. Measurement of the scale length and distance between the annuli to determine scale length to body length relationships results in yearly growth increment values. The method of determination of scale growth to body growth is termed the "back calculation technique" (Tesch, 1971).

Growth rates are an index to population densities, and slow growth rates are often symptomatic of overcrowded conditions. If there were a source of attrition in a population, it would be beneficial to know if this "cropping" was occurring in an overcrowded, stunted population or whether the population was already at the optimum density for good growth and survival.

The back calculation technique on scales from five year old white perch collected in 1972, for instance, will supply information on growth

rates for each year from 1967 through 1971. In this way, a data file can be built up on growth rates from previous years, and an attempt can be made to correlate these rates with parameters such as rainfall, solar radiation, water temperature and population densities.

Results from detailed age and growth studies which use length frequency and scale analysis are presented for white perch and striped bass. In addition, length frequency analyses of growth rates are presented in Appendix VI-A for spottail shiner, blueback herring, alewife, and Atlantic tomcod. For purposes of clarity it should be stated that the lengths of individual fish, in addition to being used in the formulation of length/weight relationships within species, were utilized to obtain information on age composition of the population, growth rates of young fish from month to month, and recruitment of slower-growing or later-spawned contingents to the Roseton/Danskammer Point fish populations.

(i) Length Frequency Analysis. The length composition of a fish population which reproduces seasonally will often exhibit modes among the smaller fish, which correspond to the youngest age groups. These modes will be most pronounced for species with a short spawning season and rapid, uniform growth.

In the older age groups, because of increased overlapping growth and a decline of age group strength due to mortality, the length peaks of the discrete age groups tend to decrease and blend together. For these reasons, length frequency analysis was used primarily to monitor growth rates of young-of-the-year (0 age group) fish from one year to the next. It was also used to validate length at annulus formation derived from scale analysis for younger age groups of selected species.

(ii) Scale Analysis. Scale analysis provided two main inputs to the study of fish populations in the Roseton/Danskammer Point vicinity during 1971, 1972 and 1973. The first and most basic source of information came from interpreting the age of individual fish by reading the number of annuli, or winter marks, on the scales. The second was provided by back calculating the length that individual fish attained during each successive year of their lives, thus compiling information on growth rates of fish for the years prior to their capture.

Quantitative information on the age structure and growth rate of a population followed from year to year in relation to environmental factors can frequently help in understanding factors that affect dominant year classes. This rate is directly and significantly affected by temperature and by other physical and biological conditions. Thus it is possible for different age classes or broods to be roughly the same size or to have wide differences in average size (Mansueti, 1961).

If scales are to be used as valid indicators of age and growth, certain assumptions must be made. One of these is that the annulus is formed yearly and at approximately the same time each year. A second assumption is that the annual increment in scale length maintains a constant ratio with the annual increment in body length (Van Oosten, 1929); i.e., the body-length, scale-length relationship is exactly linear, with its intercept at the origin, ignoring the initial length of the fish at scale formation. Actual data plots of body length on scale length for several species of fish showed that the relationship is not directly proportional and that the regression line through the data points generally has a positive y-intercept, roughly corresponding with the fish's body length at scale formation. This positive value is used as a correction factor in the back-calculation formula and must be determined separately for each species and each distinct environment, such as the Hudson River or Chesapeake Bay.

It should also be pointed out that several investigators working with various fish species have determined that the "constant ratio" mentioned by Van Oosten between increments in scale length and body length is often not present (Huntsman, 1918; Dew, 1970; Koski, 1973; Marcy, 1974). The ratio often decreases, i.e., the relationship is <u>not</u> linear, scales growing faster than the body as the fish grow older, resulting in somewhat higher values for body length at scale formation (correction factors) than would be found in nature.

It is possible to avoid this problem by using only young-of-the-year fish for the regression of body length on scale length (Koski, 1973; Marcy, 1974). The slope of the regression of body length on scale length during the early period of rapid fish growth is steeper than it is afterwards, resulting in a lower y- intercept than when older, slower-growing fish are used.

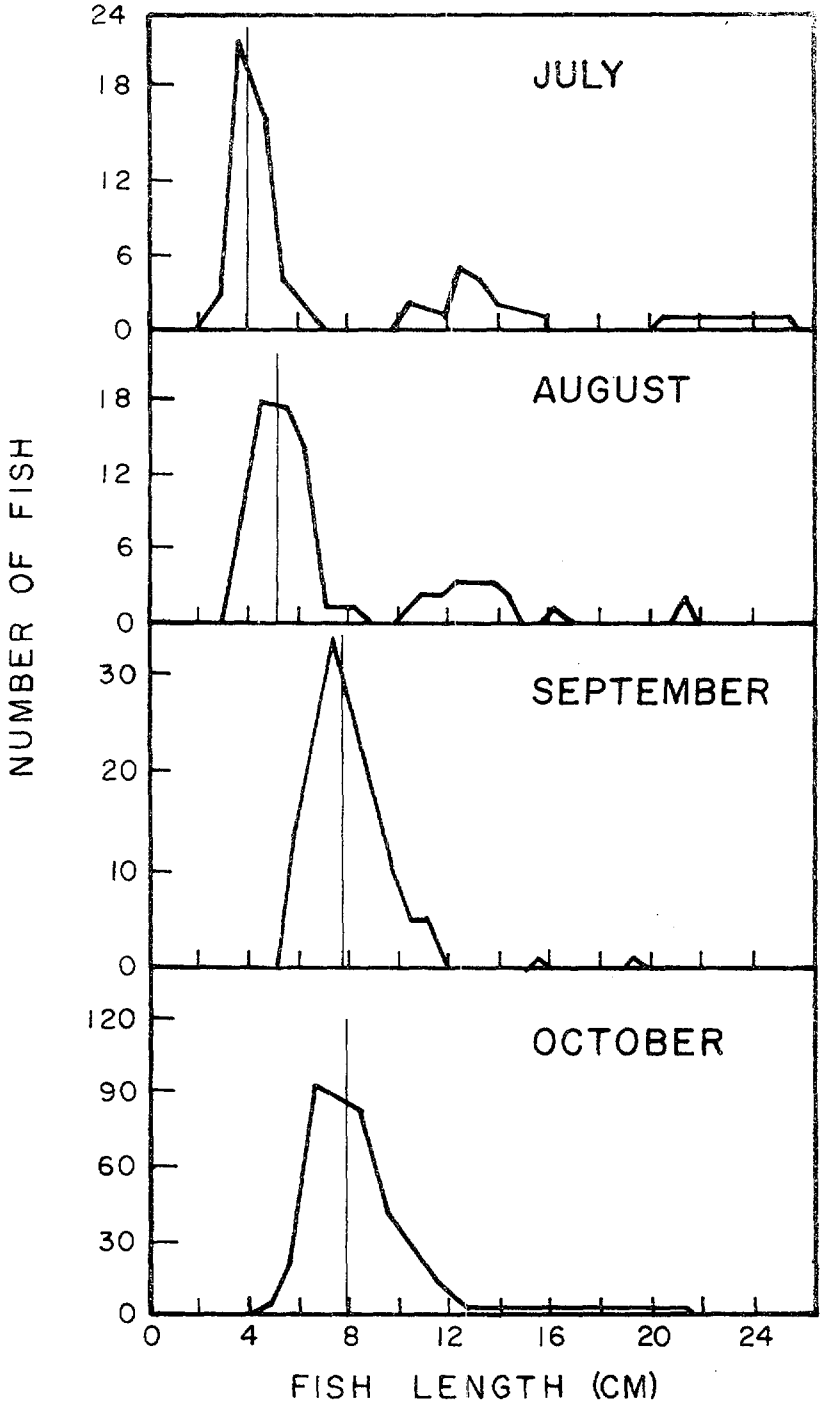
(b) Striped Bass

(i) Length Frequency. Young-of-the-year striped bass were first collected during July 1973 with a mean length of approximately 4 cm. The mean length of the young striped bass population at the end of the 1973 growing season in October and November was slightly greater than 9 cm (Figure VI-25). This compares very well with the yearly growth estimate of 8.98 cm as obtained from the back calculation technique (see below).

No comparison with 1971 and 1972 growth rates was made using length frequency methods because of smaller catches during these years. Although it is generally known that the Hudson River serves as an extensive nursery area for young striped bass, the almost complete dominance of young-of-the-year fish in trawl and seine catches may be a function of gear selectivity and gear avoidance by larger striped bass.

(ii) Body-Scale Relationship. The body-scale relationship for 44 male, female and immature striped bass collected during 1973 was described by the regression $L = 14.4 + 66.49S$ ($r = 0.98$), where L is total

LENGTH DISTRIBUTION (CM) OF STRIPED BASS COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973



length in millimeters and S is thescale radius in millimeters (Figure VI-26).

The regression intercept of 14.4 mm was used as the correction factor in the formula for body length at scale formation. The plot of the scale length-body length data is shown in Figure VI-26. Due to the small sample size (44) all individuals were used in the regression analysis.

Robinson (1960) reported that the calculated correction factor for striped bass from California was 24.6 mm (fork length) while Mansueti (1961) reported a value of 10.9 mm (fork length) for Chesapeake Bay area striped bass. Mansueti (1958) investigated actual scale formation in striped bass and found that scales were first evident at a body length of approximately 20 mm total length.

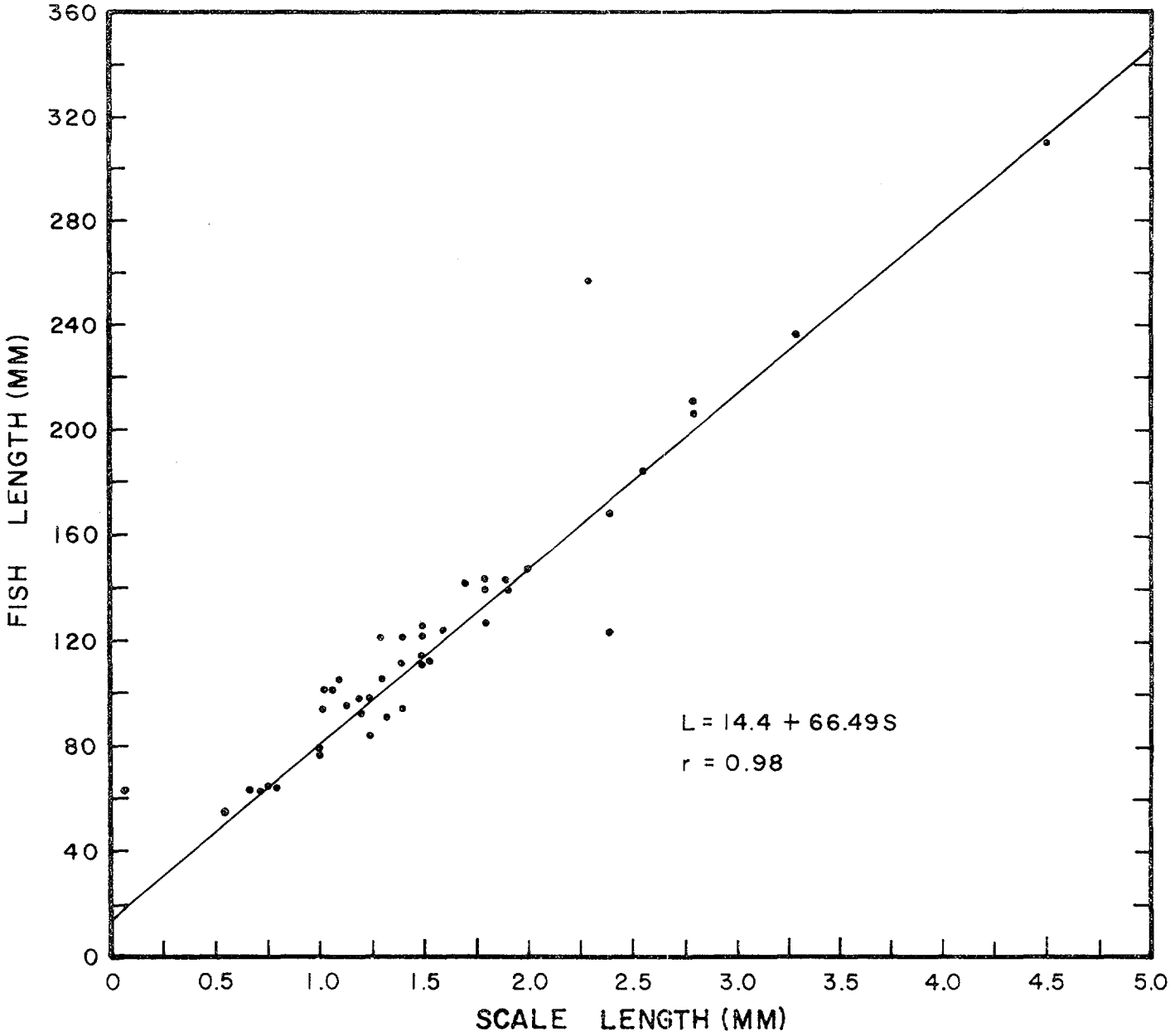
A correction factor of 15.8 mm total length was used in a study of Haverstraw Bay striped bass (Quirk, Lawler & Matusky Engineers, 1974). Texas Instruments (1973a) calculated a correction factor of 31.9 mm total length, which was the highest value in any of the reported studies.

(iii) Time of Annulus Formation. Annuli had been formed by mid-July in all of the 156 striped bass examined from the Hudson River during 1972, and most had been formed by the end of June. Merriman (1941) stated that striped bass annuli became evident by April or May, but contrary to this information Hudson River striped bass exhibited no annuli until June during 1972.

FIGURE VI-26

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

SCALE RADIUS-TOTAL LENGTH RELATIONSHIP FOR 44 MALE AND FEMALE STRIPED BASS COLLECTED AT ROSETON DURING 1973



(iv) Age and Growth. Length attained at the end of each year of life, i.e., at annulus formation, is presented in Table VI-17 for male, female, and immature striped bass from year classes 1969-1972 collected in 1973 in the Roseton/Danskammer Point vicinity.

The calculated growth rates were compared to results from several other growth studies of striped bass (Table VI-18), and it was evident that growth rates noted from the Hudson River, especially in the Roseton/Danskammer Point area, appeared to be lower than those found in most other studies. These lower growth rates may have been indicative of inter-specific competition with white perch, resulting in overcrowding and consequently stunted growth rates.

However, the differences observed between growth rates found in this and other studies may result from differences in sampling gear. Striped bass in Maryland (Mansueti, 1961) and in South Carolina (Scruggs, 1955) were captured by size selective gear such as gill and trammel nets. Mansueti (1961) stated that the more rapid growth apparent in striped bass caught by gill nets was consistent with the expectation that such selective gear would take a comparatively large segment of the faster-growing younger age groups within the population. Merriman (1941), however, utilized several methods of collection, such as pound nets, seines, and angling, and stated that it is unlikely that the growth rates in his study were biased by sampling gear.

TABLE VI-17

STANDARD DEVIATION AND STANDARD ERROR FOR AVERAGE CALCULATED GROWTH (MM) OF STRIPED BASS YEAR CLASSES 1969-1972 COLLECTED DURING 1973

ROSETON/DANSKAMMER POINT VICINITY

Year Class	Number of Fish Aged From Each Year Class	Calculated Total Length at End of Year			
		1	2	3	4
1972	14	85.72			
1971	6	86.40	144.36		
1970	2	111.38	150.31	197.90	
1969	1	124.54	271.37	292.46	310.00
GRAND AVERAGE:		89.81	159.79	229.42	310.00
SAMPLE SIZE:		23	9	3	1
STANDARD DEVIATION:		23.82	63.73	80.46	1
STANDARD ERROR:		4.97	21.24	46.45	1
VARIANCE:		567.46	4061.28	6473.95	1
CONFIDENCE INTERVAL $\alpha = 0.05$)		79.53-100.09	110.72-208.87	29.67-429.17	-
AVERAGE ANNUAL INCREMENT		89.81	69.98	69.63	80.53

TABLE VI-18

MEAN CALCULATED FORK LENGTHS (MM) AT ANNULUS FORMATION
FOR STRIPED BASS BASED ON SEVERAL STUDIES

ROSETON/DANSKAMMER POINT VICINITY

	LOCATION AND REFERENCE							
Annulus Formation	Chesapeake Bay Maryland (Mansueti, 1961)	San Joachin-Sacramento River California (Robinson, 1960)	Santee-Cooper Reservoir, South Carolina (Scruggs, 1957)	New England States (Merriman, 1941)	Hudson River MP 40-60 (Texas Instruments 1973a)	Hudson River Kingston Vicinity MP 95 (QL&M, 1973b)	Hudson River Bowline Vicinity MP 35 (QL&M, 1974)	Hudson River Roseton Vicinity MP 65 Present Study
1	129.5	104.1	170.2	124.5	111.3	101.3	105.6	83.5
2	294.6	248.9	355.6	233.7	224.7	224.8	204.3	148.6
3	384.8	388.6	466.8	365.8	310.2	-	333.3	213.4
4	449.6	497.8	528.3	449.6	401.5	-	427.8	288.3

NOTE:

1. Conversions to fork length after Mansueti (1961)
2. Sexes combined for all studies

KEY:

MP = Mile Point

QL&M = Quirk, Lawler & Matusky Engineers

(b) White Perch

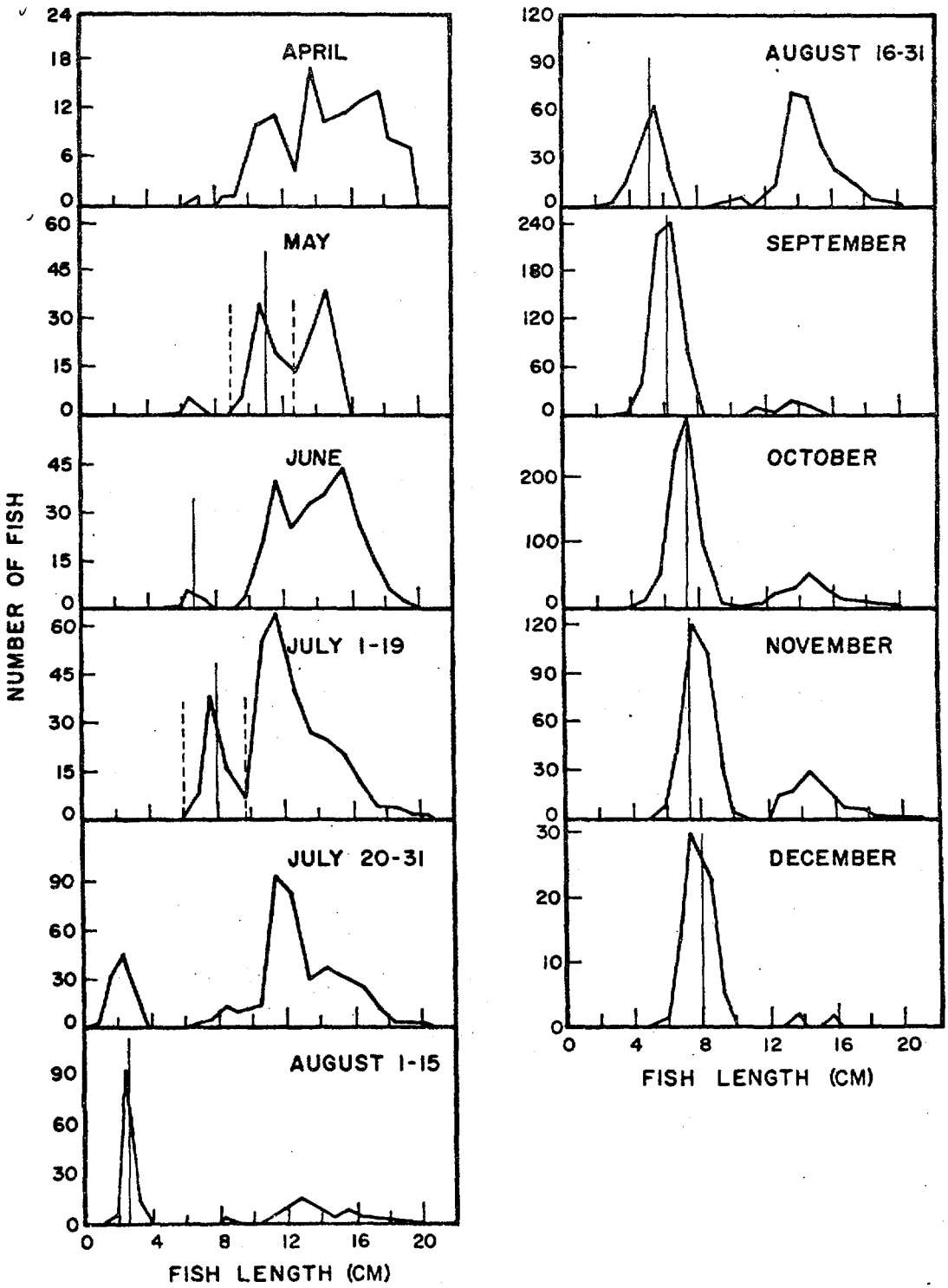
(i) Length Frequency. Length frequency analysis of white perch collected from April through June 1973 shows that the predominant segment of the white perch population in the Roseton/Danskammer Point vicinity during this time was composed of adults two years old and older (Figure VI-27). This corresponds to the timing of the spring spawning migration undertaken annually by white perch in the Hudson River and other estuaries.

Evidence of the spring spawn first appeared in trawl and seine catches during the latter part of July 1973. These young-of-the-year white perch were first recruited into the fishery at a mean length of just over 3 cm. The growth rate of the young-of-the-year white perch population was then monitored through the summer and fall until a maximum length of approximately 8 cm. was attained in November 1973 (Figure VI-27).

Comparison of annual growth rates for young white perch during the period 1971-1973 indicated that growth was similar during 1971 and 1973 and was better in both years than in 1972 (Quirk, Lawler & Matusky Engineers, 1973a), perhaps due to better growing conditions within the estuary during these years. Results from Hudson River ecological studies during 1971 and 1972 in the vicinity of Kingston (mile point 95) and Haverstraw Bay (mile point 36) showed that the trend of lower white perch growth rates in 1972 was observed

LENGTH DISTRIBUTION (CM) OF WHITE PERCH COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973

(DOTTED LINE REPRESENTS CUT-OFF POINT BETWEEN AGE GROUPS WHERE CONTINUOUS DISTRIBUTION IS PRESENT)



at each of these locations also, indicating that it was a river-wide phenomenon rather than one restricted to the Roseton area (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974).

A thirteen-year study of white perch in the Patuxent River, Maryland (Mansueti, 1961) showed that there were significantly different growth rates between certain years. Mansueti attributed these differences to interactions of biological parameters (population density) and environmental parameters (temperature, rainfall and solar radiation). A direct relationship was observed between first year growth and the time period in days that the water temperature was between 10 and 15°C (50-59°F).

Mansueti also noted a direct correlation between growth rates and solar radiation interpreted as average monthly percent of possible sunshine. This correlation of sunlight to the growth of the white perch can be explained indirectly from increased productivity at the base of the food web resulting in similar increases at higher trophic levels. Heavy spring rains and high population densities of young-of-the-year white perch were negatively correlated with first-year growth rates.

Spring rainfall in the Hudson River was greater in 1972 than in 1971, resulting in record flows throughout the estuary. Climatological data for the two years also showed that the average monthly percent of possible sunshine measured at Albany and Central Park for the

five month period of February through June was 8% less in 1972 than in 1971. Relative abundance expressed as numbers of white perch per ten minutes of bottom trawl showed that there were higher population densities of white perch at Roseton/Danskammer Point and Bowline in 1972 than in 1971 (Quirk, Lawler & Matusky Engineers, 1973a, 1974). These differences in rainfall, solar radiation and population density between 1971 and 1972 may have influenced growth rates of white perch in the Hudson River.

(ii) Body-Scale Relationships. The body-scale relationship for male, female, and immature white perch collected at Roseton/Danskammer Point and Haverstraw Bay during 1971, 1972 and 1973 are described by the regression: $L = 25.3 + 45.40S$ ($r = 0.86$) where L is total length in millimeters and S is scale radius in millimeters (Figure VI-28).

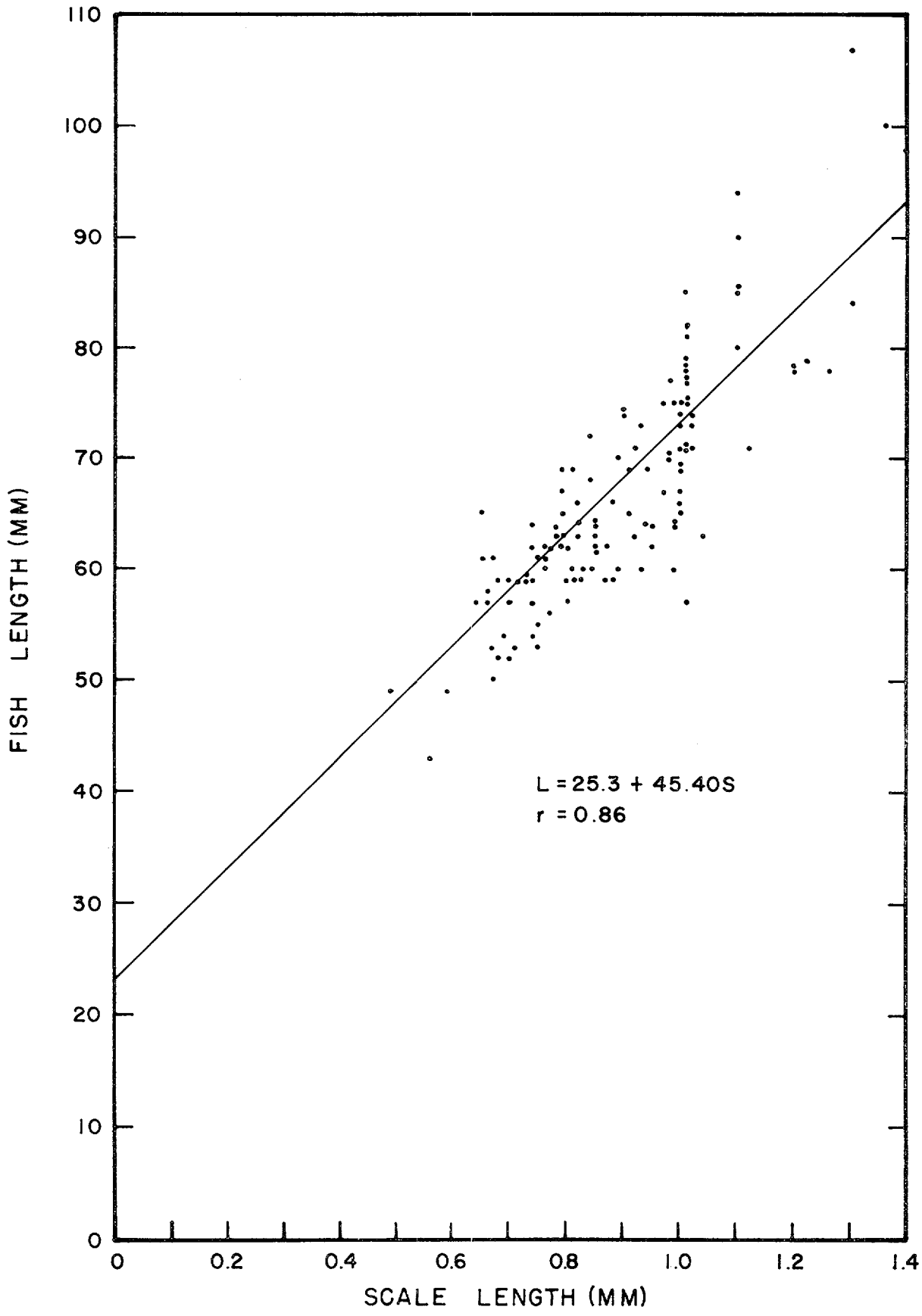
The regression intercept of 25.3 mm was used as the correction factor for body length at scale formation in this study. The correction factor was calculated only for young-of-the-year fish collected at Roseton/Danskammer Point and Haverstraw Bay. The pooling of the data from both areas of the Hudson River increased the number of observations from 39 for Roseton/Danskammer Point alone to 126; this technique was used only after the data from each area were found not to be significantly different when analysis of covariance was employed.

Calculated correction factors for other studies are: Mansueti (1961) 16.3 mm standard length in Maryland; Wallace (1971), 22.4 mm fork length in Delaware; St. Pierre and Davis (1972), 20.9 mm fork length

FIGURE VI-28

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

SCALE RADIUS-TOTAL LENGTH RELATIONSHIP FOR 126 YOUNG WHITE PERCH COLLECTED AT ROSETON AND BOWLINE



in the James and York Rivers, Virginia; Texas Instruments, Inc. (1973), 27.2 mm total length in the Hudson River, and Quirk, Lawler & Matusky Engineers (1974), 31.9 mm total length for the Bowline area.

(iii)Time of Annulus Formation. Annuli had been formed by September in all of the 566 white perch collected from the Roseton/Danskammer Point area during 1972 and 1973 and in all but two fish by August. A trend of earlier annulus formation in younger fish was evident, with the earliest formation in May and June for younger fish. The peak of annulus formation appeared to be in July. This generalized pattern was also observed for a combined sample of 1169 white perch from Bowline (mile point 35), Roseton/Danskammer Point and Kingston (mile point 95).

Time of annulus formation, in addition to being a species characteristic, is probably influenced by environmental conditions and seems to vary somewhat with both location and year.

During a study on Lake Ontario, Sheri and Power (1969) found that peak annulus formation was in July for five of the years studied but occurred in June for two years, and August for two other years. However, annulus formation generally spanned the time period from May to September as was found for the Hudson River. Marcy (1974) stated that annulus formation of Connecticut River white perch began by late March and was completed by the third week in June for all age groups.

Mansueti (1961) observed annulus formation only during April, May and June in the Patuxent River, Maryland. Wallace (1971) found that for

WEIGHTED MEAN TOTAL LENGTH AND INCREMENT IN LENGTH ATTAINED BY 226 MALE AND 279 FEMALE HUDSON RIVER WHITE PERCH AT THE END OF EACH YEAR OF LIFE

(COLLECTED IN THE ROSETON/DANSKAMMER AREA)

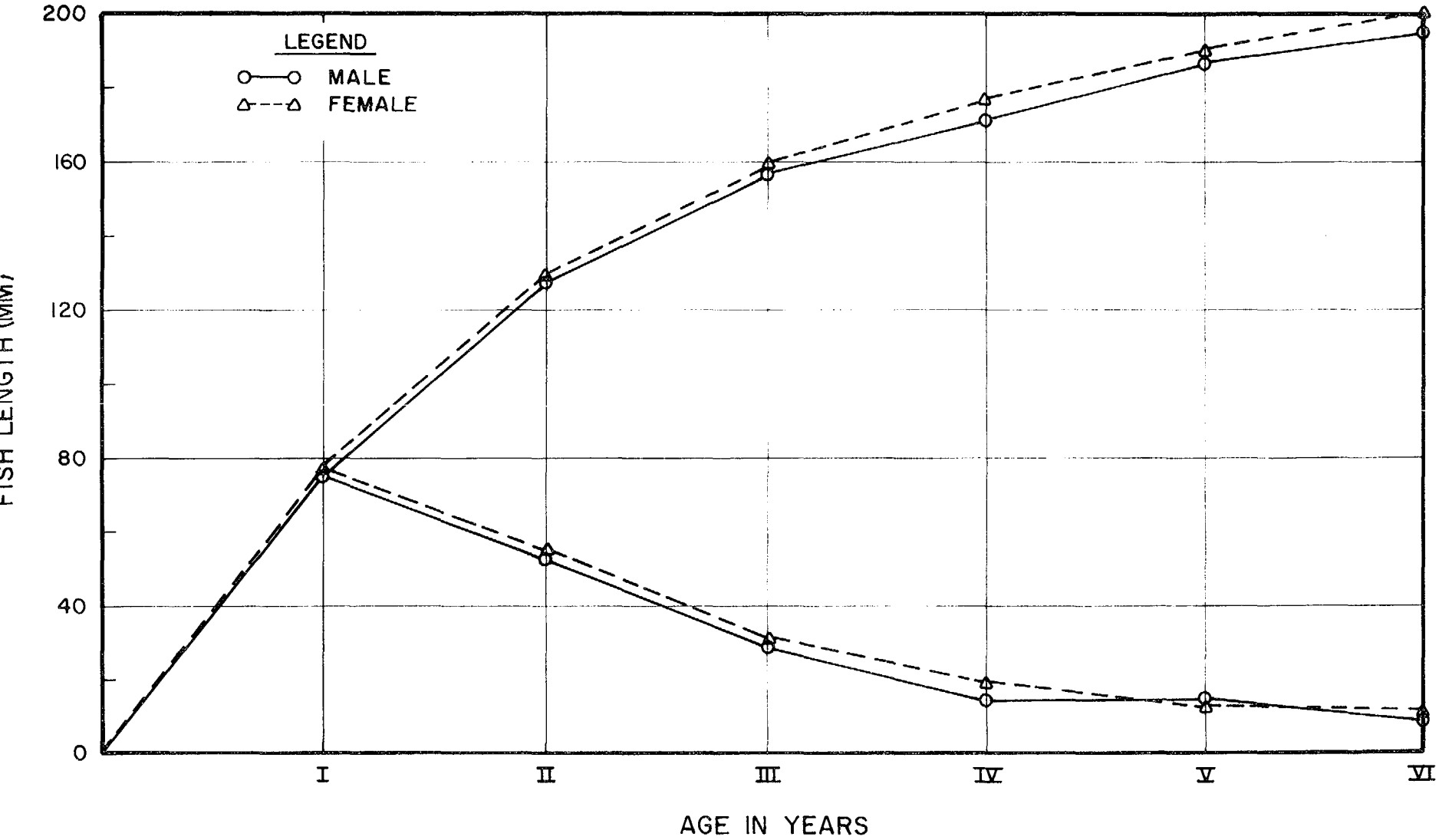


FIGURE VI-20

Greater growth for females in each year of life is a phenomenon well-established in the literature (Mansueti, 1961; Miller, 1963; Wallace, 1971; St. Pierre and Davis, 1972; Texas Instruments, Inc., 1973a). St. Pierre and Davis (1972) suggested that the smaller size of males may reflect their sexual maturation at an earlier age.

Growth in length by each sex was greater during the first year than in any other year, representing approximately 40% of the mean total length attained by five year old fish. Average annual increments decreased rapidly after age II (Figure VI-30).

White perch growth rates for fish collected in the Roseton/Danskammer Point vicinity were generally lower than those at Bowline (mile point 35)(Quirk, Lawler & Matusky Engineers, 1974) and higher than those at Kingston (mile point 95) (Quirk, Lawler & Matusky Engineers, 1973b). Young-of-the-year growth rates in this area,however, were significantly lower ($\alpha = 0.05$) than those found for young white perch at both Kingston and Bowline (Quirk, Lawler & Matusky Engineers, 1973a, b, 1974).

A trend of slower white perch growth in the upper portion of an estuary was noted by Mansueti (1961) for the Patuxent River, by Miller (1963) and Wallace (1971) for the Delaware River, by Texas Instruments, Inc. (1973) for the Hudson River, and by Marcy (1974) for the Connecticut River. Data from Bowline, Roseton/Danskammer Point and Kingston indicate that there is a trend of depressed growth from the lower to the upper regions of the Hudson River.

CALCULATED GROWTH OF YEAR CLASSES OF
505 MALE AND FEMALE WHITE PERCH COLLECTED
FROM THE HUDSON RIVER AT ROSETON DURING 1971, 1972 AND 1973
(HORIZONTAL LINES CONNECT IDENTICAL AGE GROUP IN DIFFERENT YEARS)

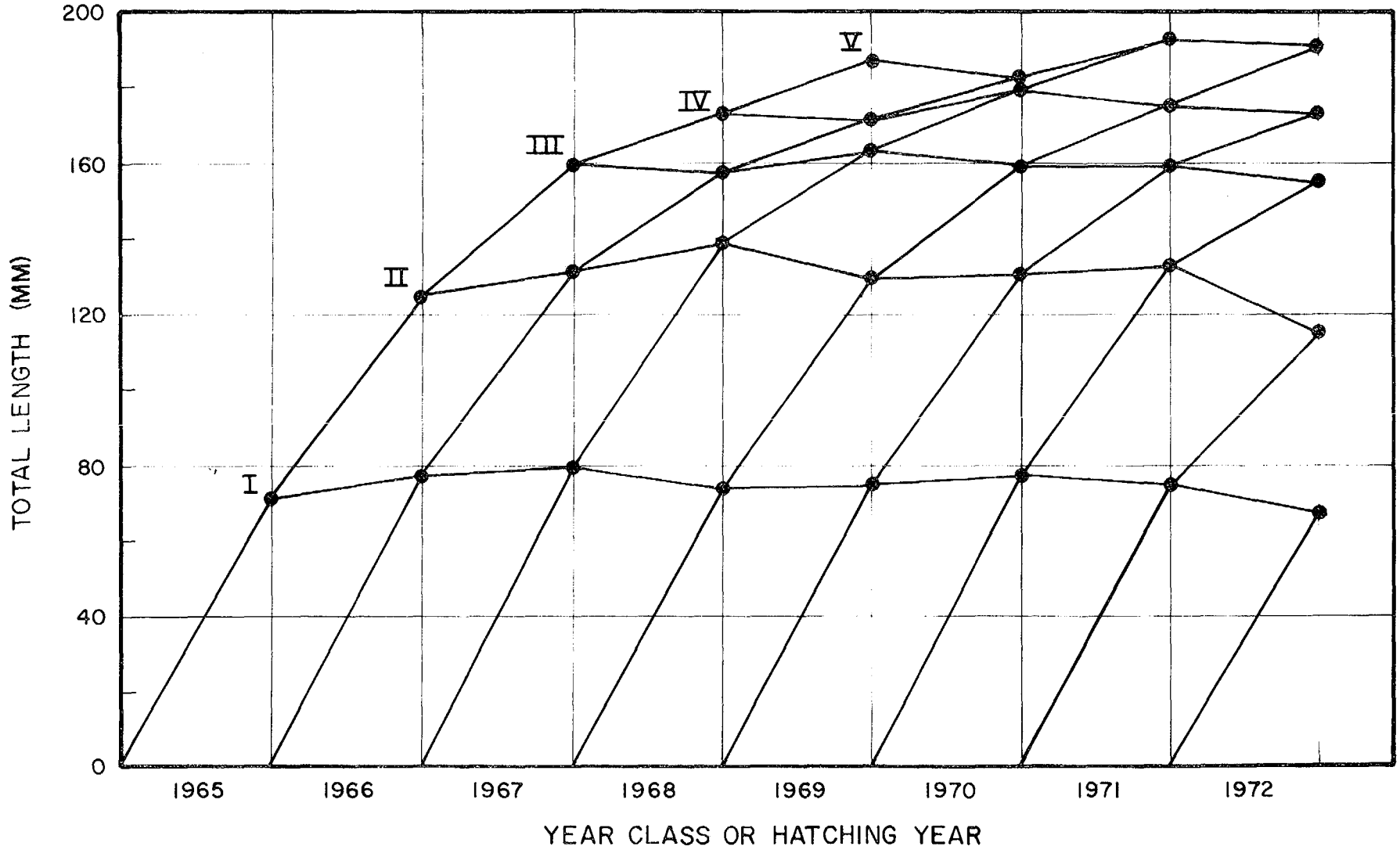


FIGURE VI-30

The fact that young-of-the-year growth rates at Roseton/Danskammer Point were significantly lower than those at Kingston or Bowline may be a function of the relatively low fish support potential of the benthos in this area. The overall abundance and biomass of benthos in the Roseton/Danskammer Point area was lower than values reported in the Kingston and Bowline areas (Quirk, Lawler & Matusky Engineers, 1974).

This suggests that the food supply for fish is relatively low, which may be responsible for reduced growth rates. However, any statement which associates conditions at Roseton/Danskammer Point with growth assumes that the fish spend their first growing season in this area. In other words, the suggestion is made that there are resident white perch at Roseton/Danskammer Point which may overwinter in the lower estuary but which return each year to this area. Additional investigations would be necessary to support such an assumption.

White perch growth rates recorded in several areas of the Hudson River were compared with growth rates found in eleven other aquatic environments (Table VI-20). Data from other investigations were converted from fork length to standard length by the equation SL = 1.31 + 0.83TL (Marcy, 1974). In general, growth rates for white perch in the Hudson River were lower than those found for most other studies, especially in the older age groups.

There was also some indication that white perch were not as long-lived in the Hudson River as in many other areas. Although Texas Instruments, Inc. (1973) showed the presence of fish more than seven years old, there were only six out of 952 fish in this age category. A biological

TABLE VI-20

MEAN CALCULATED STANDARD LENGTHS (mm) AT ANNULUS FORMATION FOR WHITE PERCH BASED ON SEVERAL STUDIES

ROSETON/DANSKAMMER POINT VICINITY

	LOCATION AND REFERENCES				
Annulus Formation	Lake Ontario (Sheri and Power 1966)	Quabbin Reservoir, Massachusettes (Taub, 1966)	Connecticut River (km 199-176; upper) Roger Road (personal communication)	Connecticut River (Km 11-74; lower) (Marcy, 1973)	State of Conn. (Whitworth & Sauter; 1972)
1st	64	74	81	71	73
2nd	105	127	146	148	107
3rd	136	171	177	106	137
4th	156	193	204	211	160
5th	174	209		230	184
6th	187	222		255	202
7th	202	233		282	
8th	219	251			
9th	232	264			
10th	232	273			

	Delaware River Estuary (Miller 1963)	Delaware River near Artificial Is. (Wallace, 1971)	Patuxent River, Maryland (Mansueti, 1961)	James River, Virginia, (St. Pierre and Davis, 1972)	York River, Virginia (St. Pierre and Davis, 1972)
1st	73	68	73	61	64
2nd	117	110	113	99	97
3rd	138	130	135	124	120
4th	153	144	151	144	142
5th	167	154	164	159	159
6th	181	162	181	172	176
7th	193	170	198	186	193
8th	204	174	209	199	209
9th	248		221	214	220
10th	257		241	222	229

	Roanoke River North Carolina (Conover, 1958)	Hudson River Cornwall-Newburgh Bay Mp 56-60 (Texas Instruments, 1972a)	Hudson River Ossining MP 30-35 (Texas Instruments, 1973a)	Hudson River Kingston Vicinity MP 95 (QL&ME, 1973b)	Hudson River Bowline MP 35 (QL&ME, 1974)	Hudson River Roseton MP 65 Present Study
1st	56	62	64	64	64	61
2nd	87	108	112	106	109	104
3rd	120	132	138	126	132	129
4th	146	147	151	138	143	140
5th	168	158	164	149	150	150
6th	188	169	177	155	164	159
7th	204	182	187	156		166
8th	218	175	192			
9th		190	222			
10th						

NOTE: format and conversions to standard length from Marcy (1974).

survey of the lower Hudson River in 1936 collected no fish older than six years old (Greeley, 1973).

Mansueti (1961) stated that the longevity of white perch varies with geographical range, the longest life spans in the north and the shortest in the southern most part of its range. Mansueti felt that length of life was inversely related to the growth rate, and that organisms living in waters with higher average temperatures and longer growing seasons would have a higher growth rate and shorter life span. This generalization is only partially consistent with results from the Connecticut River (Marcy, 1974), and it does not explain the longevity and lower growth rates found for white perch in the Hudson River.

Analysis of growth histories for white perch collected in the York and James Rivers in Virginia showed that while there was little fluctuation in first-year growth, annual growth in all later years of life appeared to have been decreasing since 1961 in both estuaries (St. Pierre and Davis, 1972). This corresponded to the trend found by Mansueti (1961) for the Patuxent River, Maryland. Such a trend, which suggests stunting (Marcy, 1974), is directly opposed to Lee's phenomenon (as defined by Hile, 1936), and St. Pierre and Davis (1972) felt that this may indicate increased competition.

Hudson River growth histories for combined sexes of the 1965-1972 year classes (based on data from Table VI-19) did not show any obvious

trends in white perch growth rates for age groups I-V (Figure VI-30); this was similar to findings by St. Pierre and Davis (1972). As indicated in Figure VI-30, young-of-the-year growth for the years 1965 through 1972 was greatest during the spring and summer of 1967. This trend of greater growth for the 1967 year class extended through the five years of growth shown, indicating that growth in the first year of life is important in determining the length attainment of subsequent age groups throughout the life of the year class.

Young-of-the-year growth for white perch was poorest during the 1972 season. This trend of poor growth also applied to one-year-old fish (1971 year class) and two-year-old fish (1970 year class) during 1972 (Figure VI-30). It is interesting to note that rainfall was very heavy in the spring of 1972, and record freshwater flows were observed in the Hudson River during this time.

Although some fluctuations in white perch growth rates from year to year were found in Roseton/Danskammer Point data, there was no evidence of a consistent decrease in growth from year to year, as found in the York and James Rivers (St. Pierre and Davis, 1972). In a study conducted in 1972 no significant difference in white perch growth rates was noted over the last nine years for the portion of the river from Ossining (mile point 30) to Newburgh Bay (mile point 56) (Texas Instruments, Inc., 1973a). These data suggest that white perch growth rates are fairly stable from year to year in the Hudson River and that there is no discernible trend of decreasing growth which would be indicative of a population undergoing stunting.

There are indications that the white perch population in the Hudson River has exhibited signs of stunting and overcrowding for almost the past half-century. The hypothesis is strengthened by the findings of a 1936 biological study of the Hudson, which reported that the white perch was one of the dominant fish species in the river and that its small size and slow growth rate was probably due to a tendency to overcrowd the capacity of the environment (Curran and Ries, 1937). However, it has already been shown that Hudson River white perch exhibit one of the lowest growth rates of populations studied thus far (Table VI-19), and it is this fact which suggests that they may have already undergone a stunting process and are now stabilized at an equilibrium of minimal growth for the species.

10. Reproduction

(a) Spawning Periodicity. Successful reproduction is an important factor ensuring the survival of a species in the face of adverse environmental conditions, predation and natural mortality. The degree of reproductive success of temperate zone organisms is often dependent upon accurate timing of the reproductive cycle. Certain times of year are more favorable than others for reproductive success of the various species. The annual reproductive cycle must be such that young are produced, or begin to develop when favorable conditions exist.

The period from April through June (spring) is primarily associated with fish spawning. This period is characterized by increasing concentrations of phytoplankton and zooplankton, by the emergence of insect larvae and adults, and by growth and reproduction of benthic organisms. Thus, a rich and diverse food supply is available for young fish produced in the spring. In order to exploit the food supply to the fullest, and increase reproductive success, it is advantageous for spawning to occur at a time when food supply is increasing and at an optimal value when needed.

Fish larvae do not actively feed for several days after hatching but obtain nutrients from an attached yolk sac. However, the larvae must begin feeding once the yolk sac nutrients have been exhausted. The yolk sac of white perch and striped bass are assimilated within four to seven days of hatching (Mansueti, 1964; Humphries and Cumming, 1972). The transition from yolk feeding to active feeding has been described as the "critical period" for larvae (Bagenal and Braum, 1971), since many larvae fail to survive this relatively rapid transition (Shelbourne, 1957; Bishai, 1960; Morris, 1955).

The presence of accurately timed daily and annual cycles in nature which persist in spite of altered or unpredictable environmental stimuli has led to the concept of the internal biological clock. This physiological clock is an innate timing mechanism which regulates much of the overt behavior of plants and animals on a daily and seasonal basis. The controlling element in the development and maintenance of the timing mechanism has been identified variously as temperature, tidal cycles, day length, or salinity cycles in the environment. Whether acting alone or together, these and other cyclically fluctuating environmental stimuli preserve the accurate yearly timing of fish reproduction.

(i) White Perch

The white perch spawning period in 1973, shown in comparison with spawning periods in 1971 and 1972 in Figure VI-31 was constructed by plotting the gonad weight, expressed as a percentage of the body weight (coefficient of maturity), against time. The actual time of spawning corresponds to the descending portion of the curve.

The figure shows the cyclic aspects of white perch reproduction and the relationship to temperature and photoperiod (measured in hours and minutes between dawn and sunset). Spawning occurred when temperatures (°F) were in the 60's or 70's in all three years. At that time day length was approaching the yearly maximum (Figure VI-31).

Although little winter work was done in the upper reaches of the river, investigations in the area of Haverstraw Bay (mile point 36) during 1971 and 1972 (Quirk, Lawler & Matusky Engineers, 1974) showed that the white perch spawning cycle generally commenced with a period of gonadal quiescence marked by very low coefficients of maturity, lasting for approximately three months after spawning. This was followed by an increasing coefficient of maturity of both sexes. The maturation cycle began in October and November and continued through the winter until the following spring, around June, when spawning occurred. The 1973 data shown in Figure VI-31 appears to follow this general trend.

WHITE PERCH REPRODUCTIVE CYCLE AT ROSETON & DANSKAMMER DURING 1971 - 1973 SPAWNING SEASONS

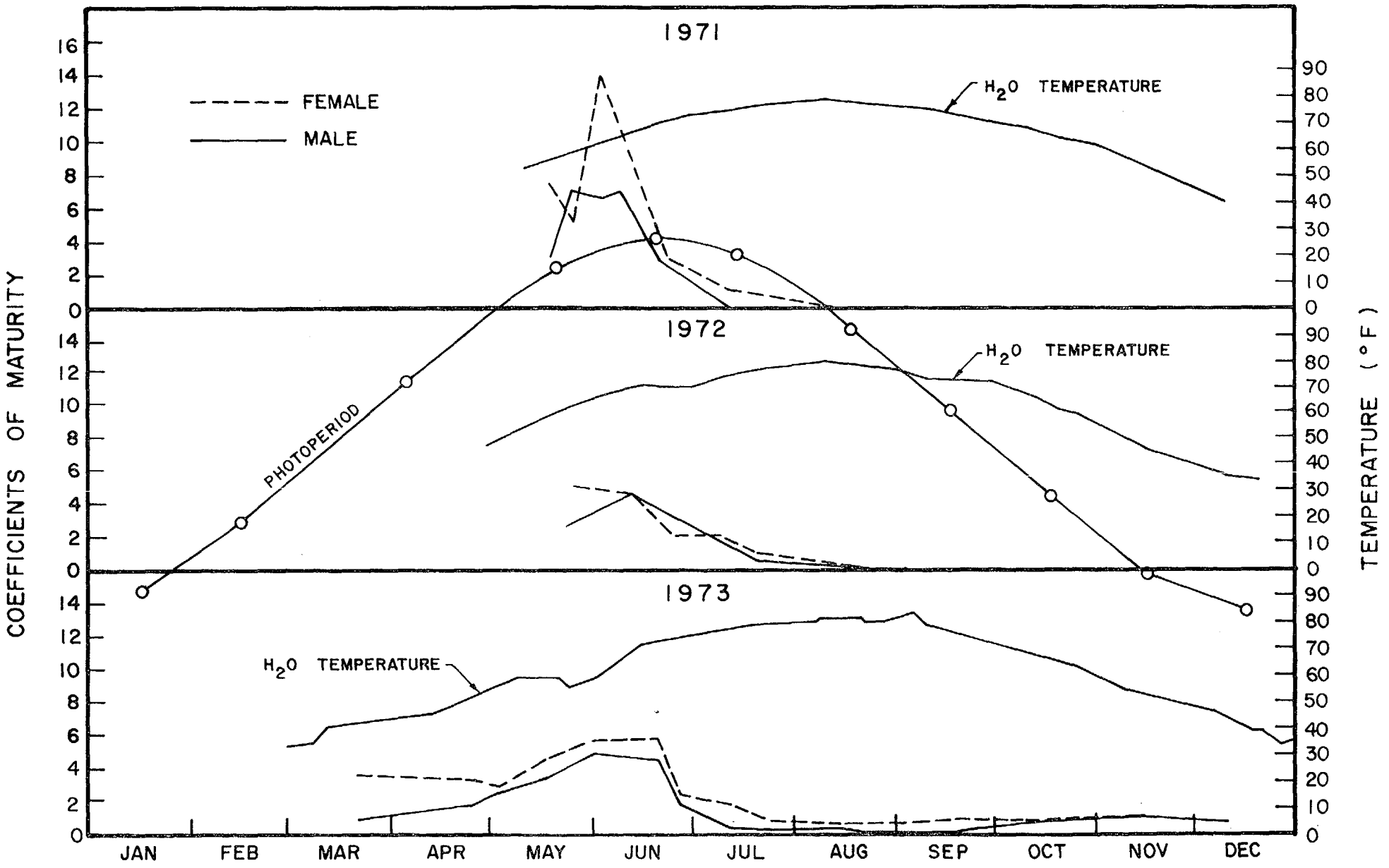


FIGURE VI-31

The initiation of white perch spawning in Haverstraw Bay was estimated to have occurred between May 25 and June 1, 1971, and between June 1 and June 5 during the 1972 season (Quirk, Lawler & Matusky Engineers, 1974). Spawning in the Roseton/Danskammer Point area during 1971 and 1972 seemed to have begun about a week later than in Haverstraw Bay and spawning during 1973 at Roseton did not reach a peak until after June 20. The difference in timing for the initiation of spawning between Roseton (mile point 65) and Haverstraw Bay (mile point 36) may be due to a time lag in the spawning migration of white perch from the lower estuary.

White perch spawning at Roseton/Danskammer Point occurred from early June through mid-July when water temperatures ranged between 61 and 75°F. This species spawns at approximately the same time in the Delaware River (Miller, 1963) and in Lake Ontario (Sheri and Power, 1968). In the Chesapeake Bay area white perch spawn from early April through May when water temperatures range from 54°F to 63°F (Mansueti, 1961). Delaware River white perch spawn at water temperatures of 68°F to 77°F (Miller, 1963). Differences in temperature and times of spawning within this range of geographical areas suggests that factors other than temperature and day length influence the timing of white perch spawning.

(b) Fecundity. An important facet of fish reproduction is fecundity, which is often defined as the total number of mature eggs spawned per female during the season studied. In addition to being a necessary input for mathematical modelling of fish populations, fecundity may

reflect physical and biological conditions in the environment. Blaxter (1969) stated that considerable intra-specific variations in fecundity from year to year, almost certainly related to environmental effects, are well established in the literature. Rounsefell (1957), for example, noted that higher temperatures resulted in lower fecundities; Bagenal (1966) reported that high population densities were correlated with low fecundity, and Scott (1961) indicated that insufficient food supply caused a reduction in egg count.

Fecundity analyses were carried out using gravimetric and volumetric methods. Estimates of egg numbers were determined for 25 tomcod (gravimetric method) and for five individuals of each of the following species: white perch, blueback herring and alewife (volumetric method).

(i) White Perch

Fecundity data from five white perch collected from the Roseton/Danskammer Point area and fecundity estimates for white perch of identical sizes collected during other studies are presented in Table VI-21. The Roseton/Danskammer Point data are limited by the small sample size; however, these may be considered with respect to data from other sources.

White perch fecundity was correlated with the equation: $F = 10^{a + bX}$ which on a $\log_{10}$ basis transforms to: $\log F = a + bX$. This equation was used by both Sheri and Power (1968) and Texas Instruments, Inc. (1972) for similar correlations on data from the Lower Hudson River and Lake Ontario, respectively.

TABLE VI-21
FECUNDITY ESTIMATES: WHITE PERCH, BLUEBACK HERRING AND ALEWIFE
ROSETON/DANSKAMMER POINT VICINITY

A. WHITE PERCH

Date of Capture	Total Length of Fish (mm)	FECUNDITY ESTIMATE		
		Hudson River Roseton (QL&M, 1973a)	Hudson River* (Milepoint 40-60) (Texas Instr., 1972)	Lake Ontario+ (Sheri and Power, 1968)+
5/3/73	189	64343	59310	32660
5/3/73	191	115805	61500	33300
6/15/73	190	48877	60400	32660
6/15/73	190	39132	60400	32660
6/15/73	200	60275	72400	40180

* Estimate based on log # eggs = 3.2836 + 0.007881 (total length in mm) $\begin{bmatrix} n=27 \\ r=0.86 \end{bmatrix}$

† Estimate based on log # eggs = 2.912 + 0.009 (fork length in mm) [r=0.82] n=50

B. BLUEBACK HERRING

Total Length of Fish (mm)	Fecundity Estimate			
	Roseton (QL&M, 1973a)	Connecticut River (Loesch, 1969)		
	All eggs ±0.3mm diam.	Total eggs in ovaries	Eggs retained after spawning	Total eggs spawned
294	159077	222000	52500	169500
298	167540	230000	56730	173270
301	131196	255400	59830	195570
307	123798	246800	57750	189050
312	158833	242450	56735	185715

C. ALEWIFE

Total Length of Fish (mm)	Fecundity Estimate			
	Roseton (QL&M, 1973a)	Connecticut River *Kissel, 1969)		
	All eggs 0.3mm diameter	Total eggs in ovaries	Eggs retained after spawn.	Tot. eggs Sp.
				<44,403
202	154375	46840.7	2432.92	**44,403**
249	69932	164654.5	18742	145,913
275	128769	228092.7	27521.12	200,572
289	118388	250749.2	30656.52	220,093
294	162754			

Fecundity values for three white perch collected at Roseton/Danskammer Point on June 15 were substantially lower than fecundity estimates for similar size fish based on May 1972 data (Texas Instrument, Inc., 1972). Figure VI-31 indicates that 1973 white perch spawning occurred about one week later than in 1972. The lower fecundity values observed on June 15, 1973 suggest that spawning may have begun prior to this collection. Fish collected prior to spawning in 1972 (Texas Instrument, Inc., 1972) had higher fecundity values than those determined for fish caught in June 1973.

The two white perch collected on May 3, 1973 had higher fecundity values than larger fish collected in June 1973. These values were also higher than values calculated for fish of identical sizes in 1972 (Table VI-21). This further supports the suggestion that spawning began before the June 15 collection. Fecundity of Lake Ontario white perch (Sheri and Power, 1968) was generally lower than that reported for Hudson River white perch.

(ii) Blueback Herring

Fecundity estimates for blueback herring collected at Roseton/Danskammer Point are similar to those predicted by Loesch (1969) for bluebacks in the Connecticut River (Table VI-21). Variation in ova production for individual fish on the Connecticut River ranged from 45,800 (238 mm fish) to 349,700 (310 mm fish). The range for retained eggs was 9,300 (253 mm fish) to 107,600 (297 mm fish). These figures on egg retention show that unspawned and resorbed eggs are a significant part of fecundity estimates.

Although an egg retention study of bluebacks was not conducted for fish collected at Roseton/Danskammer Point, only those eggs larger than 0.3 mm in diameter were counted. This method may not account for all egg retention, since spawned blueback eggs are approximately 1.0 mm in diameter (Bigelow and Schroeder, 1953). An interesting fact of Loesch's work on the Connecticut River was that egg production and retention increased with fish size through the 296 to 305 mm size interval, then notably declined, emphasizing the importance of recognizing fish size and age as functions in production estimates.

(iii) Alewives

Fecundity estimates for alewives collected in the Roseton/Danskammer Point area are presented in Table VI-21 in comparison with estimates for alewives collected in the Connecticut River (Kissel, 1969). The Connecticut River data account for egg retention and reflect fecundity of generally larger alewives than were analyzed from the Hudson River. High mortality is a factor generally associated with high fecundities such as those found for blueback herring and alewife.

Kissel (1969) determined that out of 80,000 spawned alewife eggs, one young fish survived to leave the spawning grounds in the Connecticut River. This represents a combined freshwater mortality of 99.9987% which is higher than the freshwater mortality estimated for salmonids with large eggs and low fecundities.

Comparison of the anadromous alewife along the Atlantic coast with alewife from Lake Michigan (Norden, 1967) showed that fecundity of the landlocked fish was considerably less than that of the anadromous populations. Norden reported that the number of eggs produced per female ranged from 11,147 (160 mm fish) to 22,407 (192 mm fish), and that lower fecundities were due to the smaller size of lake alewives compared to their anadromous counterparts. For example, age class VI females from Lake Ontario averaged 157 mm in length while females of the same age class from Atlantic populations averaged 248 mm (Graham, 1956).

(iv) Tomcod

Fecundity values were determined for 25 tomcod collected in the Roseton/Danskammer Point area on December 20 and 28, 1972 (Table VI-22). These fish ranged from 118 to 216 mm in length, from 19.9 to 111.0 gm in weight, and the number of eggs ranged from 1,798 to 24,850. Tomcod fecundity and length data were described by the equation: $\log F = 2.776 + 0.008X$ ($r = 0.73$), while fecundity and weight relationships were expressed by $\log F = 3.593 + 0.009X$ ($r = 0.79$). Each equation indicates that fecundity increases with an increase in length or weight.

Fecundity data from twelve tomcod collected in the Haverstraw Bay in December 1972 (Quirk, Lawler & Matusky Engineers, 1974) were based on fish lengths and weights ranging from 115 to 154 mm and from 11.7 to 34.0gm, respectively. Egg counts ranged

TABLE VI-22

FECUNDITY ESTIMATES: TOMCOD
ROSETON/DANSKAMMER POINT VICINITY

Length (mm)	Fish Weight (gms)	Ovary Weight (gms)	Number of Eggs	Log Number of Eggs
118	19.9	4.39	5667	3.75
123	20.0	3.13	5331	3.73
128	24.0	3.33	7609	3.88
135	27.3	7.23	10191	4.01
140	28.5	7.94	8673	3.94
140	25.0	3.23	1798	3.26
144	33.6	6.87	6689	3.83
147	35.9	8.60	8213	3.92
147	31.9	6.94	8503	3.93
147	36.7	9.23	8454	3.93
147	37.9	9.01	8303	3.92
148	38.4	8.84	10064	4.00
148	32.7	6.70	6578	3.82
153	28.7	5.14	3967	3.60
153	46.5	15.46	14520	4.16
157	38.3	9.70	14135	4.15
159	51.1	13.37	14459	4.16
159	42.8	11.23	9344	3.97
168	60.1	21.17	16854	4.23
171	64.8	19.85	19066	4.28
172	61.8	15.93	16171	4.21
190	68.2	21.41	17458	4.24
198	87.6	27.00	22592	4.35
200	83.2	23.74	16830	4.23
216	111.0	31.48	24850	4.40

Number of Fish	Mean Fish Length (mm)	Mean Egg Count	Range Egg Count
25	1563	11450.2	1798-24850

Regression Equations

length: $\log F = 2.776 + 0.008X$ ($r = 0.732$); F = No. Eggs, X = length, mm.

weight: $\log F = 3.594 + 0.009X$ ($r = 0.794$) F = No. Eggs, I = weight, gms.

from 1,348 to 11,437. The relationship between fecundity and length was expressed by the equation: log F = 2.05 + 0.1X (r = 0.53) and the relationship between fecundity and weight was log F = 3.10 + 0.02X (r = 0.61).

Sample sizes for both collections were small, and so these data were pooled to provide a broader data base. The relationship between fecundity and length for the combined data was expressed as log F = 2.285 + 0.011X (r = 0.77) and between fecundity and weight as log F = 3.413 + 0.012X (r = 0.81) and are shown in Figure VI-32. The rate of increase in fecundity was similar whether based on length or weight.

Fecundity values were similar for tomcod collected at Roseton/Danskammer Point and from Haverstraw Bay. Fish from Haverstraw Bay were collected two to three weeks earlier and were generally smaller than the fish collected at Roseton/Danskammer Point. Mean length of the Haverstraw Bay tomcod was 131 mm while the mean length for those collected at Roseton/Danskammer Point was 156 mm. Schaner and Sherman (1960) reported that Massachusetts tomcod averaging 217 mm in length contained an average of 22,129 eggs.

11. Stomach Content Analysis

The trophodynamic aspect of ecology, as advanced by Lindeman (1942), emphasizes the flow of energy through an ecosystem in the form of nutrients. Evaluation of the stomach contents of fish which are normally

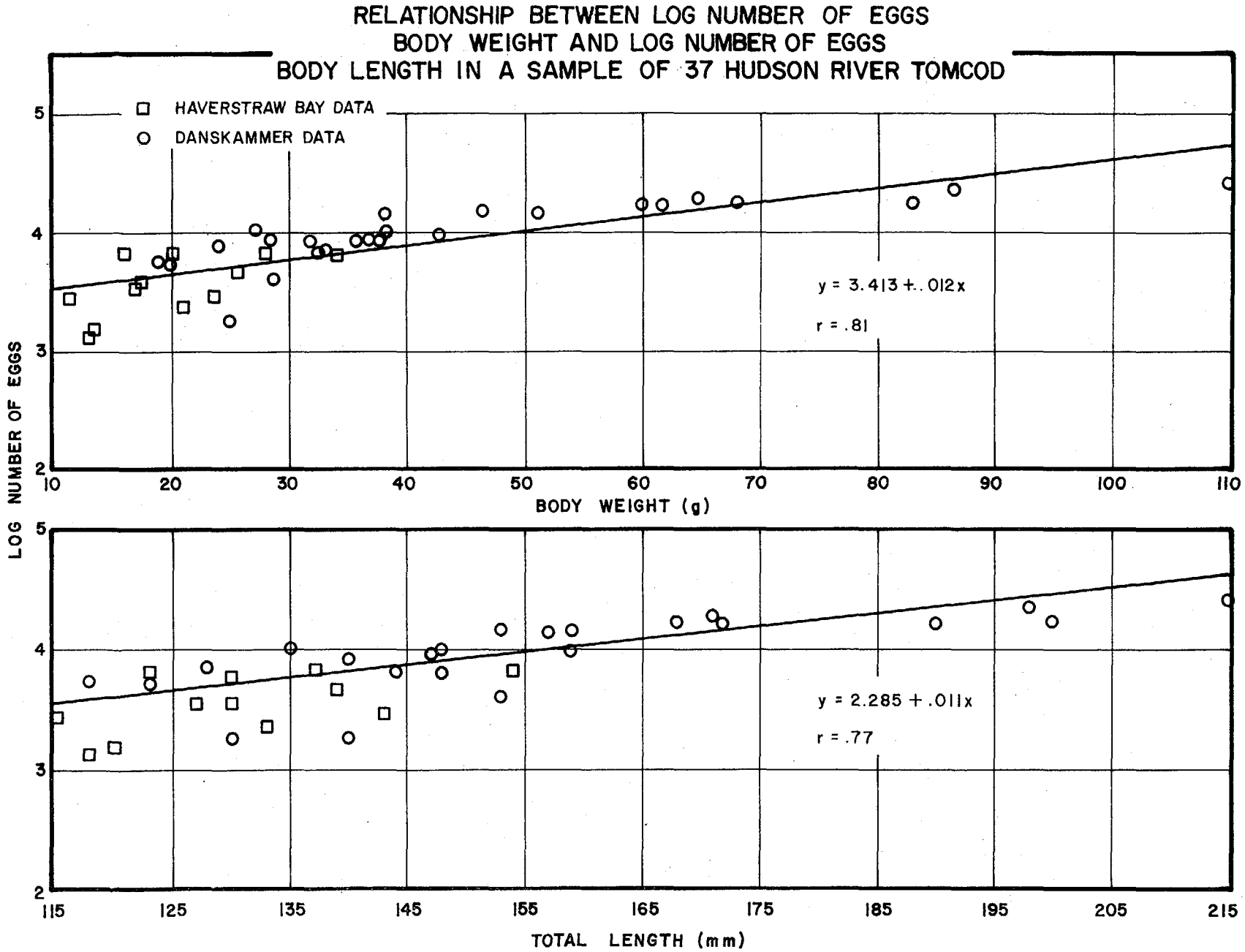

RELATIONSHIP BETWEEN LOG NUMBER OF EGGS
BODY WEIGHT AND LOG NUMBER OF EGGS
BODY LENGTH IN A SAMPLE OF 37 HUDSON RIVER TOMCOD
HAVERSTRAW BAY DATA
DANSKAMMER DATA
y = 3.413 + .012x
r = .81
LOG NUMBER OF EGGS
BODY WEIGHT (g)
y = 2.285 + .011x
r = .77
TOTAL LENGTH (mm)

FIGURE VI-32

members of the highest trophic level can be useful in confirming this energy flow and the production potential of the ecosystem (Windell, 1971). In addition, food preference and feeding habits may be a valuable tool in assessing the population dynamics of a given dietary group such as plankton, benthos, or other fish populations, and their impact on the distribution of the fish populations.

Four fish species were selected for stomach analysis on a seasonal basis; these were white perch, striped bass, brown bullhead, and pumpkinseed. These four species constituted the major members of the resident fish community in the Roseton/Danskammer Point area.

Stomach analysis collections were conducted separately from the standard ecological surveys and all fish collected were analyzed within 48 hours of collection. Between collection and analyzing, the fish were frozen to retard the digestive process.

The populations investigated were sub-divided by seasons (spring and fall) length intervals to evaluate feeding preference differences for different age groups. The length groups were:

	SIZE INTERVAL, CM		
SPECIES	I	II	III
White perch	0.1-10.0	10.1-17.0	>17.1
Striped bass	0.1-12.0	12.1-30.5	>30.6
Pumpkinseed	0.1-12.0	12.1-16.0	>16.1
Brown bullhead	0.1-10.0	10.1-20.0	>20.1

(a) White Perch

(i) Spring

The dominant food item consumed by the 49 white perch analyzed was amphipods which composed 93.0% of the total identified food volume (Table VI-23). Dipteran larvae composed 3.5% of the identified volume.

White perch of size interval I consumed primarily dipterans and trichopterans. When combined these totaled 11.5% of the total food volume, with amphipods composing 5.7%. More than 60% of fish of size intervals II and III had amphipods in their stomachs; this component equalled approximately 60% of the total volume.

(ii) Fall

Amphipods were the dominant food item consumed by 36 white perch of all size ranges (Table VI-24) and were observed in 94.4% of the stomachs, where they composed 90.7% of the total identified food volume. Unidentified fish remains amounted to 5.5% of the identified food volume, but were observed only in fish of size interval III.

Copepods were found in 29.4% of white perch of interval I, but were not observed as frequently in the larger fish. Of the 24 fish of size interval II from both the spring and fall collections, copepods were observed in only two. Copepods were not found in any of the 20 size interval III fish. The larger white perch appeared to select larger food items, primarily amphipods and forage fish.

TABLE VI-23

STOMACH CONTENT ANALYSIS: WHITE PERCH - SPRING 1973

ROSETON/DANSKAMMER POINT VICINITY

ORGANISM	SIZE GROUP 1		SIZE GROUPII		SIZE GROUP III		TOTAL	
	Volume, ml	% Total	Volume, ml	% Total	Volume, ml	% Total	Volume, ml	% Total
Amphipoda	0.07	31.8	3.6	93.7	2.2	97.4	5.87	93.0
Isopoda	0.0	0.0	0.11	2.9	0.0	0.0	0.11	1.7
Copepoda	0.01	4.5	-	-	0.0	0.0	-	-
Unidentified Crustacean Eggs	-	-	0.0	0.0	0.0	0.0	-	-
Diptera	0.09	40.9	0.10	2.6	0.03	1.3	0.22	3.5
Odonata	0.0	0.0	0.0	0.0	0.03	1.3	0.03	0.5
Trichoptera	0.05	22.7	0.03	0.8	0.0	0.0	0.08	1.3
Oligochaeta	-	-	-	-	0.0	0.0	-	-
Pelecypoda	0.0	0.0	-	-	0.0	0.0	-	-
Nema	0.0	0.0	-	-	0.0	0.0	-	-
TOTAL	0.22	99.9	3.84	100	2.26	100	6.32	100

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TABLE VI-24

STOMACH CONTENTS ANALYSIS: WHITE PERCH - FALL 1973
ROSETON/DANSKAMMER POINT VICINITY

ORGANISM	SIZE GROUP I		SIZE GROUP II		SIZE GROUP III		TOTAL	
	Volume,ml	% Total	Volume ml	% Total	Volume ml	% Total	Volume ml	% Total
Pisces	0.0	0.0	0.0	0.0	0.60	18.4	0.60	5.5
Amphipoda	1.35	89.4	5.90	96.9	2.60	79.8	9.85	90.7
Copepoda	0.15	9.9	-	-	0.0	0.0	0.15	1.4
Isopoda	0.01	0.7	0.17	2.7	0.02	0.6	0.20	1.8
Ostracoda	-	-	0.0	0.0	0.0	0.0	-	-
Cladocera	-	-	0.0	0.0	0.0	0.0	-	-
Diptera	-	-	0.01	0.2	0.04	1.2	0.05	0.5
Odonata	0.0	0.0	0.01	0.2	0.0	0.0	0.01	0.1
Oligochaeta	-	-	-	-	0.0	0.0	-	-
Pelecypoda	0.0	0.0	-	-	0.0	0.0	-	-
Gastropoda	0.0	0.0	0.0	0.0	-	-	-	-
Nema	0.0	0.0	-	-	0.0	0.0	-	-
TOTAL	1.51	100	6.09	100	3.26	100	10.86	100

Quirk, Lawler & Matusky Engineers

A spring and fall food content comparison using the index of similarity (see Kontkanen, 1957) showed a percent volume similarity of 93.0%. Comparisons were also made for the seasonal food habits of the three different size ranges. The diets of size interval I white perch were only 36.3% similar, which may be attributed to the greater volume of dipterans consumed in the spring than in the fall. Fish of size interval II were 96.6% similar in their volumetric consumption while size interval III fish showed an 81.0% similarity.

(b) Brown Bullhead

(i) Spring

Brown bullhead displayed varied feeding habits that appeared to be influenced by the availability of prey. Stomach analysis of size interval I bullhead indicated that dipterans and amphipods composed 55.6% and 27.8% of the identified food volume, respectively (Table VI-25). Odonata and oligochaetes composed 13.9% of the identified volume.

Bullheads of size interval III collected in June showed approximately the same food habits as the smaller fish, having fed primarily on amphipods and dipterans. Stomachs of interval III fish collected in July contained young-of-the-year fish. Blueback herring and Morone spp. contributed 96.7% of the total volume.

TABLE VI-25

STOMACH CONTENT ANALYSIS: BROWN BULLHEAD - SPRING 1973

ROSETON/DANSKAMMER POINT VICINITY

ORGANISM	SIZE GROUP I		SIZE GROUP II		TOTAL	
	Vol.,ml	% Total	Vol.,ml	% Total	Vol,ml	% Total
Alosa aestivalis	0.0	0.0	11.20	96.3	11.20	93.4
Morone sp.	0.0	0.0	0.4	3.4	0.4	3.3
Fish eggs	0.01	2.8	0.0	0.0	0.01	0.1
Amphipoda	0.10	27.8	0.0	0.0	0.10	0.8
Isopoda	-	-	0.0	0.0	-	-
Diptera	0.20	55.6	0.01	0.1	0.21	1.8
Odonata	0.03	8.3	0.0	0.0	0.03	0.3
Trichoptera	-	-	0.0	0.0	-	-
Oligochaeta	0.02	5.6	0.02	0.2	0.04	0.3
Pelecypoda	-	-	0.0	0.0	-	-
TOTAL	0.36	100.1	11.63	100	11.99	100

(ii) Fall

Oligochaetes, both by number and volume, were the most important prey of size interval II brown bullhead, for which they composed 13.9% of the total food volume, whereas dipterans amounted to 4.8%.

Bullheads of size interval III consumed primarily amphipods which were observed in 60.0% of the stomachs and composed 26.4% of the total food volume. Oligochaetes and dipterans constituted the remaining 8.8% of the total food volume which could be identified. Fish, which were an important food item in the spring, were not found in any stomachs from the fall collection.

A comparison of spring and fall food consumption of the brown bullhead indicates 2.9% similarity. Bullheads of size interval II had diets that were 31.7% similar, which could be attributed to variations in the consumption of insects and crustaceans between spring and fall. Size interval III bullhead show dissimilar diets (0.3%). The total length of brown bullhead appeared to be an important factor in their July feeding behavior, since only size interval III individuals consumed forage fish.

(c) Pumpkinseed

(i) Spring

Pumpkinseed of size interval I fed primarily on dipteran larvae which occurred in 72.7% of the stomachs and amounted to 30.8% of the total food volume (84.9% of the identified volume) (Table VI-26).

TABLE VI-26

STOMACH CONTENTS ANALYSIS: PUMPKINSEED - SPRING 1973
ROSETON/DANSKAMMER POINT VICINITY

ORGANISM	SIZE GROUP I		SIZE GROUP II		SIZE GROUP III		TOTAL	
	Volume, ml	% Total	Volume, ml	% Total	Volume ml	% Total	Volume, ml	% Total
Amphipoda	0.15	9.4	1.30	48.0	0.0	0.0	1.45	26.4
Copepoda	0.0	0.0	-	-	0.0	0.0	-	-
Isopoda	0.0	0.0	0.07	2.6	0.0	0.0	0.07	1.3
Diptera	1.35	84.9	0.90	33.2	0.0	0.0	2.25	40.9
Coleoptera	0.0	0.0	0.01	0.4	0.1	8.3	0.11	2.0
Odonata	0.05	3.1	0.02	0.7	0.0	0.0	0.07	1.3
Acari	-	-	0.05	1.8	0.0	0.0	0.05	0.9
Oligochaeta	-	-	0.01	0.4	0.0	0.0	0.01	0.2
Gastropoda	0.01	0.6	0.35	12.9	1.9	91.7	1.46	26.5
Hydra	0.03	1.9	0.0	0.0	0.0	0.0	0.3	0.5
TOTAL	1.59	99.9	2.71	100	1.2	100	5.50	100

Quirk, Lawler & Matusky Engineers

Amphipods were second in importance, composing 3.4% of the total food volume. Small quantities of Odonata and gastropods were also consumed.

Size interval II fish consumed primarily amphipods, dipterans and gastropods. Of the ten stomachs containing food, 50.0% had amphipods, while 30.0% had dipterans and gastropods. Amphipods and dipterans made up 23.8% and 16.5% of the total food volume, respectively.

There were only two pumpkinseeds in size interval III and their stomachs contained primarily gastropods and coleopterans.

(ii) Fall

Amphipods and dipterans were most abundant volumetrically (35.1%) in the diet of size interval I fish, while gastropods and dipterans were most abundant in size interval II fish (55.6%).

Dipterans were the most frequent food item in pumpkinseed size interval I fish, occurring in 42.9% of the stomachs. Gastropods (60.0%) were the most frequently observed food items for fish of size interval II. There was only one fish belonging to size interval III; stomach analysis revealed only unidentified material.

When all size ranges are considered together, a comparison between spring and fall feeding shows a 91.7% similarity in percent volume consumed. Interval I fish show a 47.0% similarity between seasonal food habits and interval II, a 64.0% similarity.

Pumpkinseeds subsisted primarily on various crustaceans, insects and molluscs. The volume of each of these food items depended on the season and size interval considered. There does not appear to have been any relationship between fish length and size of prey.

(d) Striped Bass

(i) Spring

All striped bass collected in July were of size interval II. Fish were the major food items, occurring in 62.5% of the stomachs. Unidentified members of the family Clupeidae (Alosa) were the only fish observed, representing 86.6% of the total food volume and 99.9% of the identified food volume (Table VI-27). Amphipods, copepods, dipterans, oligochaetes and nematodes were consumed but their combined volumes amounted to less than 0.1% of the total food volume.

(ii) Fall

With the exception of one fish, all striped bass collected in October were young-of-the-year fish, size interval I (Table VI -28). The only striped bass of size interval II had unidentifiable stomach contents.

Amphipods and copepods were the dominant prey of size interval I striped bass, each having occurred in 42.1% of the stomachs containing food. The combined volume of crustaceans amounted to 43.6% of the total identified food volume. Although unidentified fish remains formed most of the food volume (52.3%), they were found in the stomach of only one striped bass.

TABLE VI-27

STOMACH CONTENT ANALYSIS: STRIPED BASS - SPRING 1973

ROSETON/DANSKAMMER POINT VICINITY

	SIZE GROUP II	
ORGANISM	Volume, ml	% Total
Pisces, Alosa aestivalis	10.0	99.9
Amphipoda	-	-
Copepoda	-	-
Diptera	-	-
Oligochaeta	-	-
Nematoda	-	-
TOTAL	10.0	99.9

TABLE VI-28

STOMACH CONTENT ANALYSIS: STRIPED BASS - FALL 1973

ROSETON/DANSKAMMER POINT VICINITY

	SIZE GROUP I		SIZE GROUP II		TOTAL	
ORGANISM	Volume ml	% Total	Volume, ml	% Total	Volume, ml	% Total
Pisces, Unidentified	0.9	52.3	0.0	0.0	0.90	13.4
Pisces, *Morone americana*	0.0	0.0	5.0	100	5.00	74.4
Amphipoda	0.40	23.3	0.0	0.0	0.40	6.0
Copepoda	0.35	20.3	0.0	0.0	0.35	5.2
Ostracoda	-	-	0.0	0.0	-	-
Crustacean Eggs	-	-	0.0	0.0	-	-
Diptera	0.02	1.2	0.0	0.0	0.02	0.3
Odonata	-	-	0.0	0.0	-	-
Oligochaeta	0.05	2.9	0.0	0.0	0.05	0.7
TOTAL	1.72	100	5.0	100	6.72	100

The results of striped bass stomach analysis suggests that the type of food ingested depends on fish length. Amphipods and copepods were important as food items to striped bass of size interval I; while fish prey was the preferred food of size interval II striped bass. Seasonal influence on striped bass feeding was not accounted for because of catches of different size intervals in each season.

D. FISH IMPINGEMENT STUDIES

1. Introduction and Study Objectives

The impingement of fish on the travelling screens of power plants has generated concern regarding the impact of impingement on the fish populations. These concerns are related to both the total numbers of fish impinged and the viability of fish returned to the water body. To put the impact of impingement in proper perspective, the total numbers of fish in the fish population in the waterbody in question must also be considered.

The fundamental objective of the studies presented herein was to determine the species and numbers of fish impinged at the Roseton and Danskammer Point plants during the course of an annual seasonal cycle. The resulting data was to be used in assessing the impact of the Danskammer Point plant, and of the Roseton plant after commercial operation, and the combined impact of these power plants on the Hudson River. Preliminary viability estimates and a preliminary analysis of the impact of impingement are based on the results of these studies.

Data collected at the Roseton plant are limited. This plant was not operational in 1973 and impingement studies were conducted only when operation of the circulating water pumps would not interfere with plant construction or peak power demands.

2. Materials and Methods

The fish impingement studies conducted in 1973 dealt with samples collected from the travelling screen wash at each plant and the methods and materials used for sampling were as for river fish and are presented earlier in this chapter.

(a) Plant Collections. Sampling procedures at each plant consisted of one collection every alternate week at 2-hour intervals over a 24-hour period. The samples were collected from the travelling screen wash discharge at each plant.

(i) Roseton

Samples were collected from the screen wash discharge sluiceway at Unit 2. Each of the four Unit 2 travelling screens was washed, and a combined sample was collected.

(ii) Danskammer Point

Two screen wash discharge sluices exist at the Danskammer Point plant; one from Units 1 & 2 and one from Units 3 & 4. The Unit 1 & 2 sluice draws from a total of six travelling screens (3 per unit) and the Unit 3 & 4 sluices draw from a total of six travelling screens (3 per unit).

(b) Laboratory Analysis. Laboratory analysis of each impinged fish sample consisted of identification, enumeration, length and weight, determination of sex, maturity, age and growth characteristics. These procedures are discussed earlier in this chapter.

(c) Data Analysis. The resulting data were analyzed to investigate the following:

(1) species composition of impinged fish;

(2) monthly impingement rate estimates;

(3) comparison of impingement rates at Danskammer Point Units 1 & 2 and Units 3 & 4;

(4) comparison of day and night impingement rates;

(5) ebb-flood comparisons;

(6) river and plant comparisons of relative abundance, relative condition factors, length-weight equations, species diversity and length distribution;

(7) an estimate of the impact of impingement of fish on the river population.

Where appropriate, data from the 1972 impingement study at Danskammer Point are compared with the 1973 data. Where sample sizes were sufficient, the data were analyzed by a variety of statistical techniques (summarized in Appendix I-A) to determine significant differences.

3. Results and Discussion

(a) Species Composition. Numbers and species of fish collected in 1973 are shown for Roseton and Danskammer Point in Tables VI-29 and VI-30, respectively. A species inventory of fish impinged at Danskammer Point in 1973 is presented in Table VI-31. Changes in the ranked abundance of the most prevalent species in Danskammer Point impingement collections are shown in Table VI-32.

The predominant species in Danskammer Point impingement collections from January through December, 1973 was the Atlantic tomcod which composed 76.0% of the total annual catch. This was an increase from 1972 when tomcod made up only 32.1% of the total catch. This increase was also evident in the estimated numbers of impinged tomcod noted in Tables VI-33 and VI-34. Based on monthly percent composition values for 1973 (Tables VI-29) and 1972 (QLM, 1974), the estimated number of tomcod impinged during 1972 was 134,111 fish; the estimate for 1973 was 815,563 tomcod. This indicates that there may have been a substantial increase in tomcod abundance in the Danskammer Point area between 1972 and 1973. However, comparison of river abundance between years was not possible because in 1973 99.3% of the tomcod impinged were collected during January, February and March when river sampling was not feasible due to ice conditions.

White perch, which ranked first in abundance and constituted 32.7% of the total Danskammer Point impingement catch during 1972, ranked third and made up only 6.8% of the total catch in 1973. The estimated number of impinged white perch during 1972 was 136,617 fish; the estimate for 1973

TABLE VI-29

ROSETON IMPINGEMENT COLLECTIONS
1973 - MONTHLY AVERAGE SPECIES COMPOSITION

SPECIES	SCIENTIFIC NAME	July		August		September		October		November		December		TOTAL	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
White Perch	*Morone americana*	11	22.0	475	40.8	976	46.6	6328	41.8	937	51.0	71	18.4	8798	42.5
Blueback Herring	*Alosa aestivalis*			131	11.2	340	16.2	6571	43.4	633	34.5	1	0.3	7676	37.1
Alewife	*Alosa pseudoharengus*	13	26.0	426	36.6	263	12.5	690	4.5	43	2.3			1435	6.9
Bay Anchovy	*Anchoa mitchilli*			25	2.1	434	20.7	789	5.2					1248	6.0
Striped Bass	*Morone saxatilis*	1	2.0	40	3.4	20	0.9	309	2.0	34	1.8	12	3.1	416	2.0
Spottail Shiner	*Notropis hudsonius*	4	8.0	5	0.4	6	0.03	56	0.4	74	4.0	189	49.0	334	1.6
White Catfish	*Ictalurus catus*	1	2.0	29	2.5	6	0.003	53	0.3	84	4.6	17	4.4	190	0.9
Bluegill Sunfish	*Lepomis macrochiris*			1	0.08			105	0.7	4	0.2	8	2.1	118	0.6
Rainbow Smelt	*Osmerus mordax*					27	1.3	62	0.4	7	0.4	1	0.3	97	0.5
Atlantic Tomcod	*Microgadus tomcod*	2	4.0	16	1.4	9	0.4	18	0.1	8	0.4	25	6.5	78	0.4
Hogchoker	*Trinectes maculatus*	8	16.0	3	0.3	11	0.5	49	0.3	2	0.1	1	0.3	74	0.36
	Alosa sp.							65	0.4					65	0.3
Golden Shiner	*Notemigonus crysoleucas*	2	4.0					1	0.006	2	0.1	24	6.2	29	0.14
Unidentified spp.		1	2.0	1	0.08			20	0.13					22	0.1
American Shad	*Alosa sapidissima*			5	0.4			13	0.09	1	0.05			19	0.09
Crayfish	*Camburus sp.*	5	10.0	5	0.4	1	0.04	5	0.03	1	0.05			17	0.08
Pumpkinseed	*Lepomis gibbosus*			1	0.08	2	0.09	6	0.04	2	0.1	5	1.3	16	0.08
Gizzard Shad	*Dorosoma cepedianum*									1	0.05	14	3.6	15	0.07
Goldfish	*Carassius auratus*			1	0.08							11	2.8	12	0.06
Tessellated Darter	*Etheostoma olmstedi*							6	0.04					6	0.03
American Eel	*Anguilla rostrata*							3	0.02	1	0.05	1	0.3	5	0.02
Atlantic Sturgeon	*Acipenser oxyrhynchus*	1	2.0							2	0.1			3	0.01
Brown Bullhead	*Ictalurus nebulosus*	1	2.0	1	0.08							1	0.3	3	0.01
Black Crappie	*Pomoxis nigromaculatus*					1	0.04	1	0.006			1	0.3	3	0.01
Banded Killifish	*Fundulus diaphanus*											3	0.7	3	0.01
Blue Crab	*Callinectes sapidus*							3	0.02					3	0.01
Rock Bass	*Ambloplites rupestris*											1	0.3	1	0.005
TOTAL		50		1165		2096		15,153		1836		386		20,686	

TABLE VI-30

1973 MONTHLY AVERAGE SPECIES COMPOSITION
DANSKAMMER POINT IMPINGEMENT COLLECTIONS

SPECIES	SCIENTIFIC NAME	January		February		March		April		May		June		July	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
Atlantic Tomcod	Microgadus tomcod	79,125	98.7	16,930	98.1	2015	89.3	41	5.3	73	3.4	7	0.7	31	.98
Alewife	Alosa pseudohosengus	1	0.001					85	11.0	179	8.3	48	5.1	462	14.57
White Perch	Morone americana	38	0.04	10	0.05	28	1.2	365	47.2	1323	61.1	570	60.2	1966	62.02
Blueback Herring	Alosa aestivalis	1	0.001							65	3.0	80	8.5	32	1.01
Striped Bass	Morone saxatilis			5	0.02	1	0.04	1	0.1	10	.5	37	3.9	134	4.23
Bay Anchovy	Anchoa mitchilli											1	0.1	6	0.19
Spottail Shiner	Notropis hudsonius	368	0.5	96	0.5	104	4.6	187	24.2	263	12.1	34	3.6	63	1.99
Golden Shiner	Notemigonus crysoleucas	303	0.4	67	0.3	44	1.9	40	5.2	35	1.6	7	0.7	22	0.69
Pumpkinseed	Lepomis gibbosus	46	0.05	23	0.1	4	0.2	4	0.5	116	5.4	88	9.4	40	1.26
	Alosa sp.													323	10.19
Goldfish	Carassius auratus	170	0.2	75	0.4	12	0.5	3	0.4	10	0.5	4	0.4	4	0.13
White Catfish	Ictalurus catus	30	0.03	28	0.1	18	0.7	24	3.1	25	1.2	8	0.9	28	0.88
Bluegill Sunfish	Lepomis macrochirus	9	0.01	1	0.006	3	0.1	1	0.1	14	0.6	7	0.7	11	0.35
Gizzard Shad	Dorosoma cepedianum	17	0.02												
American Shad	Alosa sapidissima													5	0.16
Brown Bullhead	Ictalurus nebulosus	7	0.009	3	0.01	3	0.1	1	0.1	14	0.6	34	3.6	15	0.47
Rainbow Smelt	Osmerus mordax			2	0.01	17	0.7	8	1.0	4	0.2			2	0.06
American Eel	Anguilla rostrata	6	0.007	3	0.01	1	0.04	1	0.1	1	0.05	3	0.3	7	0.22
White Crappie	Pomoxis annularis	10	0.01			7	0.09			2	0.09			1	0.003
Yellow Perch	Perca flavescens	4	0.005	1	0.006			4	0.5	6	0.3			1	0.0003
Others		13	0.02	7	0.04	5	0.2	9	1.2	13	0.6	11	1.2	14	0.4
MONTHLY TOTAL		80,148		17,251		2,257		774		2,167		940		3,170	

TABLE VI-30
(Continued)

SPECIES	SCIENTIFIC NAME	August		September		October		November		December		Annual Total	
		#	%	#	%	#	%	#	%	#	%	#	%
Atlantic tomcod	*Microgadus tomcod*	7	0.27	2	0.03	19	0.19	2	0.07	517	38.90	98,796	76.0
Alewife	*Alosa pseudoharengus*	005	77.5	4269	70.3	3954	38.53	751	25.58	0	0	11,754	9.0
White perch	*Morone americana*	325	12.56	575	9.47	2198	21.42	1306	44.48	170	12.79	8,874	6.8
Blueback herring	*Alosa aestivalis*	95	3.67	151	2.49	1863	18.15	510	17.37	4	0.30	2,801	2.2
Striped bass	*Morone saxatilis*	63	2.43	108	1.78	1156	11.26	196	6.68	69	5.19	1,779	1.4
Bay anchovy	*Anchoa mitchilli*	18	0.70	866	14.26	759	7.40	1	0.03	0	0	1,651	1.3
Spottail shiner	*Notropis hudsonius*	9	0.35	14	0.23	15	0.15	52	1.77	170	12.79	1,375	1.1
Golden shiner	*Notemigonus crysoleucas*	11	0.43	6	0.10	1	0.01	8	0.27	73	5.49	617	0.5
Pumpkinseed	*Lepomis gibbosus*	10	0.39	14	0.23	36	0.35	2	0.07	13	0.98	396	0.3
	Alosa spp.			7	0.12							330	0.3
Goldfish	*Carassius auratus*			7	0.12	2	0.02			28	2.11	315	0.2
White catfish	*Ictalurus catus*	6	0.23	6	0.10	83	0.81	13	0.44	46	3.46	315	0.2
Bluegill sunfish	*Lepomis macrochirus*	3	0.12	22	0.36	100	0.97	42	1.43	45	3.39	258	0.2
Gizzard shad	*Dorosoma cepedianum*					2	0.02	21	0.72	173	13.02	213	0.2
American shad	*Alosa sapidissima*	22	0.85	17	0.28	48	0.47	16	0.55			108	0.08
Brown bullhead	*Ictalurus nebulosus*	2	0.08	2	0.03	1	0.01			4	0.30	86	0.07
Rainbow smelt	*Osmerus mordax*			2	0.03	4	0.04	13	0.44	1	0.08	53	0.04
American eel	*Anguilla rostrata*	2	0.08	6	0.10	6	0.06	1	0.03	2	0.15	39	0.03
White crappie	*Pomoxis annularis*					1	0.01			6	0.45	22	0.02
Yellow perch	*Perca flavescens*									3	0.23	19	0.01
Others		2	0.08	4	0.08	15	0.2	2	0.07	5	0.4	100	0.08
MONTHLY TOTAL		2587		6073		10,263		2936		1329		129,890	

TABLE VI-32

DOMINANT SPECIES
DANSKAMMER POINT IMPINGEMENT COLLECTIONS
1972 AND 1973

1972		1973	
SPECIES	%	SPECIES	%
White Perch	32.7	Tomcod	76.0
Tomcod	32.1	Alewife	9.0
Spottail shiner	8.3	White Perch	6.8
Alewife	7.8	Blueback herring	2.2
Blueback herring	6.2	Striped bass	1.4
Golden shiner	3.1	Spottail shiner	1.3

TABLE VI-31

FISH AND INVERTEBRATE IMPINGEMENT COLLECTION AT
DANSKAMMER POINT GENERATING STATION
1973

SPECIES	SCIENTIFIC NAME
Atlantic tomcod	*Microgadus tomcod*
Alewife	*Alosa pseudoharengus*
White perch	*Morone americana*
Blueback herring	*Alosa aestivalis*
Striped bass	*Morone saxatilis*
Bay anchovy	*Anchoa mitchilli*
Spottail shiner	*Notropis hudsonius*
Golden shiner	*Notemigonus crysoleucas*
Pumpkinseed	*Lepomis gibbosus*
	Alosa sp.
Goldfish	*Carassius auratus*
White catfish	*Ictalurus catus*
Bluegill sunfish	*Lepomis macrochirus*
Gizzard shad	*Dorosoma cepedianum*
American shad	*Alosa sapidissima*
Brown bullhead	*Ictalurus nebulosus*
Rainbow smelt	*Osmerus mordax*
American eel	*Anguilla rostrata*
White crappie	*Pomoxis annularis*
Yellow perch	*Perca flavescens*
Crevalle jack	*Caranx hippos*
Black crappie	*Pomoxis nigromaculatus*
Banded killifish	*Fundulus diaphanus*
Hogchoker	*Trinectes maculatus*
Red-breasted sunfish	*Lepomis auritus*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Brown trout	*Salmo trutta*
White sucker	*Catostomus commersoni*
Largemouth bass	*Micropterus salmoides*
Carp	*Cyprinus carpio*
	Morone sp.
Tessellated darter	*Etheostoma olmstedi*
Rock bass	*Ambloplites rupestris*
Four-spine stickleback	*Apeltes quadracus*
Yellow bullhead	*Ictalurus natalis*
Crayfish	*Cambarus sp.*
Black bullhead	*Ictalurus melas*
Brook trout	*Salvelinus fontinalis*
White mullet	*Mugil curema*
Redfin pickeral	*Esox americanus americanus*
Shortnosed sturgeon	*Acipenser brevirostrum*
Blue crab	*Callinectes sapidus*
Bluefish	*Pomatomus saltatrix*
Silvery minnow	*Hybognathus nuchalis*
Emerald shiner	*Notropis atherinoides*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic needlefish	*Strongylura marina*
Northern pike	*Esox lucius*
White bass	*Morone chrysops*
Chain pickeral	*Esox niger*
Chub sucker	*Erimyzon sp.*

TABLE VI-33

ESTIMATED MONTHLY IMPINGEMENT RATES
DANSKAMMER POINT GENERATING STATION
1973

MONTH	Observed Average Impingement No./MG		1973 Average Flow MGD		Estimated Number Of Impinged Fish Based on Average Flow (MGD) for Units 1-4	
	Units 1 & 2	Units 3 & 4	Units 1 & 2	Units 3 & 4	No. Per Day	No. Per Month
January	29.5	78.0	62.35	201.20	17532.9	543,520
February	15.8	23.5	60.26	167.33	4884.4	136,763
March	15.2	2.2	49.70	203.04	1202.1	37,265
April	3.8	0.2	99.79	200.51	419.3	12,579
May	4.9	0.7	120.96	249.65	767.5	23,793
June	2.4	0.7	111.64	305.32	481.7	14,451
July	6.2	1.7	120.88	328.90	1308.6	40,567
August	7.5	1.1	119.66	334.08	1264.9	39,212
September	17.6	3.1	120.96	322.98	3130.1	93,903
October	20.4	3.9	114.49	224.82	3212.4	99,584
November	10.0	1.8	89.29	259.04	1359.2	40,776
December	2.6	2.5	44.91	203.04	624.4	19,356
AVERAGE					3015.6	91,814
ANNUAL TOTAL:						1,101,769

TABLE VI-34

ESTIMATED MONTHLY IMPINGEMENT RATES
DANSKAMMER POINT GENERATING STATION
1972

MONTH	1972 Observed Average Impingement No./MG		*1972 Average Flow MGD		**Estimated Number Of Impinged Fish Based on Average Flow (MGD) for Units 1-4	
	Units 1 & 2	Units 3 & 4	Units 1 & 2	Units 3 & 4	No. Per Day	No. Per Month
January	4.8	5.9	65	217	1592	49,361
February	2.1	1.0	61	199	327	9,483
March	4.4	1.5	69	152	532	16,492
April	5.1	1.5	87	196	738	22,140
May	7.6	1.3	108	217	1103	34,196
June	6.1	0.9	117	258	946	28,386
July	3.4	0.5	111	276	515	15,965
August	4.9	1.2	115	314	941	29,165
September	5.4	1.3	112	250	982	29,454
October	10.1	3.2	97	246	1767	54,783
November	4.8	1.7	107	258	953	28,578
December	3.6	12.9	70	230	3219	99,789
AVERAGE					1135	34,816
ANNUAL TOTAL						417,792

*Based on sampling days
**Calculated from data on sampling days

TABLE VI-35

ESTIMATED MONTHLY IMPINGEMENT RATES - 1973
ROSETON GENERATING STATION
1973

MONTH	Observed Average Impingement No./MG	*Average Flow MGD	**Estimated Number of Impinged Fish Based on Average Flow (MGD)	
			No. Per Day	No. Per Month
July	0.2	288	58	1,798
August	1.0	547.2	547	16,957
September	3.8	547.2	2,079	62,370
October	9.6	417.6	4,009	124,279
November	2.2	495.4	1,090	32,700
December	0.1	288	29	899
AVERAGE			1,302	39,834

NOTE: Estimates are based on limited plant operation in 1973.
*Based on sampling days.
**Calculated from data on sampling days.

was 72,971 white perch. Bottom trawl data from river surveys at the Danskammer Point site also reflected a lower abundance level (measured as catch per unit effort) for white perch during 1973 than during 1972, suggesting a relationship between impingement rates and river abundance.

(b) Impingement Rates

Monthly Impingement Rate Estimates

The average daily impingement at Danskammer Point was 3,015.6 fish per day, estimated from flow rates through the plant (Table VI-33). The 1972 estimate was 1,135 fish per day (Table VI-34). The average daily impingement at Roseton (July through December 1973 only) was 1,202 fish per day (Table VI-35). The estimated annual impingement at Danskammer based on average plant operating conditions was 1,101,769. Average total cooling water flow over the entire study period at Danskammer Point was 343 MGD, or approximately 75% of the total cooling water pumping capacity (455 MGD).

(c) Comparison of 1973 Impingement Rates for Danskammer Point Units 1 & 2 and Units 3 & 4. Impingement rates (fish/million gallons of cooling water flow) fluctuated with time, and with the exceptions of January, February and December, Units 1 & 2 collected more fish per million gallons of flow than Units 3 & 4.

The species impinged in greatest numbers (Atlantic tomcod, alewife, white perch, blueback herring, striped bass and spottail shiner) were examined to determine if a significant difference existed between impingement rates

for Units 1 & 2 and Units 3 & 4. The time periods tested were chosen on the basis that the species examined were most abundant during those months.

Except for white perch there was a significant difference between impingement rates for all species examined. In addition, with the exception of tomcod, the number of fish impinged per million gallons of flow was greater at Units 1 & 2 than at Units 3 & 4 during the time periods tested. Impingement rates for tomcod during January, February, March and December, 1973, were significantly higher at Units 3 & 4 than at Units 1 & 2 (Table VI-36).

A non-parametric test (Wilcoxon's Signed Rank Test) was used for the above species because Bartlett's test of homogeneity of variance indicated non-homogeneity. However, homogeneity of variance was established for white perch and parametric analysis (paired t-test) was used for the period April to December. There was no significant difference between impingement rates at Units 1 & 2 and 3 & 4 for white perch ($t = 0$; 274 degress of freedom; $p > 0.5$)

(d) Comparison of Danskammer Point Impingement Rates for Night and Day. Impingement rates (Fish/MG) for six fish species (white perch, striped bass, alewife, blueback herring, bay anchovy and tomcod) were examined to determine if there was a significant difference between night and day impingement rates. Tests were run separately for the Roseton and Danskammer Point plants. Night and day were differentiated by the following schedule based on data from the National Oceanic and Atmospheric Administration.

TABLE VI-36

STATISTICAL EXAMINATION OF 1973 IMPINGEMENT RATES
AT UNITS 1 & 2 AND UNITS 3 & 4
DANSKAMMER POINT GENERATING STATION

WILCOXON SIGNED RANK TEST

Species	Time Period Tested	T+	T-	n (#Pairs)	Z (Test Statistic)*	Decision
Atlantic Tomcod	Jan-Mar, Dec	2,930	4,573	122	2.098	Significant
Alewife	July-Nov	8,510	1,360	140	7.435	Significant
Blueback Herring	Oct-Nov	1,482	663	65	2.673	Significant
Striped Bass	July-Dec	10,679	1,411	155	8.278	Significant
Spottail Shiner	Jan-May, Dec	11,627.5	5208.5	183	4.472	Significant

*If Z >1.96, then the difference is significant at the 95% confidence level.

Time of Year	Hours of Daylight*	Time Spans for Day and Night*
November - January	9.5 hrs.	Day 0730-1700 Night 1701-0729
February - April	12 hrs.	Day 0600-1800 Night 1801-0559
May - July	14.5 hrs.	Day 0445-1915 Night 1916-0444
August - October	12 hrs.	Day 0600-1800 Night 1801-0559

*Derived from local mean times of sunrise and sunset.

All samples exhibited homogeneity of variance (Bartlett's Test); Student's Paired t-test was used for testing. Only those dates when day and/or night samples contained fish were used in the tests, to avoid statistical bias resulting from zero catches for both night and day collections during certain seasons.

Impingement rates at Roseton were significantly greater during the night than during the day for white perch, alewife, blueback herring and striped bass. Impingement rates at Danskammer Point were significantly higher at night for alewives and bay anchovies (Table VI-37). All differences observed were due to higher impingement rates during the night than during the day. Satisfactory explanations for these day-night differences in impingement are not presently available; however, several possible hypotheses are presented below.

(i) Differences in impingement rates between night and day may be a manifestation of fish activity rhythms. Most species demonstrate highly periodic activity behavior in nature, and, according to species, become active during only the day

TABLE VI-37

ANALYSIS OF NIGHT AND DAY IMPINGEMENT RATES
FOR SELECTED SPECIES
ROSETON AND DANSKAMMER POINT GENERATING STATIONS

Species	Time Period Tested	Plant	Degrees of Freedom	t-Value	P	Determination
White Perch	Aug-Nov	Roseton	7	-10.861	$p < .001$	Significant
Alewife	Aug-Oct	Roseton	5	- 5.509	$.001 < p < .005$	Significant
Bay Anchovy	Sept-Oct	Roseton	3	- 3.163	$p = .025$	Significant
Blueback Herring	Sept-Nov	Roseton	5	- 6.049	$.001 < p < .005$	Significant
Striped Bass	Oct	Roseton	2	- 5.379	$.025 < p < .05$	Significant
White Perch	May-Nov	Danskammer	14	- 0.767	$.4 < p < .05$	Not Significant
Alewife	July-Nov	Danskammer	10	- 3.343	$.005 < p < .01$	Significant
Bay Anchovy	Sept-Oct	Danskammer	4	- 3.017	$.025 < p < .05$	Significant
Blueback Herring	Oct-Nov	Danskammer	4	- 1.416	$.2 < p < .4$	Not Significant
Striped Bass	Oct	Danskammer	2	1.018	$.4 < p < .5$	Not Significant
Tomcod	Jan-Mar + Dec	Danskammer	12	- 0.727	$.4 < p < .4$	Not Significant

(diurnal), only at night (nocturnal), or during the morning and evening dusk hours (crepuscular). (Dew (1970) and O'Connor (1972) have shown for the marine and estuarine fishes *Tautogolabrus adspersus* and *Trinectes maculatus*, for example, that at certain times of the day, these fishes are almost immobile, resting in protected crevasses or in the bottom sediments).

Depressed activity levels during nocturnal hours have been described for several fish species (Hasler and Villamonte, 1953; Davis and Bardach, 1965; Hergenrader and Hasler, 1966; Olla, 1966, 1974). It may be hypothesized, therefore, that during inactive periods fishes assuming a resting, immobile state in the intake plume would be subject to heaviest impingement by being passively carried into the intake.

(ii) It may also be hypothesized that for another species, impingement rates may increase in proportion to their activity, presuming that by its very activity this fish species increases the probability of its encountering the intake water flow.

(iii) Members of the herring family (alewife and blueback herring) and the anchovy are filter-feeders and are found typically in schools. When schools are actively feeding at night, fish may become entrained in the cooling water flow for the following reasons:

a. At night zooplankton (and fish) are frequently attracted to light; the plant surroundings are usually well lighted. The resulting concentration of plankton near the plant attracts nocturnal-feeding fish, thereby increasing the chance that they will enter the intake.

b. The flow of cooling water is drawn primarily from surface layers. The tendency of zooplankton to become evenly distributed in the water column by day and to concentrate in surface waters at night may attract the filter-feeding fishes into the water masses most likely to enter the plant.

(iv) White perch and striped bass are visual feeders, and may be indirectly attracted to the plant area by the presence there of forage fish (small anchovies, alewives and blueback herring), which are drawn to the plant's lights.

(v) Another factor may also be operative at night which could increase impingement rates of striped bass and white perch. These species rely heavily upon vision for predator avoidance as well as food procurement. It has been proposed (Stone and Webster, 1974) that fishes approaching power plant intakes perceive entrainment in the cooling water flow by visual cues; the rate of passage of stones, etc., through the visual field. The ability of a fish to perceive such cues at night may be reduced, with the result that, without having perceived his gradual entrainment, the organism is entrapped in a flow from which he cannot escape.

These hypotheses rely upon an assumption which has not been demonstrated to be operative in the case of the Danskammer Point plant, that is, that fishes entrapped in the cooling water flow are carried immediately to the travelling screens with a time lag equal to the time it takes a particle of water to travel the length of the intake canal.

(e) Comparison of Impingement Rates During Ebb and Flood Tide. It is known that some recirculation of Danskammer Point's thermal discharge occurs at the Roseton intake on ebb tide and at the Danskammer Point intake on flood tide. It is also true that several fish species have been collected in relatively high concentrations within the Danskammer Point thermal plume during the fall when water temperatures in the river are dropping. Because of the presence of an autumnal population in association with the Danskammer Point heated discharge, it was hypothesized that fish impingement may be greater at Roseton and/or Danskammer Point during times of recirculation.

The four species impinged in greatest numbers at Danskammer Point and Roseton during October and November (blueback herring, alewife, white perch and striped bass) were examined to determine if there were significant differences between impingement rates during ebb and flood tides. There was no significant difference for any of the species examined at Roseton or Danskammer Point (Table VI-38).

(f) River and Plant Comparisons

(i) Relative Abundance

The purpose of comparing relative abundance for plant and river was to determine if trends in impingement followed trends appearing in

TABLE VI-38

STATISTICAL EXAMINATION OF IMPINGEMENT RATES DURING
EBB AND FLOOD TIDES
ROSETON/DANSKAMMER POINT GENERATING STATIONS

WILCOXON SUM RANK TEST (UNPAIRED DATA)

SPECIES	PLANT	TIME PERIOD TESTED	T (EBB)	n (EBB)	T (FLOOD)	n (FLOOD)	z (TEST) STATISTIC)	DETERMINATION
Blueback herring	Danskammer Point	October-November	4520.5	68	3994.5	62	0.308	Not Significant
Alewife	Danskammer Point	October-November	4865.0	68	3650.0	62	1.913	Not Significant
Blueback herring	Roseton	October-November	862.5	31	790.5	26	0.577	Not Significant
Alewife	Roseton	October	423.5	20	279.5	17	1.311	Not Significant
Striped bass	Roseton	October	238.5	16	167.5	12	0.279	Not Significant

PAIRED T-TEST

SPECIES	PLANT	TIME PERIOD TESTED	t VALUE	DEGREES OF FREEDOM		DETERMINATION
Striped bass	Danskammer Point	October-November	1.185	128	$0.1 < p < 0.2$	Not Significant
White perch	Danskammer Point	October-November	0.913	128	$0.1 < p < 0.2$	Not Significant
White perch	Roseton	October-November	0.958	55	$0.1 < p < 0.2$	Not Significant

Hudson River catches. Over the past three years it has been found that the river catches generally follow the life history patterns established in the literature for estuarine species such as white perch, alewife, blueback herring, and tomcod (Quirk, Lawler & Matusky Engineers, 1973a, 1973b, 1974). A certain amount of predictability could be applied toward mitigation of impingement effects if it were found consistently that impingement itself is associated with known life history parameters for a given species.

Only those species which occur in sufficient abundance in both river catches and impingement collections can be compared. Three species were examined from the 1973 collections: white perch, alewife, and blueback herring. Tomcod were not compared because river collections were not made at the season of their peak abundance, January and February.

Plant and river abundance data for a species were compared in two different ways: first, a comparison of relative abundance as percent of total catch and second as the number of fish collected in the river per unit of fishing effort compared to the observed number of impinged fish collected per million gallons of cooling water flow.

Neither of these methods allow strict comparison of the populations collected in the plant and in the river; however, they can be used to compare the timing of peak abundance found in the plant and river, and to analyze the vulnerability to impingement of life history stages for certain species. A preliminary comparison of these populations is presented in a later section of this report.

a. White Perch

Comparisons for white perch, represented as percentage of total catch in the plant and in the river, show similar patterns for both 1972 and 1973 (Figures VI-33, VI-34 and VI-35). The greatest percentage representation of white perch impingement collections for both years was during the spring spawning migration from April through July. However, there was a large difference in numbers of white perch impinged during this period, with 54% less fish impinged per million gallons during 1973 than during 1972 for the peak month of May. This suggests that there were fewer white perch in the Roseton/Danskammer Point area in the spring of 1973 than there were during the same period in 1972.

Bottom trawls collected more white perch during the spring of 1973 than during 1972, but this may have resulted from differences in depths sampled. Several shallow-water trawls (10-30 feet) were conducted in front of and adjacent to the Danskammer Point plant in 1973, whereas only deep-water trawling (30-50 feet) was conducted in 1972. As the 1972 report stated, white perch may not use the deepest water during their spawning migration, and consequently would be found in greater numbers at shallower depths.

Although the percentage representation of white perch in the total impingement collection at Danskammer Point was highest during the spring of 1973, numbers of fish per million gallons were greatest during October and November. Length-frequency analysis indicates

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

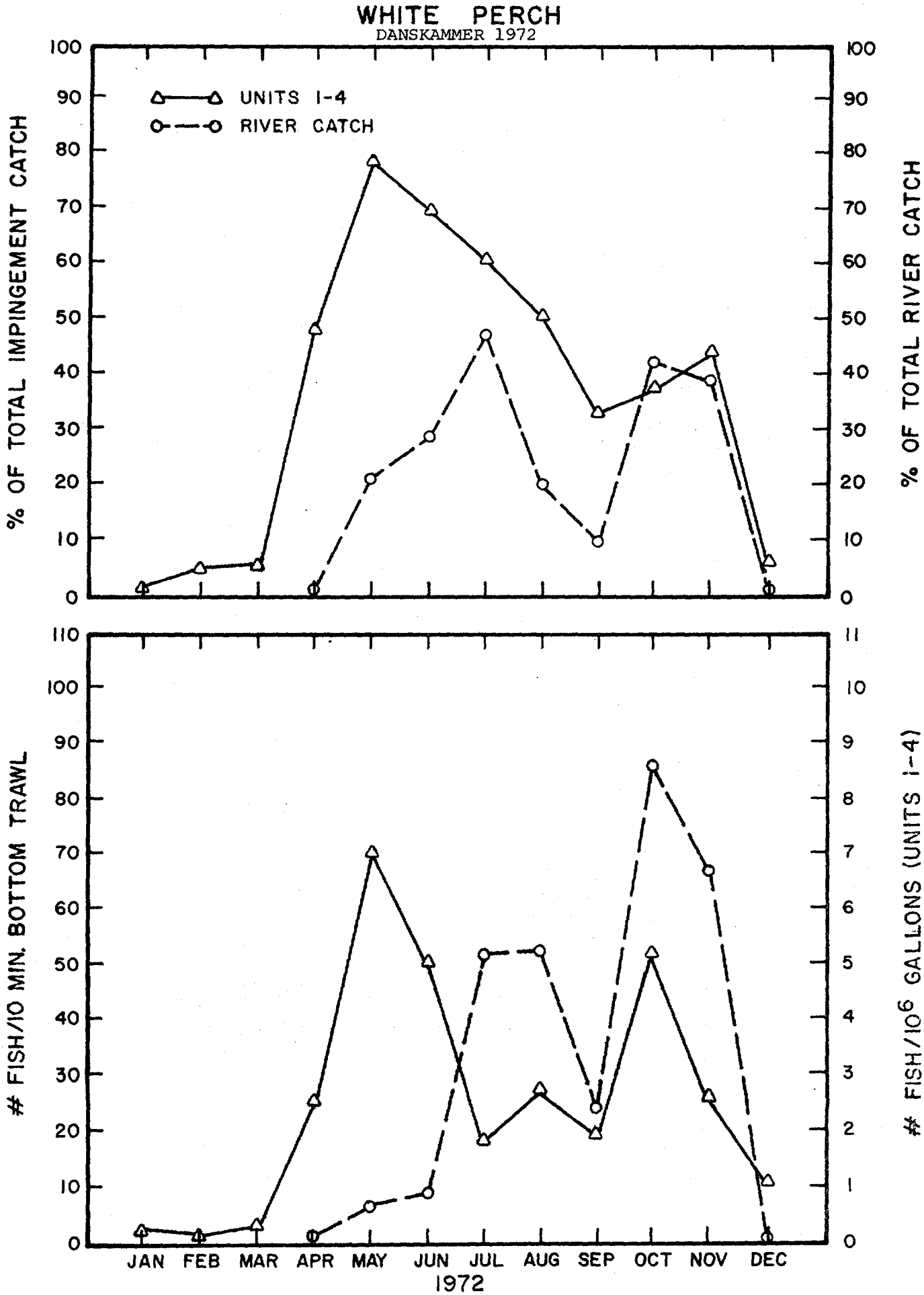


FIGURE VI-34

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

WHITE PERCH

DANSKAMMER 1973

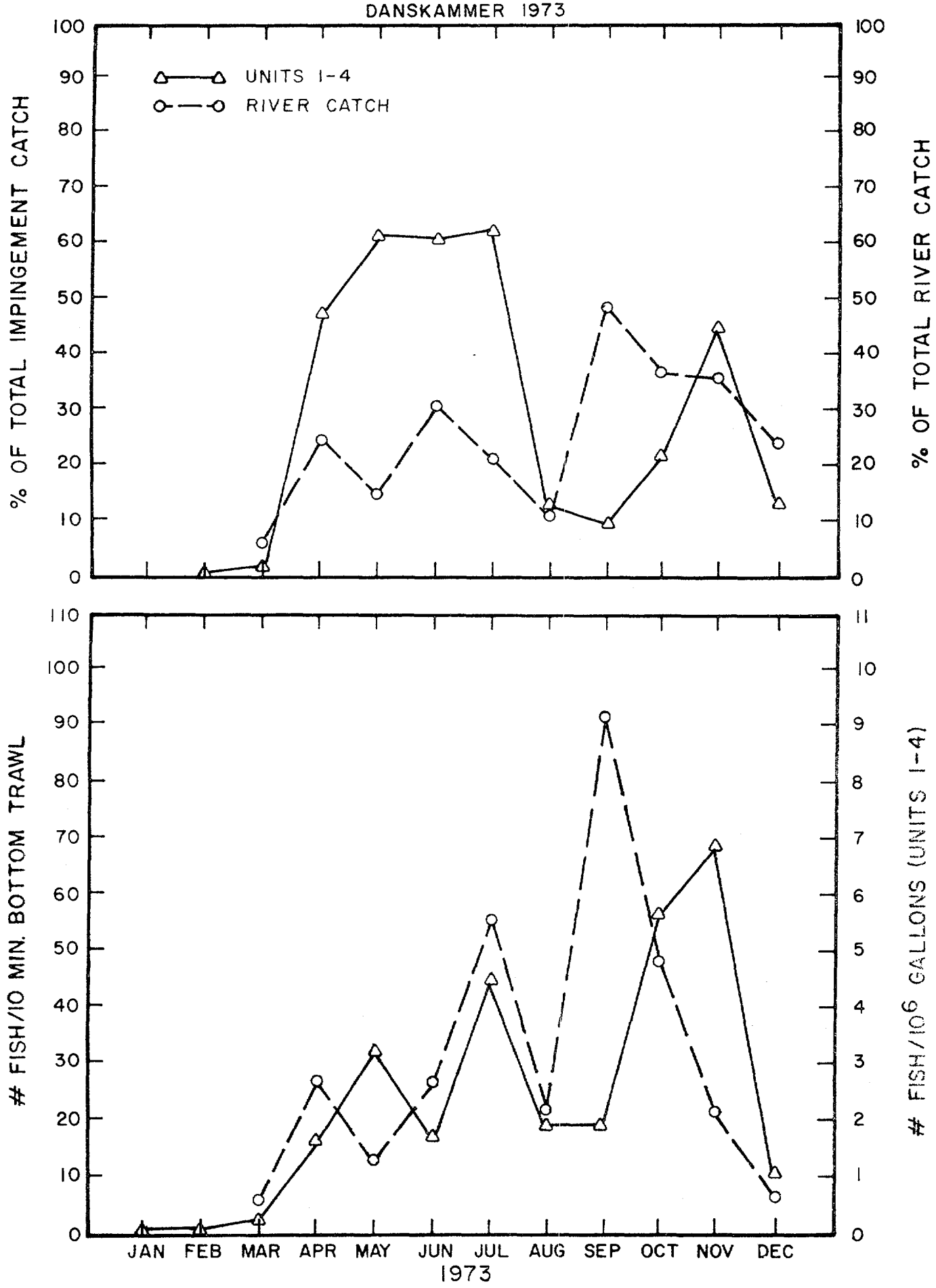
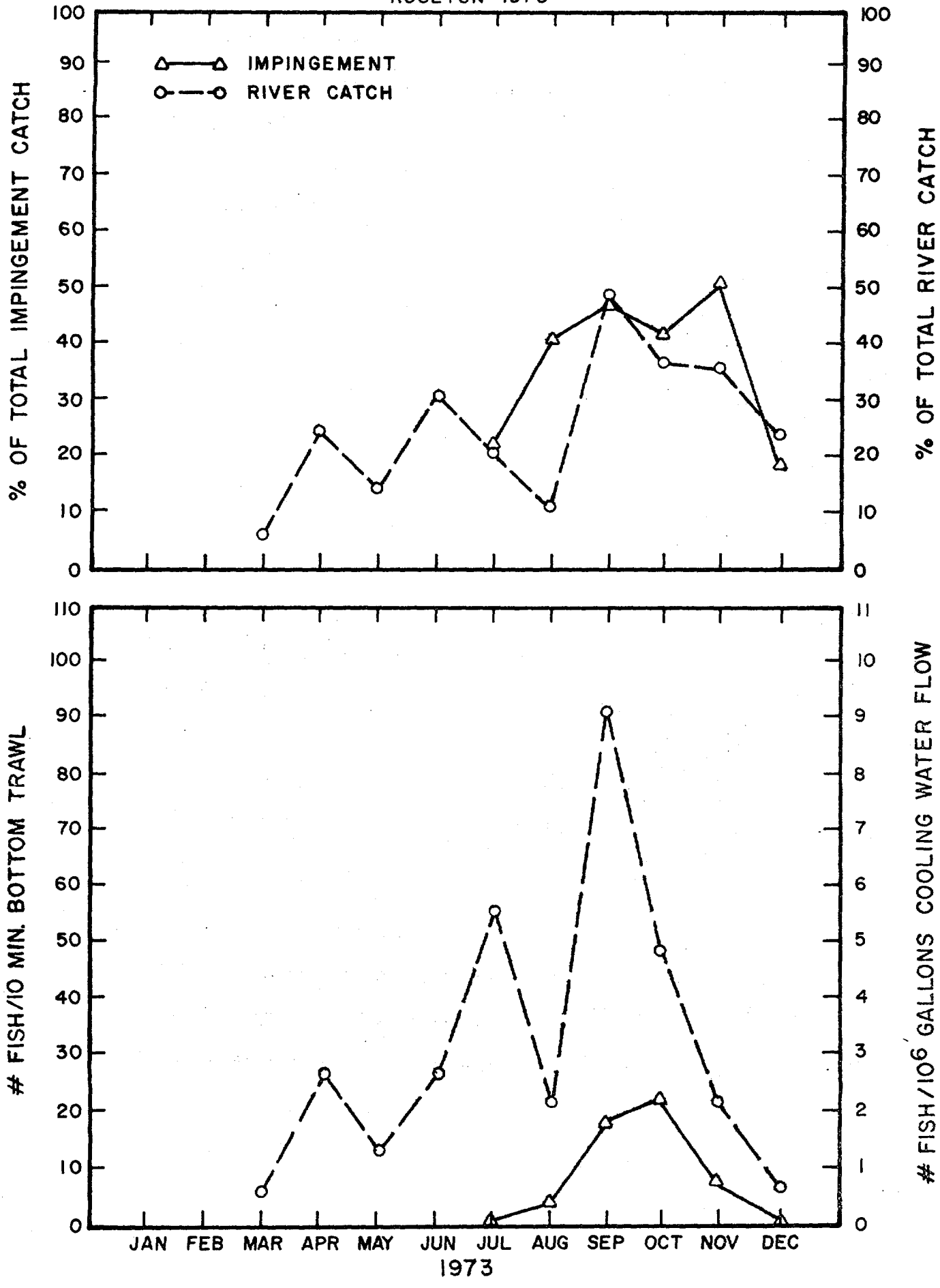


FIGURE VI-35.

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

WHITE PERCH

ROSETON 1973



that this fall peak in numbers was composed almost entirely of young-of-the-year fish. These data are consistent with the observed downstream autumnal migration for young white perch in the Hudson River. The lag time for white perch between peak river catches and peak impingement collections (Figure VI-34) may be a function of retention time in the Danskammer Point intake canal, but tagging studies would be necessary to gain insight into this question. There was also a lag time between peak river catches and peak impingement collections at Roseton, but it was not as pronounced as at Danskammer Point (Figure VI-35).

b. River Herring

The category "river herring" is composed of alewife and blueback herring, anadromous species which enter the Hudson to spawn during the spring. Although adult blueback herring and especially alewife were present in April and May gill net and seine catches, they did not appear to be vulnerable to impingement at Danskammer Point (Figures VI-36 through VI-39). The same trend for these two species was found at Danskammer Point during the spring of 1972 (Figures VI-40 and VI-41).

Peak abundance for alewife and blueback herring in Danskammer Point impingement samples occurred in the late summer and fall of 1973 (Figures VI-36 and VI-38); the same trend was observed in 1972 (Figures VI-40 and VI-41). Length-frequency analysis (Appendix VI-A) showed that the abundance peaks for both years consisted almost entirely of young-of-the-year herring, reflecting the autumnal

FIGURE VI-36

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

ALEWIFE

DANSKAMMER 1973

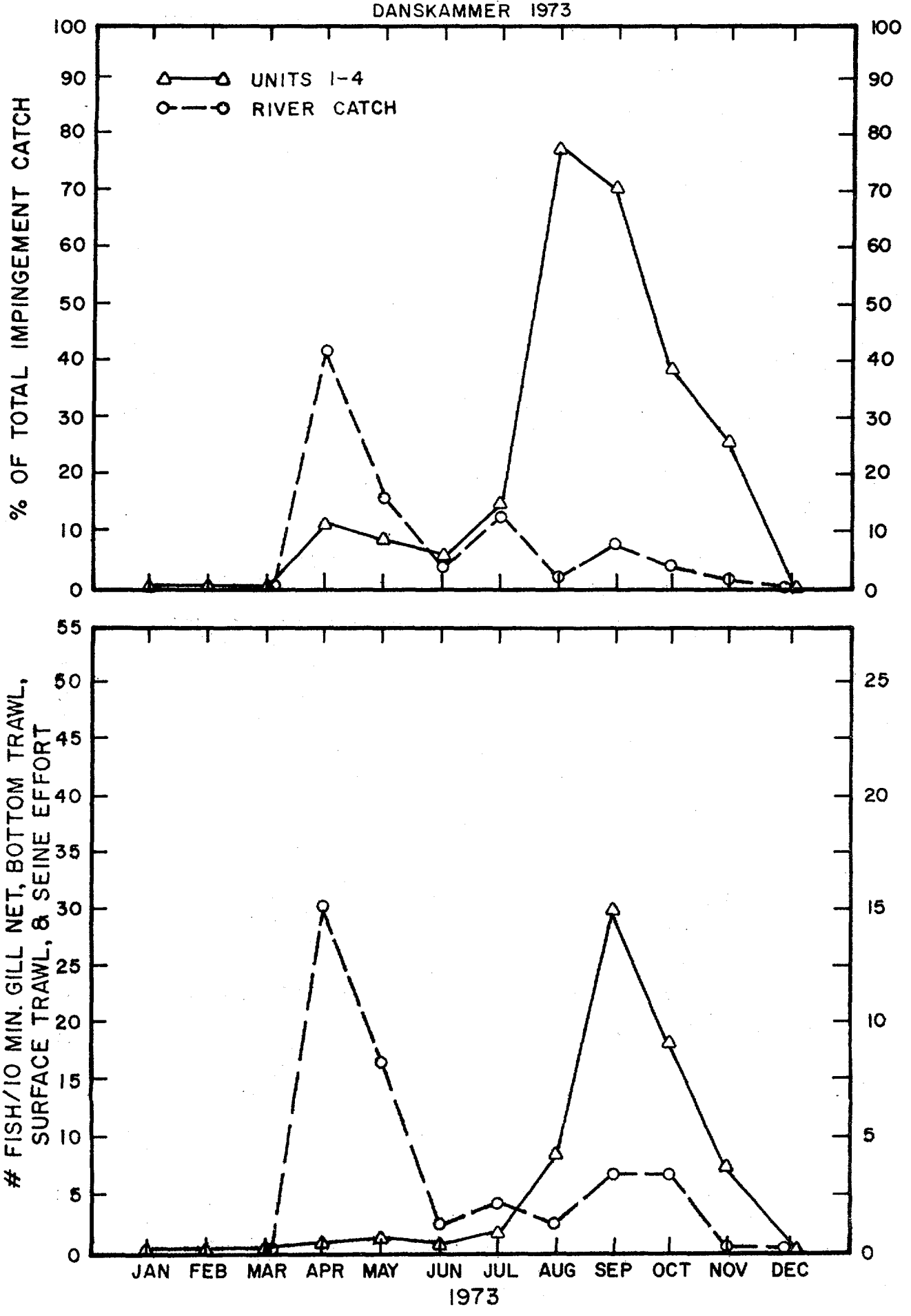
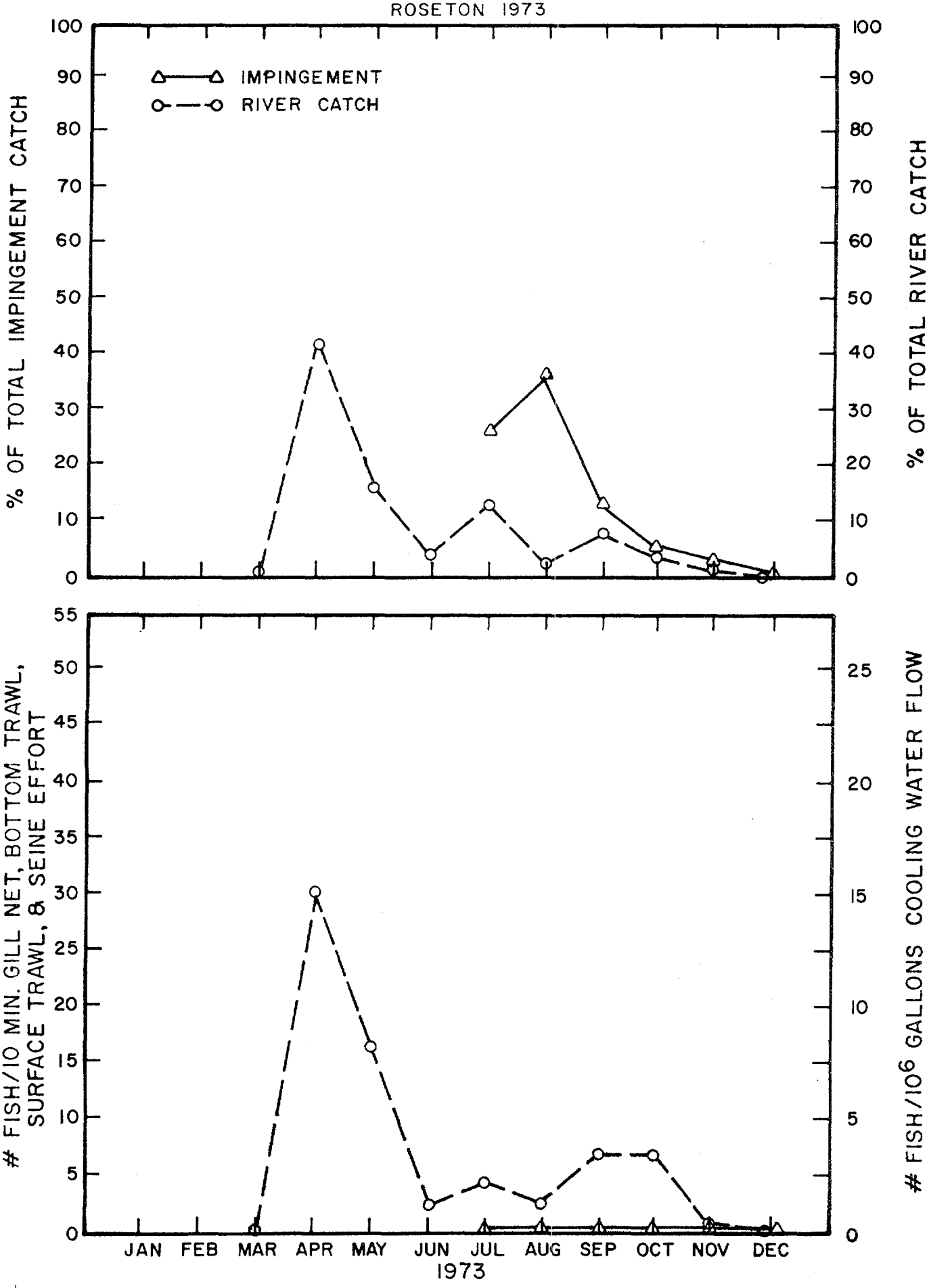


FIGURE VI-37

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

ALEWIFE

ROSETON 1973



ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BLUEBACK HERRING

DANSKAMMER 1973

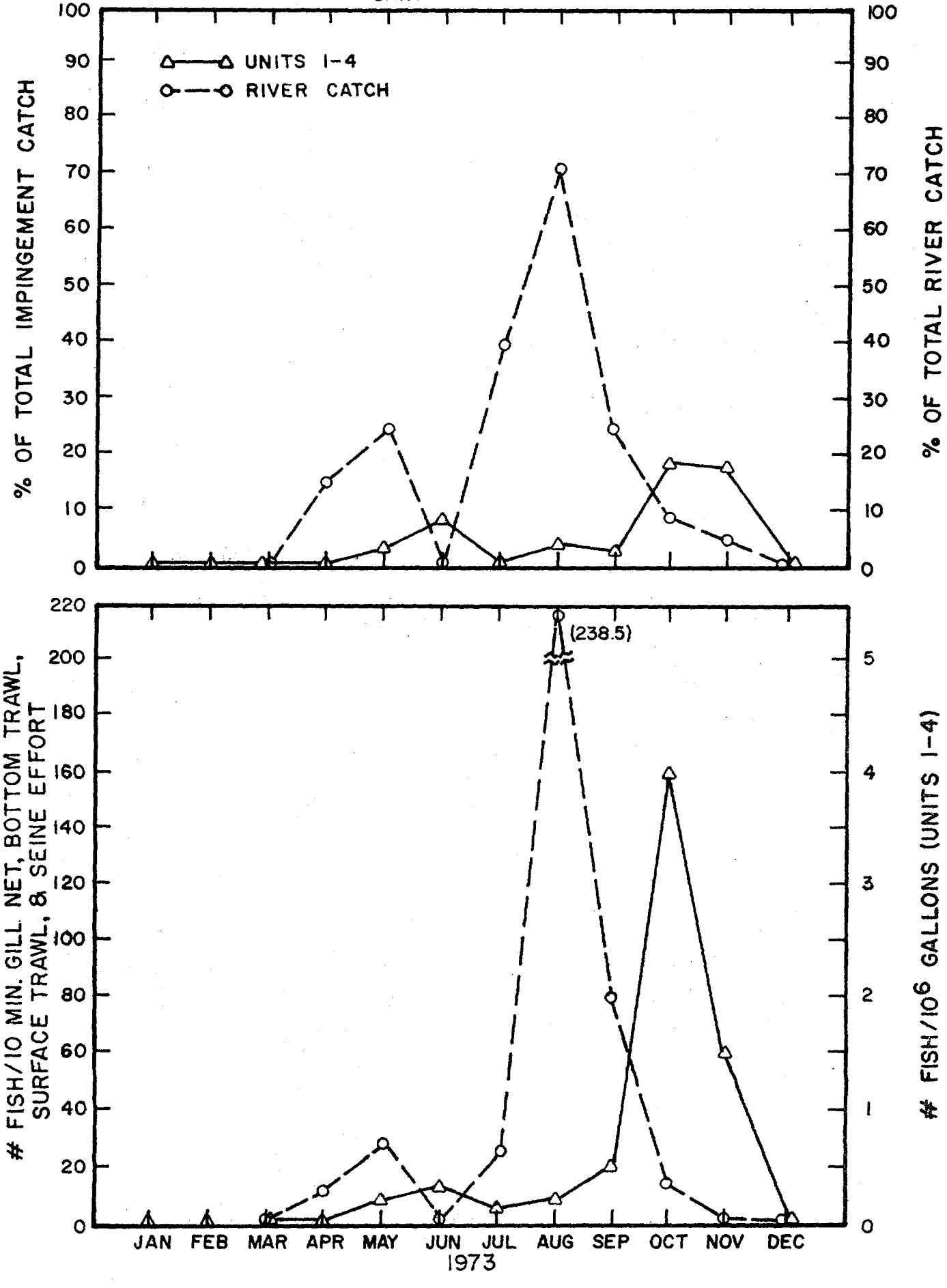
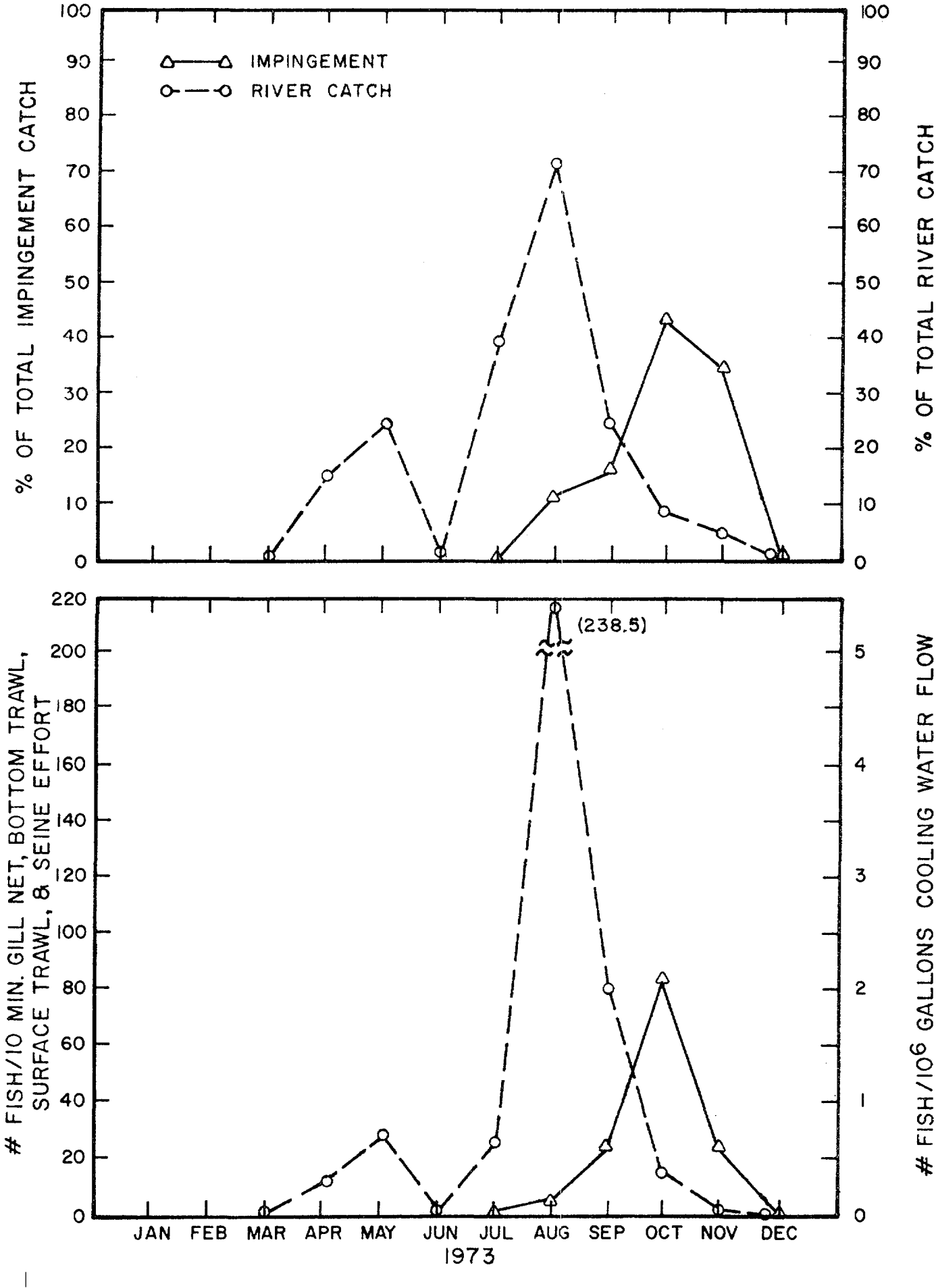


FIGURE VI-39

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

BLUEBACK HERRING

ROSETON 1973



ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES

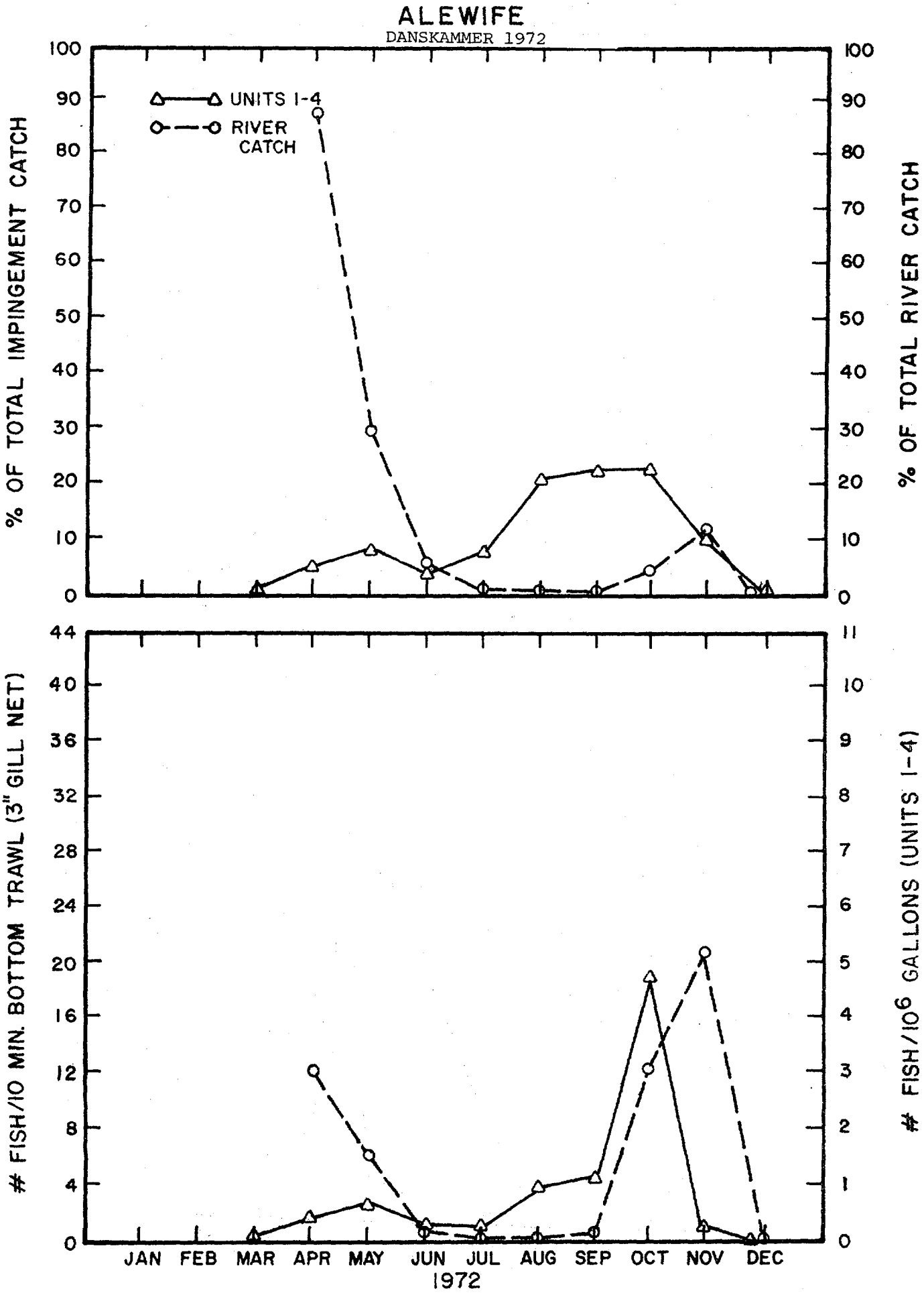
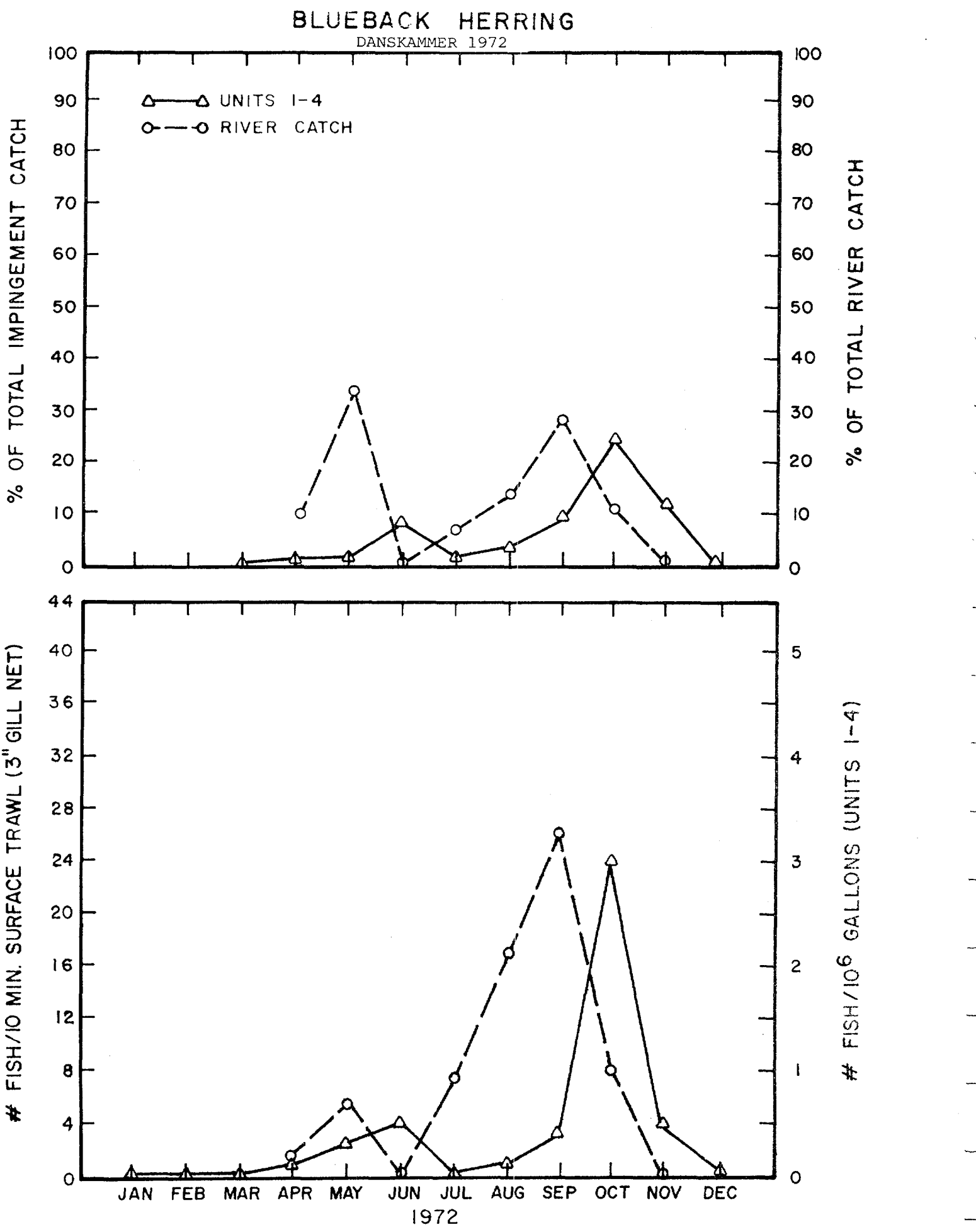


FIGURE VI-41

ROSETON/DANSKAMMER POINT RIVER ECOLOGICAL STUDIES



seaward migration for young of these species in the Hudson River. The same general trend in abundance was noted for alewife and blueback herring in Roseton impingement collections during the late summer and fall of 1973; however, the numbers of fish impinged per million gallons were much less at Roseton (Figures VI-37 and VI-39).

An interesting contrast between alewife and blueback herring is evident in river catches and Danskammer Point impingement collections during 1973. Alewife collections in the plant were proportionally larger than collections in the river during late summer and fall, whereas blueback herring collections during the same time period were much larger in the river than in the plant (Figures VI-36 and VI-38). This is a real difference rather than sampling bias, since the same stations, collection dates, and sampling gear were used for both species.

Differences in location in the water column could cause the observed disparity between alewife and blueback herring impingement rates. There was no significant difference (Table VI-39) between numbers of alewives collected in surface trawls and bottom trawls during day or night, indicating an even dispersion throughout the water column during an entire 24-hour cycle. However, significantly greater numbers of blueback herring were collected in bottom trawls during the night-time and in surface trawls during the day (Table VI-39). This indicates that blueback herring made diurnal vertical migrations and were found close to the surface during the day and close to the bottom at night.

TABLE VI-39

STATISTICAL EXAMINATION OF DAY-NIGHT BOTTOM TRAWL
AND SURFACE TRAWL CATCHES FOR ALEWIFE AND BLUEBACK HERRING

STUDENT'S t-TEST

Species	Time	Comparison	Degrees of Freedom	t-Value	p Value	Determination
Alewife	Day	Surface vs Bottom Trawls	20	.666	$p>.5$	Not Significant
Alewife	Night	Surface vs Bottom Trawls	18	.475	$p>.5$	Not Significant
Blueback Herring	Night	Surface vs Bottom Trawls	20	3.41	$.001<p<.005$	Significant

WILCOXON SUM RANK TEST

Species	Time	Comparison	T_{BT}	n_{BT}	T_{ST}	Computed Test Statistic	T Critical (α=.005)	Determination
Blueback Herring	Day	Surface vs Bottom Trawls	112.5	14	163.5	52.5	76	Significant

These findings correspond to previous data on the Hudson River in the area of Indian Point which showed that daytime surface trawl catches were dominated by blueback herring and nighttime catches by alewife (Raytheon, 1971).

These behavioral characteristics may account for the observed difference in impingement rates for alewife and blueback herring at Danskammer Point in 1973. There is a skimmer wall at the trash racks of the Danskammer Point intake which extends four feet below the mean water level. This wall may prevent surface-dwelling fish from entering the intake and therefore young-of-the-year blueback herring would be vulnerable to impingement mainly at night (12 hours during August through October). Alewives, which appear to be fairly evenly dispersed throughout the water column during night and day, would be vulnerable throughout a 24-hour day.

(ii) Relative Condition Factors

One hypothesis regarding the impingement process is that it is selective for the weaker, less healthy segment of a fish population, and that, therefore, impingement may act as a beneficial cropping mechanism. An indication of the health or well-being of fish populations can be found through analysis of length-weight relationships. Fish of a given length in good condition will generally weigh more than fish of the same length in poorer condition. This approach was used to compare the condition of fish collected from the Hudson River to the condition of fish impinged at Danskammer Point.

This approach has limitations in that length-weight relationships and condition factors may be naturally influenced by sex, age and season, in addition to possible systematic errors caused by gear selectivity and differential preservation.

The relative condition factor (K_n), as proposed by LeCren (1951), is expressed as:

$$K_n = \frac{W}{W_1}$$

where W = weight of a fish of a specific length and W_1 = the computed weight of a fish of the same length derived from the equation:

$$\log W = \log a + b \log L$$

calculated for the fish collected on the same date from the Roseton/ Danskammer Point area of the Hudson River.

The use of K_n for the measurement of fish condition results in a value that has a common base regardless of species or size. K_n is always 1.0 when the condition or weight of a fish of a specific length is equal to the average condition or weight predicted by the baseline equation for a fish of the same length. Whenever fish are in poorer condition than average, K_n is less than 1.0, and when condition is better than average, K_n is greater than 1.0. For example, respective K_n values of 0.8 and 1.2 for two fish of the same length would indicate that the second weighs 40% more than the first and 20% more than the average or base (Swingle and Shell, 1971).

Except for striped bass collected at Roseton, the weighted K_n for all impinged fish was lower than 1.0, suggesting that impinged

fish were thinner than river fish (Table VI-40). The same trend was observed for impinged tomcod and spottail shiner in 1972. Condition decreased for most species as length intervals grew larger, and it was hypothesized that increased swimming ability of larger fish enabled them to avoid actual impingement upon the travelling screen for a longer period of time, and therefore they would expend more energy than smaller fish before becoming impinged. This trend was especially evident at Danskammer Point where entrapment in the intake canal is a more important factor in impingement than at Roseton.

(iii) Species Diversity Comparison

Species diversity (H) was calculated from the following formula:

$$H = \sum_{i=1}^{S} \frac{n_i}{N} \log_2 \frac{n_i}{N}$$

where: n_i = number caught of the species i;

N = total number caught;

S = number of species.

The diversity of a community is dependent upon number of species present (species richness) and the distribution of individuals among the species (species evenness). Diversity (H) as calculated herein weights the contribution of each species in proportion to its contribution to the total number collected. Thus, by allocating numbers into species categories, this index reflects community structure.

TABLE VI-40

WEIGHTED MEAN CONDITION FACTORS - 1973
ROSETON AND DANSKAMMER POINT GENERATING STATIONS

SPECIES	PLANT	DATE	River Length-Weight Parameters*		Weighted Mean K_n for Impinged Fish
			a	b	
Striped bass	Danskammer Point	Oct. 1973	5.867	3.453	0.954
	Roseton	Oct. 1973	5.867	3.453	1.080
White Perch	Danskammer Point	May 31, 1973	5.362	3.264	0.931
	Danskammer Point	July 25, 1973	5.274	3.217	0.911
	Roseton	Oct. 3, 1973	5.069	3.13	0.861
Alewife	Danskammer Point	Oct. 9, 1973	5.121	3.021	0.995
	Roseton	Oct. 1973	5.121	3.021	0.965
Blueback herring	Danskammer Point	Oct. 1973	6.382	3.703	0.897
	Roseton	Oct. 1973	6.382	3.703	0.850
Spottail shiner	Danskammer Point	May 31, 1973	5.123	3.063	0.986

*Based on the equation logW = -a + blogL where W = Weight, and L = Length

Wilhm (1968) stressed the point that from an ecological and bio-energetic point of view it is important to know whether a collection of 100 individuals comprising five species is allocated 96:1:1:1:1 or 20:20:20:20 with respect to individual species numbers. Both of these collections have five species and a total number of 100 but their population structure is vastly different, and the diversity value for the first assemblage is much lower than for the second.

Comparisons of diversity of Roseton and Danskammer Point impingement collections with diversity of river collections show that impingement collections generally have greater species diversity values than surface trawl, bottom trawl or seine catches (Figure VI-42). Comparison of the three river communities sampled, i.e., near shore, open water surface and open water bottom, shows that the most diverse community was near shore (100-foot seine samples). The same trend was observed during a 1971-1972 river study in the area of Haverstraw Bay (Quirk, Lawler & Matusky Engineers, 1974). The reason for higher species diversity near shore may be that the varied available habitats, such as weeds, rocks and open bottom, present niches which are absent from the limnetic area of the river.

The fact that species diversity values are higher for impingement samples than for other collection methods indicates that impingement withdraws fish from all three habitats: shore, shoal water and deep water. The high diversity of the impingement samples as well as the species assemblages occurring in impingement catches suggests that

1973 SPECIES DIVERSITY COMPARISON
FOR RIVER CATCHES AND PLANT COLLECTIONS

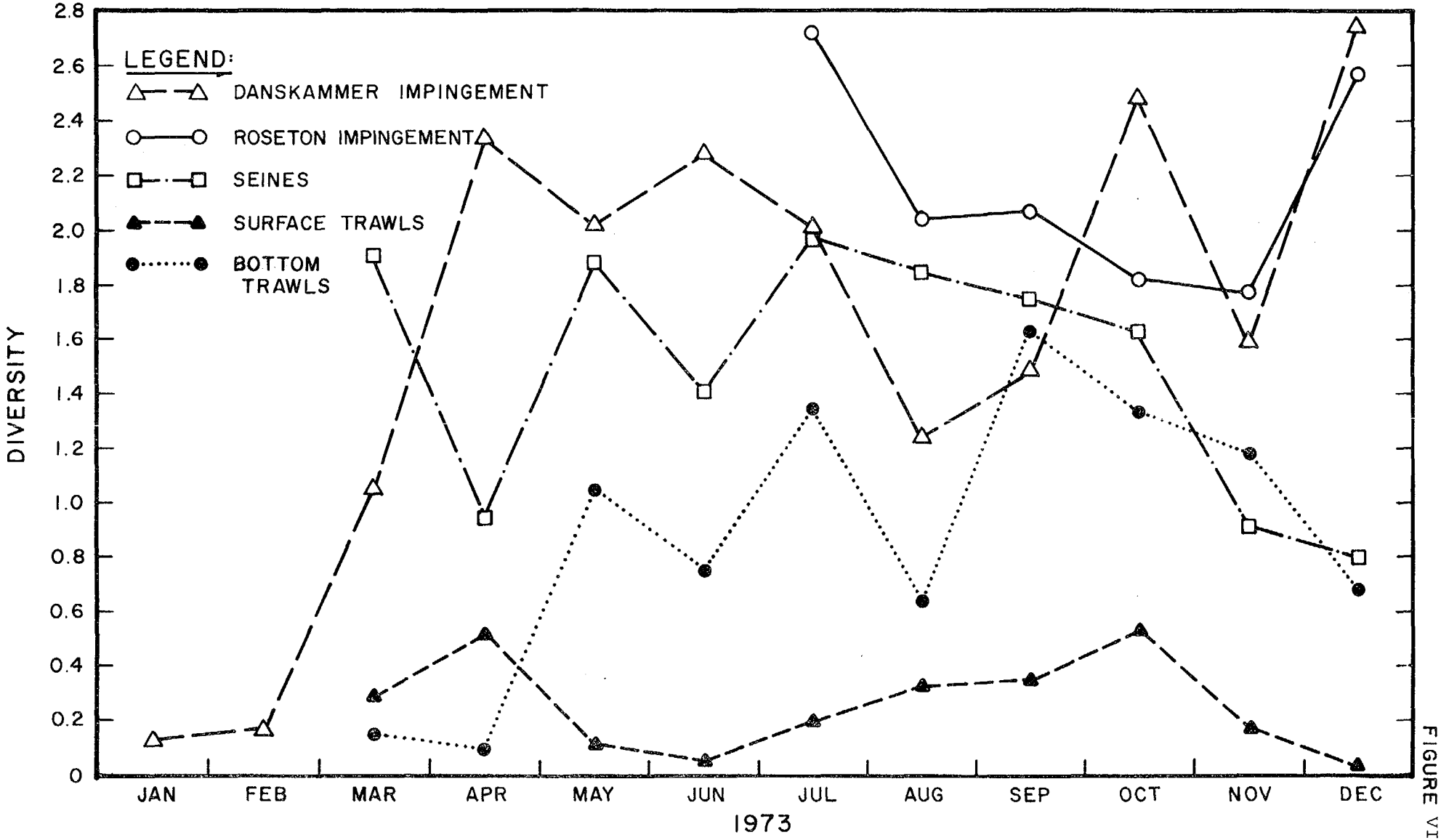


FIGURE VI-42

these collections are more representative of the shore community than the pelagic or deep-water communities. It further indicates that impingement is not species-selective when compared with conventional gear.

(iv) Length-Frequency Distribution. General length-frequency information comparing the age and size composition of river and impingement collections at Roseton and Danskammer Point are presented in Appendix VI-A.

Analysis of white perch length distributions in bottom trawls, seine hauls and impingement collections provided additional evidence that impingement at Roseton and Danskammer Point draws primarily upon the shore population.

Analysis of Danskammer Point collections in May 1973 showed that the white perch size distribution in seine collections was similar to that of impingement collections, but that on the same date the length distribution of bottom trawl catches was significantly different ($\alpha = 0.05$) than either seine or impingement collections (Table VI-41). The same trend was found for Roseton when the length distribution of impinged white perch was compared to that of white perch from seines and bottom trawl collections on August 21, 1973 (Table VI-41). These data suggest that seine hauls and impingement collections at Roseton and Danskammer Point collect the same, near shore segment of the white perch populations.

TABLE VI-41

COMPARISON OF MEAN LENGTHS OF BOTTOM TRAWL, SEINE AND IMPINGEMENT COLLECTIONS OF WHITE PERCH AT DANSKAMMER POINT ON MAY 30-31, 1973 AND AT ROSETON ON AUGUST 21, 1973

Plant	Collection Method	Sample Size	Mean Total Length (cm)	Standard Deviation	Standard Error	95% Confidence Interval
Danskammer Point	Bottom Trawl	125	16.57	2.300	0.206	16.17-16.98
	Seine	81	13.23	2.545	0.283	12.66-13.79
	Impingement	391	13.66	4.476	0.226	13.22-14.11
Roseton	Bottom Trawl	280	14.46	2.878	0.172	14.29-14.64
	Seine	123	5.66	1.626	0.147	5.37-5.95
	Impinement	341	5.54	0.882	0.048	5.45-5.64

E. CONCLUSIONS

Fish collection efforts were conducted in 1973 in the Roseton/Danskammer Point vicinity of the Hudson River to determine abundance, distribution, and composition of fish populations. Similar studies were also conducted in 1971 and 1972. These data will serve as baseline information for eventual comparison with data collected after initiation of commercial operation of the Roseton Generating Station. The results of the 1971, 1972 and 1973 studies indicate the following:

1. A total of 32,516 fish representing 39 species were collected in the Roseton/Danskammer Point vicinity during the period 1971-1973. Two species, blueback herring and white perch, composed 53.6% (17,443 individuals) of the total.

2. Trawls were the most effective method of collection; bottom trawls generally caught more fish than surface trawls.

3. Blueback herring were the most abundant species in 1973, composing 31.2% of the total; the majority were young-of-the-year fish collected by seines from the shore area or in surface trawls; surface trawl collections also peaked during this time period.

4. White perch are the dominant resident species in the Roseton/Danskammer Point area and composed 28% of the total catch in each year. Those collected were mainly young-of-the-year and were most abundant in the early fall; as a result, bottom trawl collections were also greatest during this time period.

5. The near-shore community, i.e., those collected by seine efforts, was composed of spottail shiners, juvenile striped bass, pumpkinseed, sunfish, and juvenile herring.

6. Atlantic tomcod, brown bullheads, hogchokers, and white perch were the dominant members of the offshore deeper water fish community.

7. The collection of marine species such as the white mullet and crevalle jack is associated with salt front intrusion into the study area during periods of low flow.

8. Due to the presence of adults of migratory species and a minimum of year-old resident species, the average biomass per fish was greatest in the spring and declined during the summer as the community became dominated by young-of-the-year fish. A slight increase in average biomass occurred in the fall-winter period as juveniles grew or migrated to other nursery areas, leaving the more stable overwintering populations.

9. Results of trawl and seine collections during different tidal phases indicated that:

   a) There was no significant difference between numbers of fish or numbers of species caught by trawls during ebb or flood tide.

   b) Seines collected similar numbers of fish and species regardless of the tidal stage.

c) Of the prevalent species considered, only the spottail shiner exhibited a significant difference in abundance between ebb and flood catches. More spottail shiners were collected by seine after ebb tide than after flood tide.

d) Comparison of surface trawls and bottom trawls individually for ebb-flood differences showed that:

1. At the same station bottom trawls collected significantly more individuals and species than surface trawls on both tidal stages.

2. All ebb bottom trawls and all flood bottom trawls show no significant difference in numbers of fish or species caught.

3. Significantly more fish and more species were caught by ebb surface trawls than by flood surface trawls.

10. Evaluation of differences in day and night collections by trawl and seine showed that:

a) The number of fish caught by seines did not differ between day and night and, except for December, the number of species caught was also similar for both day and night collection. In December more species were caught at night than during the day.

b) Except for collections in July there were no day-night differences between the numbers of fish or species caught by trawl. In July significantly more fish and more species were collected by trawls during the day than at night.

c) Day-night differences in community structure based on diversity index values showed that:

1. Except for July and December, there were no significant day-night differences in diversity for pooled seine and trawl collections. July day collections had a significantly higher mean diversity than night collections. December night collections had a significantly higher mean diversity than day collections.

2. For all months except November the mean monthly diversity index based on seine collections was similar for day and night collections. In November, day collections had a significantly higher mean diversity than night collections.

3. Similar diversity was exhibited in all months, except December, for day and night trawl collections. Night trawl collections in December were significantly more diverse than daylight trawl collections.

d) Diversity index values were compared between day and night collections for pooled seine and trawl data and June day diversity was significantly greater than night diversity. December night diversity was significantly higher than day diversity.

e) Trawl station diversity values were tested for differences between day and night collections and showed that stations sampled in June had significantly higher daylight diversity values and those in December had higher diversity values for night collections.

f) Tests to determine if there was any significant difference between day and night collections by either trawl or seine for the prevalent species showed that:

1. Significantly more white perch were collected by day trawls than by night trawls.

2. Day collections of spottail shiner were significantly higher than at night collections for both trawls and seines.

3. Day and night collections of other prevalent species were not significantly different.

11. Community numerical abundance and biomass structure was evaluated for each month by an index of similarity.

a) Based on numbers of fish collected, the community structure was similar during July and August, and during the winter-spring period. During the summer months the community was dominated by juvenile white perch and blueback herring. In the winter-spring period, when water temperature was low, the resident faunal community was more in evidence.

b) June through October were the most similar based on community biomass structure due in large part to the high numbers of young-of-the-year fish dominating these collections.

c) The large numbers of young-of-the-year fish of several species also explains the high monthly affinity values for numbers and biomass during the summer-fall period when seines and trawls were compared separately.

12. Diversity index values for number of organisms and the biomass of the individuals from each seine and surface and bottom trawl collection showed that:

    a) Diversity of seine collections was greatest during the summer months and gradually declined in the later part of the year.

    b) The greatest bottom trawl diversity was found during the fall. Bottom trawl diversity was generally greater than surface trawl diversity which was consistently low throughout the year.

    c) Biomass diversity was much higher for seines than for trawls, indicating a broader distribution of weight among the near-shore species.

13. Comparisons of species numbers, diversity indices and numbers of organisms collected on the various tidal cycles and for the two time periods, day and night, at each station showed a great deal of variation in all areas sampled, with each station exhibiting faunal assemblages and activity different from the other stations.

14. Length distribution for white perch and striped bass indicated that:

    a) Striped bass young-of-the-year, first collected in July, averaged 4cm in length. At the end of the growing season, a length of approximately 9cm was attained.

    b) Length data for white perch collected during the spring indicated the presence of adult fish. The first young-of-the-year fish were collected in July and averaged 3cm in length. An average length

of 8cm was reached at the end of the growing season. White perch growth rates were similar in 1971 and 1973 and somewhat lower in 1972.

15. Analysis of striped bass and white perch scales to determine age and growth rates showed that:

a) The body length corresponding to scale formation in the striped bass was 14.4mm, with the first annulus formed around the end of June or early July. Comparison of Hudson River striped bass with those in other estuaries indicate that the Hudson River population had lower growth rates, especially those from the Roseton area.

b) For white perch from Haverstraw Bay and Roseton/Danskammer Point combined, the body length corresponding to scale formation was 25.3mm. Annuli formation occurred in all but two fish by August, and these formed around September. Younger fish appeared to form their annulus at an earlier date, around May and June.

c) Female white perch attained greater length during each year than males, and for both sexes the greatest growth was in the younger age groups. Hudson River white perch do not appear to reach the same length nor grow as fast as those from other areas, suggesting overcrowding of the population.

16. Based on the coefficient of maturity, spawning of white perch in the Roseton/Danskammer Point area was estimated to occur during June.

17. Stomach content analysis of fish collected during the spring and fall to determine feeding preference of selected species showed that:

a) Amphipods were the primary food item for white perch in both seasons with the smaller fish also feeding on dipterans in the spring.

b) Brown bullheads exhibited a more varied dietary pattern with the larger size fish feeding on blueback herring young in the spring and switching to amphipods and dipterans in the fall. The smaller bullheads fed on dipterans and amphipods in the spring.

c) Pumpkinseeds feed on dipterans, gastropods and amphipods in both seasons with preference depending on size group of fish.

d) Striped bass of the size examined preferred other fish during both seasons.

18. Much greater numbers of tomcod were impinged in 1973 than in 1972, suggesting that tomcod were more abundant in the river in 1973.

19. Impingement of white perch was about 30% higher in 1972 than in 1973. This was also reflected in river abundance data obtained for this species, suggesting that the rate of impingement may be directly related to river abundance.

20. The estimated number of all fish impinged in 1973 was twice that found in 1972. This increase is due in large part to the very great increase in impingement of tomcod in 1973 as compared to 1972.

21. There were significant differences between day and night impingement rates in 1973, with the differences due to increases in night impingement rather than to a decrease in day impingement rates.

22. Based on fish population diversity and length-frequency measurements, it appears that the impinged fish population is most closely related to the extant near-shore fish population and is probably recruited from this population.

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CENTRAL HUDSON GAS & ELECTRIC CORPORATION

1973

HUDSON RIVER AQUATIC ECOLOGY STUDIES AT ROSETON AND DANSKAMMER POINT

VOLUME VI

APPENDICES (PART 2)

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TABLE OF CONTENTS

REPORT

TABLE OF CONTENTS

Chapter

VOLUME I

SUMMARY OF FINDINGS AND CONCLUSIONS

I INTRODUCTION

II LOCAL CONDITIONS IN THE VICINITY OF ROSETON AND DANSKAMMER POINT AND THE RELATIONSHIP TO FAR-FIELD CONDITIONS

VOLUME II

III PHYTOPLANKTON, MICROZOOPLANKTON AND MACROZOOPLANKTON

IV BENTHOS

V FISH LARVAE

VOLUME III

VI FISH

VOLUME IV

VII HYDRODYNAMIC CHARACTERISTICS AND WATER QUALITY

VOLUME V

Appendices for Chapters I(A); III(A,B,C); IV(A)

VOLUME VI

Appendices for Chapters V(A,B); VI(A,B): VII(A,B,C,D,E)

VOLUME VI
APPENDICES (PART 2)

TABLE OF CONTENTS

Chapter	Appendix No.	Appendix Title
V	V-A	Fish Larvae Abundance and Composition
	V-B	Fish Larvae Length-Frequency
VI	VI-A	Fish Length Frequency for Ecological & Impingement Sampling at Roseton and Danskammer Point Generating Stations
	VI-B	Trawl, Seine, Trap & Gill Net Data
VII	VII-A	Major Water Quality Sampling Locations on the Hudson River
	VII-B	Discussion of Relevant Water Quality Parameters
	VII-C	Results of Monthly Water Quality Sampling
	VII-D	Statistical Summaries and Correlations 1973 Monthly Water Quality Sampling
	VII-E	Statistical Summaries and Correlations 1973 Monthly Water Quality Data Mile Points 37, 42, 80.8 and 96

APPENDIX V-A

APPENDIX V-A

ROSETON/DANSKAMMER POINT
1973
FISH LARVAE ABUNDANCE AND COMPOSITION

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	3/13/73	1028-1033	1720	.2023	30	148								148		
20'	"	"	1480	.1740	57	328								328		
0'	3/21/73	1436-1441	1880	.2211	45	203								203		
20-25'	"	1450-1455	2890	.3399	133	391								391		
0'	4/11/73	0945-0950	1690	.1987	1	5										5
10'	"	1150-1155	2370	.2787	0	0										
0'	5/10/73	1028-1030	1950	.2293	139	606	593			3						
0'	"	1929-1934	1600	.1882	20	106	106									
10'	"	1052-1057	1540	.1811	308	1701	1673			28						
10'	"	1945-1950	1650	.1940	2	10	10									
0'	5/22-23/73	1145-1150	1570	.1846	554	3001	2622	379								
0'	"	1740-1745	1520	.1788	329	1840	1840									
0'	"	0025-0030	1360	.1599	111	694	SAMPLE	LOST								
0'	"	0354-0359	1540	.1811	265	1463	1404	22								
0'	"	0723-0728	1310	.1541	151	980	SAMPLE	LOST								
10'	"	1145-1150	1140	.1341	260	1939	1931					8				

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	5/22-23 /73	1740-1745	1320	.1552	303	1952	1952									
10'	"	0025-0030	1360	.1599	12	75	50	13	6		6					
10'	"	0354-0359	1540	.1811	111	613	552	17			27	17				
20'	"	0436-0441	1750	.2058	271	1317	1244	44			9	5	5	5		5
30'	"	0436-0441	1750	.2058	336	1642	1574	10	10		29	5		9		5
0'	6/7-8/73	1945-1950	1580	.1858	42	226										
0'	"	0318-0323	1940	.2281	389	1705	1390		276	17	13					9
0'	"	0720-0725	1590	.1870	1103	5898										
0'	"	0845-0850	1490	.1752	120	685										
10'	"	2013-2018	1890	.2223	183	823										
10'	"	0318-0323	1650	.1940	122	628	505		72	41	10					
10'	"	0720-0725	1590	.1870	1685	9011										
10'	"	0845-0850	1490	.1752	303	1729										
20'	"	1945-1950	1380	.1361	373	2740										
20'	"	2013-2018	1660	.1952	243	1245										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	6/7-8/73	0440-0445	1650	.1940	308	1586	1531		15	5	15		15			5
30'	"	1945-1950	1260	.1482	164	1106										
30'	"	0440-0445	1330	.1564	183	1247	1036		25	13	19					77
0'	6/19-20/73	1045-1050	1700	.1999	701	3507	3402	100			5					
0'	"	1753-1758	1810	.2129	70	329										
0'	"	1930-1935	1900	.2234	54	241	233	4	4							
0'	"	0710-0715	1790	.2105	517	2456										
10'	"	1100-1105	1340	.1576	37	235	102		32	82	19					
10'	"	2012-2017	1720	.2023	51	252	422		5	5						
10'	"	0510-0517	1740	.2046	620	3030										
20'	"	1100-1105	2270	.2670	76	285	225			56		4				
20'	"	2012-2017	1690	.1991	4	20	5			15						
20'	"	0510-0515	1790	.2105	946	4494										
30'	"	1045-1050	1730	.2034	45	222	84		15	108	15					
30-35'	"	1930-1935	1630	.1917	251	1309	788		193	302	26					

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	7/17-18 73	0024-0029	2150	.2528	66	261	87		32	138						4
*10'	"	0024-0029	2520	.0741	4	54	27			27						
20'	"	1840-1845	1410	.1658	1	6			6							
20'	"	2300-2305	1280	.1505	12	79	66		13							
20'	"	0603-0608	1240	.1458	4	28	7		14	7						
0'	7/31/73 8/1/73	1000-1005	1080	.1270	0	0										
0'	"	1738-1743	1760	.2070	0	0										
0'	"	2023-2028	1830	.2152	0	0										
0'	"	0035-0040	1500	.1764	5	28	23			5						
0'	"	0523-0528	1720	.2023	6	70	10		30							30
10'	"	1020-1025	2110	.2481	1	4										4
*10'	"	1020-1025	2600	.0764	0	0										
10'	"	1421-1426	1700	.1999	0	0										
*10'	"	1421-1426	4194	.1233	0	0										
10'	"	1755-1800	2210	.2599	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*10'	7/31/73 8/1/73	1755-1800	2710	.0797	0	0										
10'	"	2042-2047	2310	.2717	2	8				4						4
*10'	"	2042-2047	1910	.0562	0	0										
10'	"	0103-0108	2340	.2752	5	18	18									
*10'	"	0103-0108	3080	.0906	1	11	11									
10'	"	0559-0604	2530	.2975	0	0										
*10'	"	0559-0604	2770	.0814	0	0										
20'	"	1000-1005	1530	.1799	0	0										
20'	"	1738-1743	1540	.1811	0	0										
20'	"	2023-2028	1670	.1964	0	0										
20'	"	0035-0040	1780	.2093	11	53	34			19						
20'	"	0523-0528	1960	.2305	26	112	82		4	26						
0'	8/14-15 73	0949-0954	1350	.1588	0	0										
0'	"	1620-1625	1390	.1635	0	0										
0'	"	2004-2009	2580	.3634	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	8/14-15 73	0226-0231	1720	.2023	0	0										
10'	"	1008-1013	2370	.2788	0	0										
*10'	"	1008-1013	1600	.0470	0	0										
10'	"	1638-1643	1480	.1740	0	0										
*10'	"	1638-1643	90	.0026	0	0										
10'	"	2024-2029	1560	.1835	0	0										
*10'	"	2024-2029	1920	.0564	0	0										
10'	"	0247-0252	1790	.2105	0	0										
20'	"	0949-0954	930	.1094	0	0										
20'	"	1620-1625	1310	.1541	0	0										
20'	"	1808-1813	1240	.1458	0	0										
*20'	"	1808-1813	1520	.0447	0	0										
20'	"	2004-2009	1130	.1329	0	0										
20'	"	0553-0558	1860	.2187	1	5										
0'	8/29-30 73	0104-0109	2090	.2458	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDE

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	8/29-30 73	0104-0109	1940	.2281	0	0										
0'	"	0534-0539	2210	.2599	9	9										
0'	"	0534-0539	2410	.2834	0	0										
10'	"	2305-2310	1620	.1905	0	0										
10'	"	2305-2310	1870	.2199	0	0										
*10'	"	0740-0745	2750	.0809	0	0										
*10'	"	0740 0745	4340	.1276	0	0										
20'	"	2248-2253	1760	.2070	0	0										
20'	"	2248-2253	1990	.2340	0	0										
20'	"	0617-0622	1660	.1952	0	0										
20'	"	0617-0622	2320	.2728	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	4/11/73	0932-0937	2030	.2387	0	0										
10'	"	1135-1140	2450	.2881	0	0										
0'	5/10/73	1013-1018	1990	.2340	84	358	350			8						
0'	"	1918-1923	2110	.2481	21	85	85									
10'	"	1957-2002	1630	.1917	14	73	73									
20'	"	2130-2135	2050	.2411	4	12	12									
30'	"	1124-1129	1860	.2187	82	375	375									
30'	"	1306-1311	1570	.1846	343	1858	1853			5						
30'	"	2156-2201	1540	.1841	0	0										
40'	"	1417-1422	1620	.1905	108	568	556		6	6						
40'	"	2338-2343	0990	.1164	0	0										
50'	"	2354-2359	1710	.2011	3	15	15									
0'	5/22-23/73	1125-1130	1690	.1987	404	2033	2033									
0'	"	1805-1810	1350	.1576	330	2094	2094									
0'	"	0045-0050	1220	.0359	17	501	501									

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	5/22-23/73	0045-0050	1220	.1437	120	836	787				49					
0'	"	0316-0321	1410	.1658	776	4680	4294	356			30					
0'	"	0737-0742	2400	.2822	198	702	702									
10'		1125-1130	1530	.1799	152	845	834				11					
*10'	"	1520-1525	2010	.0591	253	4281	3942	339								
10'	"	1520-1525	1780	.2093	1041	4974	4974									
10'	"	1805-1810	1130	.1393	234	1761	1753		8							
10'	"	0005-0010	1160	.1364	2	15					15					
10'	"	0316-0321	1410	.1658	288	1737	1635	60	6	18	12	6				
20'	"	1210-1215	1620	.1905	98	514		5	5	5	5	499				
20'	"	2200-2205	1240	.1458	2	14	7					7				
20'	"	0005-0010	1160	.1364	1	7	7									
20'	"	0456-0501	1640	.1929	798	4137	3981	130		26						
30'	"	1210-1215	1380	.1623	2	12	12									
30'	"	2200-2205	1240	.1458	1	7	7									

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	5/22-23/73	2220-2225	1440	.1693	10	59	29.5				29.5					
30'	"	0456-0501	1640	.1929	440	2281	342	1887			52					
40'	"	1350-1355	1770	.2082	392	1883	1873	5		5						
40'	"	1350-1355	1890	.0556	61	1097	899	144			54					
40'	"	2220-2225	1440	.1693	1	6					6					
40'	"	0702-0707	2010	.2364	175	740	719	13			4	4				
50'	"	0702-0707	2010	.2364	211	888	821	42	4	4	13					4
0'	"	1921-1926	1620	.1905	170	892										
0'	"	2328-2333	1570	.1846	97	525	114	5	5	406						
0'	"	0258-0303	1850	.2176	103	473										
0'	"	0702-0707	1710	.2011	459	2282										
0'	"	0910-0915	1570	.1846	443	2400										
10'	"	2036-2041	1380	.1623	431	2656										
10'	"	2328-2333	1370	.1611	81	621	106		279							118
10'	"	0258-0303	2030	.2387	125	524										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	6/7-8/73	0702-0707	1610	.1893	849	4485										
10'	"	0910-0915	1690	.1991	182	914										
20'	"	1921-1926	1130	.1329	247	1792										
20'	"	0424-0429	1720	.2023	169	835	553		198	84						
30'	"	1921-1926	1130	.1329	141	1061										
30'	"	2328-2333	1250	.1470	81	551										
30'	"	0424-0429	1640	.1929	131	678	575		98	5						
40'	"	2036-2041	1430	.1682	279	1658										
40'	"	0015-0020	1610	.1893	62	396	206		43		10					69
40'	"	0052-0057	1570	.1846	231	1251										
50'	"	2036-2041	1330	.1564	160	1023										
50'	"	0015-0020	1550	.1823	34	186	132		38	16						
50'	"	0552-0557	1360	.1599	234	1463										
0'	6/19-20 73	1015-1020	1830	.2152	294	1366	1324		5	32	5					
0'	"	1727-1732	1650	.1940	14	72										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	6/19-20/73	2232-2237	1930	.2274	434	1909										
0'	"	2340-2345	1660	.1952	172	881	784		10	46	41					
0'	"	0654-0659	1600	.1882	271	1440										
10'	"	1120-1125	1390	.1635	232	1419	826		24	563	6					
10'	"	2033-2038	1540	.1801	26	143										
10'	"	0140-0145	1760	.2070	331	1599	1512		48	29	5					5
20'	"	1120-1125	1800	.2121	117	551	75		70	401	5					
20'	"	2033-2038	1240	.1458	158	1084										
20'	"	0140-0145	1770	.2082	326	1566	1244	5	149	168						
30'	"	1320-1324	1790	.2105	305	1449										
30'	"	2202-2207	1640	.1932	165	1170	507		16	16						316
30'	"	2232-2237	1630	.2860	268	934										
30'	"	0528-0533	1970	.2317	514	2218										
40'	"	1320-1325	1800	.2117	185	874	775		9	71	19					
40'	"	2202-2207	1500	.1764	5	28										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
40'	6/19-20 73	0528-0533	1860	.2187	681	3114										
50'	"	1015-1020	1640	.1929	41	212	52		47	72	41					
50-55'	"	1727-1732	1470	.1729	434	2510										
50'	"	2340-2345	1640	.1929	170	907	586		36	223	10					26
50'	"	0654-0659	1510	.1776	249	1402										
0'	7/2-3/73	1027-1032	2190	.2575	385	1495										
0'	"	1352-1357	1880	.2211	114	516	511								5	
0'	"	1808-1813	2280	.2681	150	559										
0'	"	2207-2212	2040	.2399	69	288	246			17	4				21	
0'	"	0503-0508	1980	.2328	8	34										
10'	"	1129-1134	2740	.3222	41	127										
10'	"	1508-1513	1820	.2140	19	89										
10'	"	1932-1937	2060	.2423	33	136										
10'	"	0122-0127	2730	.3210	458	1427										
20'	"	1232-1237	3190	.3751	97	258	248			5	5					

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*20'	7/2-3/73	1232-1237	1440	.0423	4	94	47				47					
20'	"	1700-1705	2450	.2881	67	233	205			21	7					
*20'	"	1700-1705	3230	.0950	9	94	74		10		10					
20	"	2045-2050	2880	.3387	36	106	94			6	3				3	
*20'	"	2045-2050	3110	.9143	17	19	18			1						
20'	"	0320-0325	2350	.2764	85	308	217	80	4							7
*20'	"	0320-0325	1010	.1188	0	0										
30'	"	1129-1134	1870	.2199	30	136										
30'	"	1508-1513	1720	.2023	41	203										
30'	"	1932-1937	1950	.2293	43	188										
30'	"	0122-0127	1890	.2223	513	2308										
40'	"	1027-1032	1800	.2117	13	61										
40'	"	1352-1357	1590	.1870	17	91	27			64						
40'	"	1808-1813	2260	.2658	4	15										
40'	"	2207-2212	2350	.2764	249	897	817		4	76						

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
40'	7/2-3/73	0503-0508	1830	.2152	627	2914										
0'	7/17-18 73	0942-0947	1640	.1929	18	93										
0'	"	1442-1447	1070	.1258	4	32	32									
0'	"	1823-1828	1540	.1811	3	17										
0'	"	2240-2245	2580	.3034	0	0										
0'	"	0538-0543	1080	.1270	4	31										
10'	"	1100-1105	1150	.1352	2	15										
10'	"	1609-1614	1088	.1270	0	0										
10'	"	2001-2006	1880	.2211	1	5										
10'	"	0055-0100	1620	.1905	8	42										
20'	"	1317-1322	1640	.1929	7	36	5		10	21						
*20'	"	1317-1322	1770	.0520	0	0										
20'	"	1720-1725	1480	.1740	8	46				46						
*20'	"	1720-1725	1850	.0544	0	0										
20'	"	2129-2134	1700	.1999	7	35	30			5						

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*20'	7/17-18/73	2129-2134	1960	.0576	0	0										
20'	"	0310-0315	970	.0285	2	76			38	38						
20'	"	0310-0315	1780	.2093	101	482	105		57	320						
30'	"	1100-1105	1380	.1623	2	12										
30'	"	1609-1614	1100	.1294	32	247										
30'	"	2001-2006	1770	.2082	10	48										
30'	"	0055-0100	1510	.1776	23	130										
40'	"	1442-1447	1070	.1258	7	56			16	32	8					
40'	"	1823-1828	1200	.1411	14	99										
40'	"	2240-2245	1900	.2234	4	18	13			5						
40'	"	0503-0508	1290	.1517	17	112										
0'	7/31/73 8/1/73	0928-0933	610	.0717	0	0										
0'	"	1326-1331	1210	.1423	0	0										
0'	"	1356-1401	2110	.2481	0	0										
0'	"	1718-1723	1420	.1670	0	0										

** 1/2 Meter Net*

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	7/31/73 8/1/73	2001-2006	1650	.1940	0	0										
0'	"	0006-0011	1610	.1893	4	21	2									
0'	"	0500-0505	1880	.2211	21	95	90		5							
10'	"	1045-1050	1190	.1399	0	0										
10'	"	1448-1453	1740	.2046	0	0										
10'	"	1810-1815	1790	.2105	0	0										
10'	"	2104-2109	1680	.1979	3	15	15									
10'	"	0127-0132	2620	.3081	4	13	10									
10'	"	0618-0623	1320	.1552	14	90	71		19							
20'	"	0928-0933	1180	.1388	0	0										
20'	"	1326-1331	1440	.1693	0	0										
20'	"	1356-1401	1870	.2199	0	0										
20'	"	1718-1723	1340	.1576	0	0										
20'	"	2001-2006	1230	.1446	0	0										
20'	"	0006-0011	1460	.1717	7	41	35			6						

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	7/31/73 8/1/73	1045-1050	1490	.1752	0	0										
30'	"	1448-1453	1870	.2199	0	0										
30'	"	1810-1815	1730	.2034	0	0										
30'	"	2104-2109	1530	.1799	0	0										
30'	"	0127-0132	1790	.2105	9	43	38									5
30'	"	0618-0623	2270	.2670	4	15	4			11						
40'	"	0928-0933	1370	.1614	1	6	6									
40'	"	1326-1331	1610	.1893	0	0										
40'	"	1718-1723	1280	.1505	0	0										
40'	"	0006-0011	1420	.1670	15	90	48		30	12						
40'	"	0500-0505	2080	.2446	9	37	25			12						
0'	8/14-15 73	0932-0937	1740	.2046	0	0										
0'	"	1602-1607	1320	.1552	0	0										
0'	"	1951-1956	2580	.3034	0	0										
0'	"	0212-0217	1920	.2258	1	4										4

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	8/14-15 73	1026-1031	260	.0306	0	0										
10'	"	1703-1708	1070	.1258	0	0										
10'	"	2045-2050	1490	.1752	3	17	17									
10'	"	0302-0307	1050	.1235	7	57										
20'	"	1310-1315	1590	.1870	0	0										
*20'	"	1310-1315	1800	.0529	0	0										
20'	"	2212-2217	1780	.2097	4	18	14									4
20'	"	0537-0542	1920	.2258	7	31	18		9							4
30'	"	1026-1031	1000	.1176	0	0										
30'	"	1703-1708	1070	.1258	0	0										
30'	"	2045-2050	1300	.1529	0	0										
30'	"	0608-0613	1790	.2105	0	0										
0'	8/29-30 73	0048-0053	1770	.2082	3	14										
0'	"	0048-0053	1720	.2023	2	10										
0'	"	0516-0521	1840	.2164	2	9										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDECH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	8/29-30 73	0516-0521	2330	.2740	2	7										
20'	"	2318-2323	1620	.1905	0	0										
20'	"	2318-2323	1900	.2234	0	0										
20'	"	0630-0635	1780	.2093	0	0										
20'	"	0630-0635	2390	.2811	0	0										
40'	"	2045-2050	1730	.2034	0	0										
40'	"	2045-2050	1960	.2305	0	0										
40'	"	0802-0809	2320	.2728	0	0										
40'	"	0802-0809	1830	.2152	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	4/11/73	0915-0920	2390	.2810	0	0										
10-	"	1115-1120	2160	.2540	1	4								4		
0'	5/10/73	0949-0945	2080	.2446	54	221	221									
0'	"	1905-1910	1520	.2675	127	464	456			4						4
10'	"	1135-1140	1540	.1811	129	712	129									
10'	"	2011-2016	1740	.2046	5	24	24									
20'	"	1230-1235	1820	.2140	17	79	79									
20'	"	1246-1251	1510	.1775	221	1245	1245									
20'	"	2108-2113	1660	.1952	7	36	36									
30'	"	1324-1329	1600	.1881	75	399	388		11							
30'	"	2230-2235	1890	.2222	0	0										
40'	"	1400-1405	1850	.2175	22	101	101									
40'	"	2314-2319	2370	.2787	21	75	72		3							
50'	"	1430-1435	1610	.1893	9	48	42	6								
50'	"	1605-1610	1770	.2081	4	19	19									

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
50'	5/11/73	0018-0023	1900	.2234	3	12	4		4	4						
0'	5/22/73	1045-1050	1670	.1963	325	1656	1636				6					
0'	"	1640-1645	1370	.1611	57	353	186	12			17					
0'	"	2050-2055	1530	.1799	66	367	367		10		10					
0'	5/22-23/73	0754-0759	1860	.2187	98	448	448		155							
10'	"	1045-1050	1760	.2069	51	246	NO SAMPLE									
10'	"	1640-1645	1500	.1764	24	136	130	6								
10'	"	2025-2030	1390	.1634	36	220	208	12								
10'	"	2340-2345	1530	.1799	0	0										
10'	"	0248-0253	1490	.1752	98	572	388	154			17					11
20'	"	1305-1310	1710	.2010	17	85	85									
20'	"	1445-1450	1370	.1611	50	310	298				12					
*20'	"	"	1890	.0555	8	144	144									
20'	"	2115-2120	1510	.1775	5	28	28									
20'	"	2340-2345	1530	.1799	2	11					11					

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	5/22-23/73	0517-0522	1620	.1905	102	535	505	10		5	10		5			
30'	"	1305-1310	1930	.2269	86	379	366		4		9					
30'	"	2115-2120	1510	.1775	2	11	11									
30'	"	2245-2250	1430	.1681	65	387	381			6						
30'	"	0517-0527	1620	.1905	43	226	SAMPLE	LOST								
*40'	"	1335-1340	1760	.0518	16	309	193	116								
40'	"	1335-1340	1540	.1811	35	193	193									
40'	"	2245-2250	1430	.1681	3	18	12				6					
40'	"	0639-0644	1490	.1752	45	257	257									
50'	"	0639-0644	1490	.1752	108	616	594	17			5					
+0'		1107-1112	1450	.1705	230	1349	1349									
+10'	"	1107-1112	1650	.1940	35	181	165			5	11					
+20'	"	1240-1245	1430	.1681	107	636	606	18	6		6					
+30'	"	1240-1245	2440	.2869	197	687	614	10			63					
+40'	"	1410-1415	1270	.1494	108	729	696	7			26					

+ Channel Station
*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
+50'	5/22-23/73	1410-1415	1270	.1494	42	281	74	174			33					
0'	6/7-8/73	1858-1903	2180	.2564	58	226										
0'	"	2240-2245	1650	.1940	542	2794	856		1871	26	14					
0'	"	0236-0241	1850	.2176	44	202										
0'	"	0643-0648	1790	.2105	31	147										
0'	"	0930-0935	1400	.1646	70	425										
10'	"	2055-2100	1500	.1764	605	3430										
10'	"	2240-2245	1460	.1717	425	2475	373		2038	47	17					
10'	"	0236-0241	1680	.1976	102	516										
10'	"	0643-0648	1790	.2105	53	252										
10'	"	0930-0935	2270	.2670	51	191										
20'	"	1858-1903	1140	.1341	104	775										
20'	"	0405-0410	1460	.1717	195	1136	349		764	17	6					
30'	"	1858-1903	910	.1070	199	1860										
30'	"	2240-2245	1570	.1846	305	1652	130		1511	11						

+Channel Station

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	6/7-8/73	0405-0410	1460	.1717	193	1124										
30'	"	1039-1044	2350	.2764	118	427										
40'	"	2055-2100	1330	.1564	162	1036										
40'	"	0035-0040	1680	.1976	233	1179	223		941	5	10					
40'	"	0520-0525	2050	.2411	226	938										
50'	"	2055-2100	1600	.1882	93	494										
50'	"	0035-0040	1630	.1917	189	986	266		709	11						
50'	"	0520-0525	2150	.2528	588	2326										
0'	6/19-20 73	0951-0956	1380	.1623	159	979										
0'	"	1655-1700	1160	.1364	34	249	117			132						
0'	"	0000-0005	1870	.2199	296	1346	*MISSING VIAL		95	9						
0'	"	0633-0638	1570	.1846	136	737										
10'	"	1145-1150	1600	.1882	579	3076	2136		21	903			16			
10'	"	2049-2054	1260	.1482	2	14										
10'	"	0057-0102	1400	.1646	104	740	480		12	18	12					109

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	6/19-20 73	1145-1150	1620	.1905	258	1354	299		142	903	10					
20'	"	2049-2054	1220	.1435	232	1617										
20'	"	0057-0102	1290	.1517	88	593			13							13
30'	"	1240-1245	1920	.2258	180	797										
30'	"	2139-2144	1500	.1764	98	555										
30'	"	0547-0552	1620	.1905	220	1155										
40'	"	1240-1245	1860	.2187	184	841	142		59	617	23					
40'	"	2139-2144	1490	.1765	80	453										
40'	"	0547-0552	1730	.2034	122	600										
50'	"	0951-0956	940	.1105	51	461										
50'	"	1655-1700	1300	.1529	4	26										
50'	"	0000-0005	1520	.1788	211	1258	861		185	50	6					78
50-55'	"	0633-0638	1450	.1705	53	311			13		13					
+50'	"	1406-14011	1810	.2129	87	409										
+50'	"	1406-1411	1450	.1705	62	363										

+ Channel Station

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	7/2-3/73	0915-0920	2080	.2446	44	180										
0'	"	1332-1337	1760	.2070	71	343	338								5	
0'	"	1742-1747	2150	.2528	1212	4794										
0'	"	2132-2137	2160	.2540	70	276	260				8	4				4
0'	"	0435-0440	1590	.1870	3	16										
10'	"	1155-1200	1590	.1870	10	53										
10'	"	1555-1600	2000	.2352	7	30										
10'	"	1947-1952	2200	.2587	24	93										
10'	"	0145-0150	1530	.1799	106	589										
20'	"	0915-0920	1270	.1494	2	13										
*20'	"	1638-1643	2700	.0794	1	13	13									
20'	"	1638-1643	2500	.2940	7	24	24									
*20'	"	2037-2042	2920	.0858	2	23	23									
20'	"	2037-2042	3270	.3846	11	29	26								3	
*20'	"	0241-0246	1540	.1811	15	83	83									

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	7/2-3/73	0241-0246	2360	.2775	242	872	857		4	11						
30	"	1155-1200	1830	.2152	19	88										
30'	"	1555-1600	1840	.2164	3	14										
30'	"	1947-1952	2070	.2434	16	66										
30'	"	0145 0150	1440	.1693	97	573										
40'	"	0915-0920	1250	.1470	4	27										
40'	"	1332-1337	1890	.2223	19	85	36		9	40						
40'	"	1742-1747	2200	.2587	17	66										
40'	"	2132-2137	2940	.3457	46	133	130			3						
40'	"	0435-0440	1530	.1799	59	328										
0'	7/17-18 73	0911-0916	1440	.1693	6	35										
0'	"	1356-1401	1450	.1705	0	0										
0'	"	1800-1805	1360	.1599	1	6										
0'	"	2214-2218	1320	.1552	6	38	26		6	6						
0'	"	0503-0508	1110	.1305	1	8										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	7/17-18 73	1133-1138	1160	.1364	1	7										
10'	"	1628-1633	1250	.1470	1	7										
10'	"	2027-2032	1410	.1658	0	0										
10'	"	0137-0142	1270	.1494	16	123										
20'	"	1300-1305	1750	.2058	5	24			14	10						
*20'	"	1300-1305	1970	.5792	0	0										
20'	"	1705-1710	1620	.1905	2	10				10						
*20'	"	1705-1710	2080	.0612	0	0										
20'	"	2108-2113	1890	.2223	6	27	22			5						
*20'	"	2108-2113	2160	.0635	2	31			31							
20'	"	0235-0240	1960	.2305	22	95	69			22						
*20'	"	0235-0240	3260	.0958	3	31	31									
30'	"	1133-1138	1390	.1635	0	0										
30'	"	1628-1633	1320	.1552	1	6										
30'	"	2027-2032	1510	.1776	5	28										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	7/17-18 73	0137-0142	1660	.1952	12	61										
40'	"	0911-0916	1540	.1814	0	0										
40'	"	1356-1401	1520	.1788	0	0										
40'	"	1800-1805	1270	.1494	3	20										
40'	"	2214-2218	1800	.2121	7	33	28		5							
40'	"	0503-0508	1290	.1517	17	112										
0'	7/31/73 8/1/73	0857-0902	1060	.1247	0	0										
0'	"	1300-1305	970	.1141	2	18										
0'	"	1657-1702	1410	.1658	0	0										
0'	"	1937-1942	1430	.1682	0	0										
0'	"	2330-2335	1520	.1788	0	0										
0'	"	0412-0417	1590	.1870	2	10	5		5							
10'	"	1108-1113	1640	.1929	0	0										
10'	"	1530-1535	1510	.1776	0	0										
10'	"	1826-1831	1580	.1858	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	7/31/73 8/1/73	2142-2147	1650	.1940	0	0										
10'	"	0149-0154	1610	.1897	2	11	11									
10'	"	0639-0644	1500	.1764	0	0										
20'	"	0857-0902	1300	.1529	0	0										
20'	"	1300-1305	1290	.1517	0	0										
20'	"	1657-1702	1220	.1435	0	0										
20'	"	1937-1942	1460	.1717	0	0										
20'	"	2330-2335	1450	.1705	8	47	47									
*20'	"	0720-0725	---	---	0	0										
20'	"	0720-0725	30	.0035	0	0										
30'	"	1108-1113	820	.0964	0	0										
30'	"	1530-1535	1930	.2270	0	0										
30'	"	1826-1831	1680	.1976	1	5					5					
30'	"	2142-2147	1670	.1964	0	0										
30'	"	0149-0154	1790	.2105	3	14	14									

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	7/31/73 8/1/73	0639-0644	2060	.2423	3	12	12									
40'	"	0857-0902	1020	.1200	1	8	8									
40'	"	1300-1305	1250	.1470	0	0										
40'	"	1657-1702	1250	.1470	0	0										
40'	"	1937-1942	1370	.1611	1	6	6									
40'	"	2330-2335	2030	.2387	14	58	46			4						8
40'	"	0435-0440	2850	.3352	8	24	21		3							
0'	8/14-15 73	0909-0914	1400	.1649	0	0										
0'	"	1542-1547	1630	.1917	0	0										
0'	"	1918 1923	1460	.1717	0	0										
0'	"	1940-1945	1470	.1729	0	0										
0'	"	0133-0138	2190	.2575	0	0										
10'	"	1050-1055	1160	.1364	0	0										
10'	"	1720-1725	2200	.2588	0	0										
10'	"	2106-2111	1200	.1435	2	14	7									7

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	8/14-15 73	0325-0330	2650	.3116	0	0										
20'	"	1252-1257	1280	.1505	0	0										
*20'	"	1252-1257	1670	.0491	0	0										
20'	"	1753-1758	1450	.1705	0	0										
*20'	"	1753-1758	1720	.0506	0	0										
20'	"	1918-1923	1250	.1470	0	0										
20'	"	2158-2203	1470	.1729	3	17				6						11
20'	"	0518-0523	1460	.1717	1	6										6
30'	"	1050-1055	1180	.1388	0	0										
30'	"	1720-1725	1390	.1638	0	0										
30'	"	2106-2111	1520	.1788	1	6	6									
30'	"	0625-0630	1720	.2023	1	5	5									
40'	"	0909-0914	1710	.2015	0	0										
40'	"	1542-1547	1380	.1623	0	0										
40'	"	1940-1945	1190	.1399	0	0										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDWCH							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	8/29-30 73	0032-0037	1530	.1799	0	0										
0'	"	0032-0037	1960	.2305	2	9										
0'	"	0500-0505	2236	.2630	1	4										
0'	"	0500-0505	2930	.3346	1	3										
20'	"	2345-2350	1610	.1893	0	0										
20'	"	2345-2350	2100	.2470	1	4										
20'	"	0651-0656	2190	.2575	0	0										
20'	"	0651-0656	2800	.3293	0	0										
40'	"	2025-2030	1810	.2129	0	0										
40'	"	2025-2030	1580	.1858	0	0										
40'	"	0821-0826	1780	.2093	0	0										
40'	"	0821-0826	2420	.2846	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'25'	3/21/73	1355-1400	1740	.2046	393	1921								1921		
0'	"	1412-1417	2340	.2752	290	1054								1054		
0'	4/11/73	0900-0905	2450	.2881	0	0										
10'	"	1100-1105	2110	.2481	0	0										
*0'	5/3/73	0835-0840	3020	.0888	2	23	23									
*35'	"	"	2550	.0751	4	53	53									
0'	5/10/73	0933-0938	2240	.2634	84	319	319									
0'	"	1808-1813	1360	.1599	8	50	50									
10'	"	1150-1155	1700	.1999	187	935	930			5						
10'	"	2028-2033	1360	.1599	2	13	13									
20'	"	1209-1214	1790	.2105	111	523	508		5	10						
20'	"	2044-2049	1510	.1775	0	0										
30'	"	1340-1345	1580	.1858	3	16	16									
30'	"	2257-2302	2350	.2763	18	65	65									
0'	5/22-23/73	1010-1015	1400	.1646	192	1166	1166									

*1/2Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	5/22/73	1620-1625	1510	.1764	145	750	720	22								6
0'	"	2025-2030	2270	.2674	415	1465	1369	45	4	15						32
0'	"	0148-0158	2280	.2686	1293	4811	4685	7	7		108					4
*0'	"	0148-0158	2280	.0671	227	3364	3299	45			20					
0'	"	0230-0235	NO SAMPLE													
0'	"	0809-0814	NO SAMPLE													
10'	"	1010-1015	1590	.1873	41	218	218									
10'	"	1620-1625	1500	.1764	43	244	227	17								
10'	"	2025-2030	1400	.1649	90	511	491				18					6
10'	"	2325-2330	1440	.1693	1	6	6									
10'	"	0230-0235	1670	.1964	204	1044	983	36	5		10					5
20'	"	2325-2330	1440	.1693	3	18	12				6					
30'	"	0556-0601	1610	.1893	111	586	571		5	5	5					
30'	"	0556-0601	1610	.1893	284	1500	1431	21	16		32					
40'	"	0619-0624	1330	.1564	35	224	205	13			6					
50'	"	0619-0624	1330	.1564	137	876	857				19					

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	6/7-8/73	1820-1825	1250	.1470	103	701										
0'	"	2210-2215	1620	.1905	233	1223	16		1171	10	10					16
0'	"	2347-2352	1540	.1811	78	430										
0'	"	0212-0217	1860	.2187	333	1522										
0'	"	0628-0633	1740	.2046	114	557										
0'	"	0946-0951	2020	.2376	195	821										
10'	"	2124-2129	1960	.2305	218	945										
10'	"	2210-2215	1480	.1740	248	1425	46	11	1310	35	6		6		11	
10'	"	2347-2352	---	---	0	0										
10'	"	0212-0217	1430	.1682	124	737										
10'	"	0628-0633	1590	.1870	167	893										
10'	"	0946-0951	2090	.2458	164	667										
20'	"	1820-1825	1380	.1623	183	1127										
20'	"	2124-2129	1440	.1693	105	620	224		325	6	12		6			47
20'	"	0345-0350	1500	.1764	214	1213										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	6/7-8/73	1820-1825	1520	.1788	100	559										
30'	"	2210-2215	1100	.1294	139	1151	124	8	796	15	54					77
30'	"	2347-2352	1270	.1494	0	0										
30'	"	0345-0350	1500	.1764	214	1213										
30'	"	1020-1025	2410	.2834	511	1803										
0'	6/19-2073	0925-0930	1710	.2011	758	3769										
0'	"	1453-1458	1420	.1673	368	2200	1447	6	6	741						
0'	"	0018-0023	1360	.1599	203	1269	976	181	19	62	31					
0'	"	0611-0616	2010	.2364	249	1053										
10'	"	1205-1210	1542	.1813	129	711	496		11	199	5					
10'	"	2110-2115	1630	.1917	54	281										
10'	"	0037-0042	1320	.1552	84	559	509		6				6			19
20'	"	1205-1210	1710	.2011	93	462	194		44	219	5					
20'	"	2110-2115	1230	.1449	56	386										
20'	"	0037-0042	1570	.1846	164	88	834			16	38					

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
30'	6/19-20 73	0925-0930	940	.1105	44	398										
30'	"	1453-1458	1120	.1317	23	174	23		38	106	7					
30'	"	0018-0023	1230	.1446	125	864	816		7	7	34					
30'	"	0611-0616	1620	.1905	109	572										
0'	7/2-3/73	0850-0855	1950	.2293	110	480										
0'	"	1313-1318	1750	.2058	104	505	495				10					
0'	"	1723-1728	2160	.2540	84	331										
0'	"	2108-2113	2590	.3046	102	335										
0'	"	0400-0405	2100	.2470	60	243	227			8			4			4
10'	"	1214-1219	1960	.2305	26	113	91		9	9	4					
*10'	"	1214-1219	2360	.0694	0	0										
*10'	"	1620-1625	2710	.0792	0	0										
10'	"	1620-1625	2380	.2799	9	33	25			4	4					
*10'	"	2008-2013	2790	.0820	3	37	37									

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
10'	7/2-3/73	2008-2013	2340	.2752	23	84	84									
*10'	"	0215-0220	1890	.0556	13	234	198			36						
10'	"	0215-0220	2070	.2434	201	826	793		8	25						
20'	"	0850-0855	1420	.1670	3	18										
20'	"	1313-1318	1770	.2082	0	0										
20'	"	1723-1728	1890	.2223	7	31										
20'	"	2108-2113	1650	.1940	219	113										
	"	0400-0405	2410	.2834	265	935	843		56	32						4
0'	7/17-18 73	0812-0817	1300	.1529	11	72	72									
0'	"	1338-1343	1270	.1493	7	47	47									
0'	"	1549-1504	1260	.1482	2	13	13									
0'	"	1539-1544	1540	.1811	3	17	11			6						
0'	"	2152-2157	1560	.1835	2	11	11									
0'	"	0428-0433	1390	.1635	7	42	24			18						
10'	"	1145-1150	1690	.1987	0	0										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*10'	7/17-18 73	1145-1150	1720	.1807	0	0										
10'	"	1648-1653	1530	.1799	0	0										
*10'	"	1648-1653	1760	.2070	0	0										
10'	"	2050-2055	1810	.2131	0	0										
*10'	"	2050-2055	1910	.2246	0	0										
10'	"	0215-0220	1630	.1917	19	99	68			31						
*10'	"	0215-0220	1870	.0550	3	54	36			18						
20'	"	0812-0817	1250	.1470	1	7				7						
20'	"	1338-1343	1710	.2011	5	25	20			5						
20'	"	1459-1504	1280	.1505	13	86			13	73						
20'	"	1539-1544	1230	.1446	5	35			14	21						
20'	"	2152-2157	1560	.1835	8	43	16		5	22						
20'	"	0428-0433	1490	.1752	6	34	17			17						
0'	7/31/73 8/1/73	0830-0835	900	.1058	0	0										
0'	"	1240-1245	1530	.1799	1	6										6

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
0'	7/31/73 8/1/73	1918-1923	1890	.2223	0	0										
0'	"	2223-2228	830	.0976	3	30	20			10						
0'	"	0253-0258	1860	.2187	3	15	5		5							5
*10'	"	1131-1136	1950	.0573	0	0										
10'	"	1131-1136	1480	.1740	0	0										
*10'	"	1550-1555	2520	.0741	0	0										
10'	"	1550-1555	1830	.2152	0	0										
*10'	"	1843-1848	1980	.0582	0	0										
10'	"	1843-1848	1960	.2305	0	0										
*10'	"	2203-2208	1750	.0515	1	19	19									
10'	"	2203-2208	1950	.2293	4	17	13			4						
*10'	"	0223-0228	2690	.3163	2	6	6									
10'	"	0223-0228	2150	.2528	5	20	16			4						
*10'	"	0700-0705	2400	.0706	0	0										
10'	"	0700-0705	2970	.3493	1	3	3									

*1/2Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	7/31/73 8/1/73	0830-0835	1140	.1341	0	0										
20'	"	1240-1245	1590	.1870	0	0										
20'	"	1633-1638	1520	.1788	0	0										
20'	"	1918-1923	1660	.1952	1	5			5							
20'	"	2223-2228	1660	.1952	4	20	15			5						
20'	"	0253-0258	1960	.2305	3	13	13									
0'	8/14-15 73	0853-0858	2410	.2834	0	0										
0'	"	1525-1530	1680	.1976	0	0										
0'	"	0115-0120	2110	.2481	1	4										4
*10'	"	1738-1743	2400	.0706	0	0										
10'	"	1738-1743	2150	.2531	0	0										
*10'	"	2133-2138	1070	.0315	0	0										
10'	"	2133-2138	1240	.1458	0	0										
10'	"	0340-0345	1720	.2023	0	0										
20'	"	0853-0858	1860	.2191	0	0										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	8/14-15 73	1427-1432	1030	.1211	0	0										
20'	"	1427-1432	1260	.1482	0	0										
20'	"	1525-1530	1090	.1282	0	0										
20'	"	0505-0507	2040	.2399	4	16	8									8
0'	8/29-30/73	0440-0445	2200	.2587	0	0										
0'	"	0440-0445	2040	.2399	0	0										
0'	"	0018-0023	1920	.2258	0	0										
0'	"	0018-0023	2210	.2599	0	0										
*10'	"	0726-0731	2690	.0791	0	0										
*10'	"	0726-0731	3360	.0988	0	0										
10'	"	0001-0006	1270	.1494	0	0										
10'	"	0001-0006	1850	.2176	2	9										
20'	"	0707-0712	2120	.2493	0	0										
20'	"	0707-0712	2900	.3410	0	0										
20'	"	2007-2016	2160	.2540	0	0										

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RDW

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
20'	8/29-30/73	2007-2012	2720	.3199	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
Surface	5/22-23	1200														
		1207	-	201.1	101	502	373	124			5					
Bottom		1200														
		1207	-	201.1	126	626	402	224								
S		1330														
		1333	-	86.2	38	441	209	209			23					
B		1330														
		1333	-	86.2	5	58	58									
B		1515														
		1520	-	143.6	15	104										
S		1908														
		1915.5	-	215.5	67	311										
S		2100														
		2103.5	-	100.6	148	1481										
S		0000														
		0003.5	-	100.6	172	1710	1441	129			99					
S		0205														
		0208.5	-	100.6	717	7127	5059	1580		20	467					
S		0325														
		0329	-	114.9	723	6292				35						
S		0425														
		0428	-	86.2	388	4501				12						
S		0525														
		0528.5	-	100.6	167	1660										
S		0625														
		0628	-	86.2	439	5093			12							
S		0735														
		0738.5	-	100.6	409	4066										
S		0835														
		0838.5	-	100.6	239	2376										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S	5/22-23	0915														
		0922	-	201.1	420	2089			5							
S*		1200														
		1207	-	50.3	23	457										
m*		1200														
		1207	-	50.3	74	1471										
B*		1200														
		1207	-	50.3	54	1074										
S*		1330														
		1337.5	-	53.8	14	260	130	112			19					
M*		1330														
		1338	-	57.4	14	244	157	87								
B*		1330														
		1338.5	-	61.0	21	344	131	197			16					
S*		1515														
		1520	-	35.9	6	167	139			28						
M*		1515														
		1520	-	35.9	10	279	251		28							
B*		1515														
		1520	-	35.9	8	223	167	28		28						
S*		1908														
		1915.5	-	53.8	6	112										
M*		1908														
		1916	-	57.4	7	122										
B*		1908														
		1915	-	53.8	12	223										
S*		2100														
		2104	-	28.7	34	1185										
M*		2100														
		2104	-	28.7	20	697										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	5/22-23	0000														
		0003.5	-	25.1	52	2072	1673	239		40	120					
M*		0000														
		0003.5	-	25.1	35	1394	1275	120								
B*		0000														
		0004.5	-	32.3	11	341	279	31	31							
S*		0205														
		0208.5	-	25.1	116	4582	3187	956			438					41
M*		0205														
		0209	-	28.7	147	5122	3554	1185	70		314					
B*		0205														
		0209.5	-	32.3	101	3127	2508	464	62		93					
S*		0325														
		0329	-	28.7	170	5923	5122	279		35	453					35
M*		0325														
		0329	-	28.7	74	2578	1977	247			282					
B*		0325														
		0329	-	28.7	47	1638	1394	35		35	174					
S*		0425														
		0428.5	-	25.1	72	2869										
M*		0425														
		0429	-	28.7	84	2927										
B*		0425														
		0429.5	-	32.3	56	1734										
S*		0525														
		0528.5	-	25.1	54	2151										
M*		0525														
		0528.5	-	25.1	53	2112	1992		50							
B*		0525														
		0529.5	-	32.3	17	526										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	5/22-23	0625														
		0628.5	-	25.1	157	6255										
M*		-625														
		0629	-	28.7	132	4599										
B*		0655														
		0629.5	-	32.3	76	2353										
S*		0735														
		0738.5	-	25.1	104	4143										
M*		0735														
		0743	-	57.4	128	2246										
B*		0735														
		0743.5	-	61.0	109	1787										
S*		0835														
		0838.5	-	25.1	167	6653										
M*		0835														
		0839	-	28.7	111	387	370	7								
B*		0835														
		0843	-	57.4	91	1585										
S*		0940														
		0947	-	50.3	88	1750										
M*		0940														
		0947	-	50.3	73	1451										
B*		0940														
		0947	-	50.3	68	1352										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	6/7-8	1655														
		1700	-	143.6	17	85			5							
S		1702														
		1709	-	201.1	19	94										
B		1702														
		1709	-	201.1	70	348										
S		2315														
		2322	-	201.1	230	1144	65		323	25						
B		2315														
		2322	-	201.1	131	651	189	40	333		90					
B		0215														
		0222	-	201.1	97	482	264	10	164		45					
S		0215														
		0222	-	201.1	135	671	423	55	144	5	45					
B		0353														
		0400	-	201.1	148	736										
S		0353														
		0400	-	201.1	13	65										
S		0644														
		0651	-	201.1	223	1109										
B		0644														
		0651	-	201.1	44	219										
B		1500														
		1504	-	115.0	70	348	278	40		30						
S*		1655														
		1700	-	35.9	22	613	111	23	418		56					
M*		1655														
		1700	-	35.9	28	780	56		446	111	167					
B*		2016														
		2021	-	35.9	38	1058										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	6/7-8	2016														
		2021	-	35.9	38	1058										
M*		2016														
		2021	-	35.9	26	724										
B*		2319														
		2327	-	57.4	14	244			192		52					
M*		2319														
		2327	-	57.4	28	488	52		418		17					
S*		2319														
		2327	-	57.4	54	941	366		453		87		17			17
B*		0215														
		0222	-	50.3	24	477	219	60	159	20	20					
M*		0215														
		0222	-	50.3	16	318	239		60				20			
S*		0215														
		0222	-	50.3	50	994	736		80	99	80					
B*		0353														
		0400	-	50.3	0	0										
S*		0353														
		0400	-	50.3	38	755										
M*		0353														
		0400	-	50.3	19	378										
B*		0644														
		0651	-	50.3	50	994										
M*		0644														
		0651	-	50.3	19	378										
S*		0644														
		0651	-	50.3	24	577										
M*		1500														
		1504	-	28.7	10	348	279	35		35						

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	6/7-8	1500														
		1504	-	28.7	3	105	70		35							
B	6/19-20	0831														
		0838	-	201.1	571	2839										
B		1106														
		1113	-	201.1	540	2685	2282	35	30	338						
B		1300														
		1309	-	201.1	34	169	104	10	15	30	10					
S		1457														
		1504	-	201.1	99	492	273	25	25	149	20					
B		1457														
		1504	-	201.1	115	572										
S		1736														
		1743	-	201.1	115	572	259	149	114	45	5					
B		1736														
		1743	-	201.1	91	453										
B		2000														
		2007	-	201.1	1243	6181										
B		2207														
		2214	-	201.1	399	1984	1810	129	10		30		5			
B		0055														
		0102	-	201.1	248	1233	1000	99	15		119					
S		0420														
		0427	-	201.1												
S*		0831														
		0838	-	50.3	147	2922										
B*		0831														
		0838	-	50.3	113	2247										
S*		1106														
		1113	-	50.3	82	1630	1213	139		60						219

* - 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	6/19-20	1106														
		1113	-	50.3	221	4394	3877		219	258	40					
S*		1300														
		1307	-	50.3	6	119	119									
M*		1300														
		1307	-	50.3	5	99	80		20							
B*		1300														
		1307	-	50.3	18	358	169	20	20	40	40		20			40
M*		1457														
		1504	-	50.3	13	258	119		60	60	20					
S*		1738														
		1745	-	50.3	15	298										
M*		1738														
		1745	-	50.3	13	258										
B*		1738														
		1745	-	50.3	15	298										
M*		2002														
		2009	-	50.3	161	3201										
S*		2209														
		2216	-	50.3	114	2266	1968	80			219					
B*		2209														
		2216	-	50.3	105	2087	1650	258			159		20			
S*		0055														
		0102	-	50.3	24	477	358	60		20	40					
B*		0055														
		0102	-	50.3	38	755	676			20	60					20
S*		0420														
		0427	-	50.3	71	1412										
M*		0420														
		0427	-	50.3	83	1650										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	6/19-20	0420 0427	-	50.3	34	676										
B	7/2-3	0827 0834	-	201.1	235	1169										
B		1005 1012	-	201.1	151	751										
S		1154 1201	-	201.1	33	164	154		10							
B		1154 1201	-	201.1	22	109	60		30	15	5					
S		1400 1407	-	201.1	24	119	80		15	25						
B		1400 1407	-	201.1	58	288	99		60	119	5					5
B		1705 1712	-	201.1	49	244										
B		1920 1927	-	201.1	64	318										
B		2113 2120	-	201.1	422	2093										
B		2345 2350	-	143.5	48	334	307		21	7						
B		0137 0140	-	201.1	34	169	139		15	15						
M*		0824 0832	-	50.3	30	596										
B*		0825 0832	-	50.3	51	1014										
S*		1003 1010	-	50.3	13	258										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/2-3	1003														
		1010	-	50.3	23	457										
S*		1156														
		1203	-	50.3	2	40	40									
M*		1156														
		0003	-	50.3	3	60	40			20						
B*		1156														
		1203	-	50.3	12	239	99			139						
S*		1402														
		1409	-	50.3	2	40	20			20						
M*		1402														
		1409	-	50.3	8	149	20			60						80
B*		1402														
		1409	-	50.3	20	398	119			258						20
S*		1705														
		1712	-	50.3	13	258										
B*		1705														
		1712	-	50.3	15	298										
S*		1920														
		1927	-	50.3	34	676										
B*		1920														
		1927	-	50.3	30	596										
S*		2113														
		2120	-	50.3	23	457										
B*		2113														
		2120	-	50.3	24	477										
S*		2345														
		2350	-	35.9	3	84	84									
M*		2345														
		2350	-	35.9	20	557	474		84							

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	7/2-3	2345														
		2350	-	35.9	17	474	223		137	28			28			
S*		0137														
		0144	-	50.3	20	398	358		20							20
M*		0137														
		0144	-	50.3	7	139	80		40	20						
B*		0137														
		0144	-	50.3	11	219	119		40	60						
S*		0450														
		0457	-	50.3	8	60										
M*		0450														
		0457	-	50.3	7	139										
B*		0450														
		0457	-	50.3	16	318										
M*		0600														
		0607	-	50.3	20	398										
B*		0600														
		0607	-	50.3	21	577										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	7/17-18	0723														
		0730	-	201.1	7	35										
B		0858														
		0905	-	201.1	13	65										
S		1101														
		1108	-	201.1	0	1										
S		1254														
		1301	-	201.1	0	0										
B		1254														
		1301	-	201.1	1	5				5						
S		1454														
		1501	-	201.1	4	20	10		10							
S		1645														
		1652	-	201.1	1	5										
B		1645														
		1652	-	201.1	14	70										
B		1945														
		1952	-	201.1	15	75										
B		2150														
		2157	-	201.1	12	60	30		25	5						
S		0007														
		0014	-	201.1	11	55	50			5						
B		0007														
		0014	-	201.1	34	169	70		20	70						10
-		0105														
		0112	-	201.1	7	35	30		5							
S		0212														
		0217	-	143.6	20	139	96		14	21						7
B		0212														
		0217	-	143.6	17	118	49		7	63						

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S	7/17-18	0412														
		0419	-	201.1	4	20										
B		0412														
		0419	-	201.1	5	25										
S		0607														
		0614	-	201.1	0	0										
B		0607														
		0614	-	201.1	1	5										
S*		0725														
		0732	-	50.3	0	0										
B*		0725														
		0732	-	50.3	1	20										
M*		0900														
		0907	-	50.3	0	0										
B*		0900														
		0907	-	50.3	5	99										
S*		1104														
		1111	-	50.3	0	0										
M*		1104														
		1111	-	50.3	1	20										
B*		1104														
		1111	-	50.3	0	0										
S*		1257														
		1304	-	50.3	0	0										
M*		1257														
		1304	-	50.3	0	0										
B*		1257														
		1304	-	50.3	0	0										
S*		1456														
		1503	-	50.3	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
M*	7/17-	1456														
	18	1503	-	50.3	2	40	20			20						
B*		1456														
		1503	-	50.3	1	20			20							
S*		1647														
		1654	-	50.3	0	0										
M*		1647														
		1654	-	50.3	1	20										
B*		1647														
		1654	-	50.3	2	40										
M*		1947														
		1954	-	50.3	2	40										
B*		1947														
		1954	-	50.3	5	99										
M*		2152														
		2154	-	14.4	3	208	208									
B*		2152														
		2154	-	14.4	4	278				278						
S*		0005														
		0012	-	50.3	0	0										
M*		0005														
		0012	-	50.3	1	20	20									
B*		0005														
		0012	-	50.3	8	159										
S*		0210														
		0217	-	50.3	0	0										
M*		0210														
		0217	-	50.3	5	99	20		40	40						
B*		0210														
		0217	-	50.3	5	99			40	60						

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/17-18	0410														
		0417	-	50.3	3	60										
M*		0410														
		0417	-	50.3	1	20										
B*		0410														
		0417	-	50.3	2	40										
S*		0605														
		0612	-	50.3	0	0										
M*		0605														
		0612	-	50.3	0	0										
B*		0605														
		0612	-	50.3	3	60										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	7/31-	0818														
	8/1	0825	-	201.1	4	20	15									15
B		0918														
		0925	-	201.1	3	15	15									
B		1023														
		1030	-	201.1	1	5	5									
B		1131														
		1138	-	201.1	0	0										
B		1416														
		1423	-	201.1	0	0										
S		1416														
		1423	-	201.1	0	0										
S		1557														
		1604	-	201.1	0	0										
B		1557														
		1604	-	201.1	0	0										
B		1828														
		1835	-	201.1	5	25										
B		2143														
		2150	-	201.1	7	35	20			15						
B		2350														
		2357	-	201.1	0	0										
B		0114														
		0121	-	201.1	11	55	55									
S		0431														
		0438	-	201.1	4	20	15		5							
B		0431														
		0438	-	201.1	5	25	25									
B*		2143														
		2150	-	50.3	17	40	20			20						

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
M*	7/31-8/1	2350														
		2357	-	50.3	0	0										
B*		2350														
		2357	-	50.3	2	40				40						
M*		0114														
		0121	-	50.3	1	20	20									
B*		0114														
		0121	-	50.3	1	20				20						
S*		0431														
		0438	-	50.3	0	0										
M*		0431														
		0438	-	50.3	0	0										
B*		0431														
		0438	-	50.3	1	20	20									
M*		0823														
		0830	-	50.3	1	20	20									
B*		0823														
		0830	-	50.3	0	0										
M*		0920														
		0927	-	50.3	2	40	40									
B*		0920														
		0927	-	50.3	2	40	20			20						
M*		1023														
		1030	-	50.3	0	0										
B*		1023														
		1030	-	50.3	0	0										
M*		1131														
		1138	-	50.3	0	0										
B*		1131														
		1138	-	50.3	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/31-	1416														
	8/1	1423	-	50.3	0	0										
M*		1416														
		1423	-	50.3	0	0										
B*		1416														
		1423	-	50.3	0	0										
S*		1557														
		1604	-	50.3	0	0										
M*		1557														
		1604	-	50.3	0	0										
B*		1557														
		1604	-	50.3	0	0										
M*		1828														
		1835	-	50.3	0	0										
B*		1828														
		1835	-	50.3	1	20	20									
M*		2143														
		2150	-	50.3	2	40				40						

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	8/14-	0850														
	15	0857	-	201.1	0	0										
S		1035														
		1042	-	201.1	0	0										
B		1035														
		1042	-	201.1	0	0										
B		1320														
		1327	-	201.1	0	0										
S		1348														
		1355	-	201.1	0	0										
S		1540														
		1547	-	201.1	3	15										15
B		1540														
		1547	-	201.1	1	5										5
S		1740														
		1747	-	201.1	1	5										5
B		1940														
		1947	-	201.1	2	10										10
B		2002														
		2009	-	201.1	1	5										5
B		2115														
		2122	-	201.1	1	5										5
S		2115														
		2122	-	201.1	1	5										5
B		2338														
		2345	-	201.1	1	5										5
S		2338														
		2345	-	201.1	0	0										
B		0223														
		0230	-	201.1	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S	8/14-15	0223														
		0230	-	201.1	0	0										
B		0325														
		0332	-	201.1	1	5										5
S		0325														
		0332	-	201.1	0	0										
B		0609														
		0616	-	201.1	0	0										
S		0607														
		0616	-	201.1	0	0										
B*		0850														
		0857	-	50.3	0	0										
M*		0850														
		0857	-	50.3	0	0										
B*		1035														
		1042	-	50.3	0	0										
M*		1035														
		1042	-	50.3	0	0										
S*		1035														
		1042	-	50.3	0	0										
B*		1320														
		1327	-	50.3	0	0										
M*		1320														
		1327	-	50.3	0	0										
S*		1320														
		1327	-	50.3	0	0										
B*		1542														
		1547	-	35.9	0	0										
M*		1542														
		1547	-	35.9	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	8/14-15	1542														
		1547	-	35.9	0	0										
S*		1742														
		1749	-	50.3	0	0										
M*		1742														
		1749	-	50.3	0	0										
B*		1742														
		1749	-	50.3	0	0										
M*		2004														
		2011	-	50.3	0	0										
B*		2004														
		2011	-	50.3	0	0										
B*		2117														
		2114	-	50.3	0	0										
M*		2117														
		2124	-	50.3	1	20										20
S*		2117														
		2124	-	50.3	0	0										
B*		2340														
		2347	-	50.3	0	0										
M*		2340														
		2347	-	50.3	0	0										
S*		2340														
		2347	-	50.3	0	0										
B*		0225														
		0232	-	50.3	0	0										
M*		0225														
		0232	-	50.3	0	0										
S*		0225														
		0232	-	50.3	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	8/14-	0327														
	15	0334	-	50.3	0	0										
M*		0327														
		0334	-	50.3	0	0										
S*		0327														
		0332	-	50.3	0	0										
B*		0611														
		0618	-	50.3	0	0										
M*		0611														
		0618	-	50.3	0	0										
S*		0611														
		0618	-	50.3	0	0										
S		0325														
		0332	-	201.1	0	0										
B		0609														
		0616	-	201.1	0	0										
S		0609														
		0616	-	201.1	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S	8/29	0413														
		0420	-	201.1	0	0										
B		0413														
		0420	-	201.1	0	0										
S		0457														
		0504	-	201.1	0	5										
B		0457														
		0504	-	201.1	0	0										
B		0644														
		0651	-	201.1	0	0										
B		0733														
		0740	-	201.1	0	0										
S		1642														
		1649	-	201.1	0	0										
B		1642														
		1649	-	201.1	0	0										
S		1716														
		1723	-	201.1	4	20										
B		1716														
		1723	-	201.1	0	0										
B		1904														
		1911	-	201.1	1	5										
S		1904														
		1911	-	201.1	0	0										
S		1935														
		1942	-	201.1	0	0										
B		1935														
		1942	-	201.1	0	0										
S		2200														
		2207	-	201.1	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	8/29	2200														
		2207	-	201.1	0	0										
S		2229														
		2236	-	201.1	0	0										
B		2229														
		2236	-	201.0	1	5										
B*		0413														
		0420	-	50.3	0	0										
S*		0413														
		0420	-	50.3	0	0										
S*		0457														
		0504	-	50.3	0	0										
M*		0457														
		0504	-	50.3	0	0										
S*		0711														
		0718	-	50.3	0	0										
B*		0711														
		0718	-	50.3	0	0										
M*		0733														
		0740	-	50.3	0	0										
B*		0733														
		0740	-	50.3	0	0										
S*		1642														
		1649	-	50.3	1	20										
B*		1642														
		1649	-	50.3	0	0										
S*		1716														
		1723	-	50.3	0	0										
M*		1716														
		1723	-	50.3	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	8/29	1904														
		1911	-	50.3	0	0										
B*		1904														
		1911	-	50.3	0	0										
S*		1935														
		1942	-	50.3	0	0										
B*		1935														
		1942	-	50.3	0	0										
S*		2200														
		2207	-	50.3	0	0										
B*		2200														
		2209	-	64.6	0	0										
S*		2200														
		2209	-	64.6	0	0										
B*		2229														
		2236	-	50.6	0	0										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	5/22-23	1245														
		1252.5	-	353.4	87	246	209	31		3	3					
B		1640														
		1647.5	-	353.4	17	48	37	8								3
B		1826														
		1833	-	329.8	54	164	127	9			24		3			
B		1958														
		2001	-	141.4	58	410	311	99								
B		2145														
		2152	-	329.8	14	42	36				3					3
B		2310														
		2317	-	329.8	0	0										
B		0254														
		0257.5	-	164.9	0	0										
B		0412														
		0415.5	-	164.9	32	194	182				12					
B		0511														
		0514.5	-	164.9	9	55	49									6
B		0623														
		0633	-	377.0	104	276	247	29								
B		0710														
		0720	-	471.2	108	229	216	8								5
B		0813														
		0823	-	471.2	33	70	64	6								
B		1037														
		1044.5	-	353.4	248	702	580	99					3			20

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	6/7-8	1655														
		1700	-	235.6	132	560	68		170	34	259		17			13
B		2335														
		0002	-	329.9	132	400	97	12	133	36	121					
B		0250														
		0253	-	141.4	16	113	85		14	7	7					
B		0430														
		0437	-	329.9	46	139	79		13	6	36					
B		0722														
		0729	-	329.9	22	67	52		15							
B	6/19-20	1012														
		1019	-	329.8	598	1813	1425	121	103	155	9					
B		1402														
		1409	-	329.8	2	6	6									
B		1634														
		1641	-	329.8	110	334										
B		1900														
		1907	-	329.8	75	227										
B		2345														
		2352	-	329.8	316	958	912		6	3	27		9			
B		0301														
		0308	-	329.8	35	106										
B		0532														
		0539	-	329.8												

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	7/2-3	0925														
		0932	-	329.8	63	191										
B		1115														
		1122	-	235.6	32	136	132		4							
B		1245														
		1252	-	329.8	12	33	3		12	18						
B		1505														
		1512	-	329.8	18	55										
B		1825														
		1832	-	329.8	6	18										
B		2018														
		2025	-	329.8	4	12										
B		2230														
		2237	-	329.8	15	45	45									
B		0020														
		0027	-	329.8	166	503	182		18	61			6			236

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	7/17-18	0819														
		0826	-	329.8	8	24										
B		0949														
		0956	-	329.8	11	33										
B		1158														
		1205	-	329.8	2	6			3	3						
B		1359														
		1406	-	329.8	0	0										
B		1605														
		1612	-	329.8	0	0										
B		1730														
		1737	-	329.8	2	6										
B		2035														
		2042	-	329.8	0	0										
B		2235														
		2242	-	329.8	4	12	6			6						
B		0245														
		0252	-	329.8	1	3										
B		0515														
		0522	-	329.8	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	7/31-	0722														
	8/1	0729	-	329.8	1	3	3									
B		0849														
		0856	-	329.8	2	6	6									
B		0954														
		1001	-	329.8	0	0										
B		1105														
		1112	-	329.8	1	3			3							
B		1337														
		1343	-	282.7	0	0										
B		1515														
		1522	-	329.8	0	0										
B		1656														
		1708	-	329.8	1	3	3									
B		1920														
		1927	-	329.8	4	12	12									
B		2303														
		2310	-	329.8	5	15	9			6						
B		0040														
		0047	-	329.8	9	27	15			9						3
B		0155														
		0202	-	329.8	1	3										
B		0524														
		0531	-	329.8	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	8/14-	0940														
	15	0947	-	329.8	0	0										
B		1140														
		1147	-	329.8	0	0										
B		1415														
		1422	-	329.8	1	3										3
B		1640														
		1647	-	329.8	0	0										
B		1820														
		1827	-	329.8	0	0										
B		2030														
		2037	-	329.8	1	3			3							
B		2153														
		2200	-	329.8	0	0										
B		0027														
		0032	-	329.8	0	0										
B		0300														
		0307	-	329.8	0	0										
B		0354														
		0401	-	329.8	0	0										
B		0641														
		0648	-	329.8	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: DD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B	8/29	0542														
		0549	-	329.4	0	0										
B		0600														
		0607	-	329.4	0	0										
B		0803														
		0810	-	329.4	0	0										
B		0819														
		0826	-	329.4	0	0										
B		1746														
		1753	-	329.4	0	0										
B		1801														
		1808	-	329.4	0	0										
B		2002														
		2009	-	329.4	0	0										
B		2017														
		2024	-	329.4	0	0										
B		2301														
		2308	-	329.4	0	0										
B		2317														
		2324	-	329.4	0	0										

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	6/7-8	1908														
		1916	-	-	11	-										
B*		2042														
		2047	-	-	14	-										
B*		0856														
		0903	-	-	22	-										
B*		0925														
		0932	-	-	11	-										
B*		1537														
		1544	504	.0148	13	878	203		608		68					
S*	7/2-3	0828														
		0835	380	.0112	0											
M*		0828														
		0835	330	.0097	2	206	206									
B*		0828														
		0835	55.4	.0028	0											
S*		1233														
		1241	330	.0097	1	103	103									
M*		1233														
		1241	550	.0162	1	62	62									
B*		1233														
		1241	4.1	.0002	0											
S*		1443														
		1451	390	.0115	0											
M*		1443														
		1451	-	-	1											
B*		1443														
		1451	6.0	.0003	0											
S*		1736														
		1746	450	.0132	1	76	76									

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
M*	7/2-3	1736														
		1756	610	.0179	8	447			391	56						
B*		1736														
		1746	0.4	.0000	0											
S*		2040														
		2050	8.0	.0004	31	77500	72500			2500						
M*		2040														
		2050	81.0	.0041	68	16585	15122		244	488						
B*		2040														
		2050	6.4	.0003	8	26667	26667									
S*		2250														
		2300	480	.014	29	2057	1773			213			71			
M*		2250														
		2300	760	.0223	38	1704	1659			45						
B*		2250														
		2300	0.1	.0000	1	-										
S*		0050														
		0100	640	.0188	22	1170	745		213	160					53	
M*		0050														
		0100	550	.0162	35	2161	1975	62	62				62			
B*		0050														
		0100	0.6	.0000	9											
S*		0237														
		0247	250	.0074	5	676	676									
M*		0237														
		0247	610	.0169	17	950	950									
B*		0237														
		0247	0.2	.0000	2											
S*		0540														
		0550	520	.0153	4	261	65		196							

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
M*	7/2-3	0540														
		0550	1710	.0503	6	119	99			20						
B*		0540														
		0550	0.1	.0000	1											

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/17-18	0740														
		0750	870	.0256	0											
M*		0740														
		0750	1290	.0379	0											
B*		0740														
		0750	1350	.0397	0											
S*		0947														
		0957	830	.0244	0											
M*		0947														
		0957	960	.0282	1	35										
B*		0947														
		0957	1180	.0347	0											
S*		1210														
		1220	1030	.0303	0											
M*		1210														
		1220	1060	.0312	0											
B*		1210														
		1220	1330	.0392	3	769				769						
S*		1341														
		1351	1190	.0350	6	171	171									
M*		1341														
		1351	1120	.0329	0											
B*		1341														
		1351	1050	.0309	1	32				32						
S*		1523														
		1533	790	.1314	2	9										
M*		1523														
		1533	850	.0250	0											
B*		1523														
		1533	990	.0291	0											

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

							Larval Fish Concentration Per 1000 m^3									
Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/17-18	1705														
		1715	840	.0247	0											
M*		1705														
		1715	1000	.0294	2	68										
B*		1705														
		1715	2320	.0682	3	44										
S*		2010														
		2020	980	.0288	1	35										
M*		2010														
		2020	2060	.0606	4	66										
B*		2010														
		2020	11190	.3290	0											
S*		2202														
		2212	1100	.0323	5	155										
M*		2202														
		2212	3990	.1173	0											
B *		2202														
		2212	4620	.1358	0											
S*		2345														
		2355	560	.0165	9	545	303		121	121						
M*		2345														
		2355	980	.0288	9	313	174			139						
B*		2345														
		2355	2010	.0591	1	17	17									
S*		0135														
		0145	1290	.0379	8	211	132		26	53						
M*		0135														
		0145	2250	.0662	10	151	91		30	30						
B*		0135														
		0145	1340	.0394	6	152	76		25	51						

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/17-18	0415														
		0425	770	.0226	4	177										
M*		0415														
		0425	830	.0224	4	179										
B*		0415														
		0425	1790	.0526	3	57										
S*		0600														
		0610	1230	.0362	0											
M*		0600														
		0610	1320	.0388	3	77										
B*		0600														
		0610	1400	.4116	3	7										
S*		0657														
		0706	610	.0169	0											
S*	7/31-8/1	0940														
		0950	1010	.0297	0											
B*		0940														
		0950	1150	.0338	0											
S*		1107														
		1117	1150	.0338	0											
B*		1107														
		1117	1270	.0373	0											
S*		1256														
		1306	980	.0288	0											
B*		1256														
		1306	980	.0288	0											
B*		1256														
		1306	1900	.0559	0											
S*		1408														
		1418	820	.0241	0											

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	7/31-	1408														
	8/1	1418	1070	.0315	0											
S*		1545														
		1555	770	.0226	0											
B*		1545														
		1555	140	.0041	0											
S*		1830														
		1840	1180	.0347	1	29										29
B*		1830														
		1840	1320	.0388	0											
S*		1942														
		1952	1110	.0323	1	31										
B*		1942														
		1952	1260	.0370	0											
S*		2135														
		2145	1380	.0406	1	25										25
B*		2135														
		2145	1450	.0426	4	94	47			47						
S*		2330														
		2340	810	.0238	1	42				42						
B*		2330														
		2340	920	.0270	1	37	37									
S*		0049														
		0059	810	.0238	2	84	42			42						
B*		0049														
		0059	1050	.0309	5	162	162									
S*		0333														
		0343	530	.0156	4	256	192									64
B*		0333														
		0343	810	.0238	2	84	84									

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	7/31-	0530														
	8/1	0540	870	.0256	1	39	39									
B*		0530														
		0540	1000	.0294	1	34				34						

*1/2 Meter Net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: R

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
S*	8/14-15	1008														
		1015	560	.0165	0											
B*		1008														
		1015	690	.0203	0											
S*		1108														
		1118	980	.0288	0											
B*		1115														
		1125	1440	.0423	0											
S*		1229														
		1239	930	.0273	0											
B*		1229														
		1239	1350	.0397	0											
S*		1323														
		1333	1210	.0356	0											
B*		1323														
		1333	1350	.0397	0											
S*		1428														
		1438	800	.0235	0											
B*		1428														
		1438	1110	.0326	0											
S*		1635														
		1642	650	.0191	0											
B*		1635														
		1642	1010	.0297	0											
S*		2010														
		2017	730	.0215	0											
B*		2010														
		2017	1080	.0318	1	31										
S*		2213														
		2220	590	.0173	0											

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RI

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	8/14-	2213														
	15	2220	860	.0253	0											
S*		2355														
		0002	610	.0179	0											
B*		2355														
		0002	820	.0241	0											
S*		0105														
		0112	330	.0097	0											
B*		0105														
		0112	500	.0147	0											
S*		0645														
		0652	570	.0168	0											
B*		0645														
		0652	940	.0276	0											

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	6/7-8	1927														
		1932	-		11											
B*		1954														
		1957			26											
B*		2019														
		2025	-		43											
B*		1004														
		1012	-		56											
B*		1038														
		1041	-		34											
B*		1116														
		1120	-		56											
20'*		1334														
		1337	170	.0050	40	8000	1200		6600		200					
20'*		1407														
		1410	178	.0052	19	3654	2885		577							192
20'*		1430														
		1433	120	.0035	4	1143	857			286						
20'*		1445														
		1449	36	.0011	4	3636	2727		909							
*	7/2-3	1046														
		1054	1895.0	.0961	1	10	10									
*		1356														
		1403	377.2	.0191	3	157	105		52							
*		1642														
		1657	2162.8	.1097	7	64			9	55						
*		1836														
		1846	1373.3	.0698	69	989	716		29	43			14			186
*		2145														
		2155	1439.4	.0730	97	1328	1301			27						

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*	7/2-3	2334														
		2344	862.4	.0437	0											
*		0147														
		0157	523.9	.0266	82	3083	2594		338						150	
*		0445														
		0455	1128.7	.0223	64	2870	1973		404	404			45		45	
*	7/17-18	0807														
		0814	610	.0179	0											
*		1011														
		1023	5690	.1673	1	6										
*		1233														
		1243	5600	.1646	5	30	18			12						
*		1407														
		1417	4470	.1314	1	8				8						
*		1550														
		1600	-	-	0											
*		1735														
		1745	990	.0291	0											
*		2033														
		2043	980	.0288	0											
*		2220														
		2230	5450	.1602	3	19										
*		0025														
		0035	3080	.0906	21	232	121			110						
*		0158														
		0208	16770	.4930	32	65	22		6	37						
*		0435														
		0445	5980	.1758	0											
*		0619														
		0629	4770	.1402	19	136										

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
B*	7/31-	1010														
	8/1	1020	5300	.1558	0											
B*		1128														
		1138	3530	.1391	0											
B*		1320														
		1330	2940	.0867	0											
B*		1426														
		1436	3130	.0920	0											
B*		1620														
		1630	20	.0006	0											
B*		1915														
		1925	1000	.0029	0											
B*		2030														
		2040	2060	.0606	0											
B*		2225														
		2235	-	-	0											
B*		0010														
		0020	2830	.0832	8	96	96									
B*		0132														
		0142	10	.0003	0											
B*		0403														
		0413	6380	.1876	0											
B*		0615														
		0625	2300	.0676	1	15	15									

* = 1/2 meter net

ROSETON-DANSKAMMER FISH LARVAE
1973

Station: RD

Depth	Date	Time	Meter Revs.	Vol., m^3	# Larvae	# Larvae 1000 m^3	Larval Fish Concentration Per 1000 m^3									
							Alosa	American Shad	Striped Bass	White Perch	Cyprinids	Rainbow Smelt	Darters	Atlantic Tomcod	Sunfish	Others
*	8/14-15	1555														
		1602	4150	.1220	0											
*		1738														
		1745.5	3140	.0923	0											
*		2055														
		2062.5	3670	.1079	0											
*		2320														
		2327	2170	.0638	0											
*		0045														
		0052	370	.0109	0											
*		0605														
		0612	600	.0176	0											

* = 1/2 meter net

APPENDIX V-B

APPENDIX V-B

ROSETON/DANSKAMMER POINT
1973
FISH LARVAE LENGTH-FREQUENCY

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1028																
	1033	S															0
3/21/73	1436																
	1441	SIM															0
	1450																
	1456	BIM															0
4/11/73	0945																
	0950	S															0
5/10/73	1028																
	1033	SIM			6	60	64	6									136
	1052																
	1057	10'		3	16	138	124	22									303
	1929																
	1934	S		1	1	15	1			2							20
	1945																
	1950	10'				1	1										2
5/22-23/	1145																
73	1150	S				48	314	92	4	4	4	7	11				484
	1740																
	1745					220	81	6	3		13	3	3				329
	1740																
	1745	10'				114	135	18	12	6							303
	0025																
	0030	10'		2	1	3		2									8
	0354																
	0359	S			69	97	32	24	21	3	8						254
	0354																
	0359	10'			1	13	11	12	20	10	13	8	2				100
	0436																
	0441	20'		5	5	17	32	56	44	40	35	20					254
6/8/73	0318																
	0323	1M		2	2	6	27	24	28	57	48	46	34	34	4	2	317

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/8/73	0318																
	0323	10'			2	2	3	3	4	4	6	14	17	16	22	5	98
	0440																
	0445	20'															0
	0440																
	0445	30'			5	3	8	25	8	20	25	34	22	3	8		162
6/19/73	1045																
	1050	1M									7	58	116	289	123	82	680
	1045																
	1050	1M0'															0
	1045																
	1050	30'			2	1		4	4	3	3	1					18
	1100																
	1105	10'				3	1	3	2	2	2		2			1 /	16
	1100																
	1105	20'						4	3	9	3	10	12	8	4	7	60
	1930																
	1935	1M		1	3	12	1	5	7	4	7	6	1	1	1	3	52
	1930																
	1935	1MB															0
	1930																
	1935	30'															0
	2012																
	2017	10'				5	2	13	5	10	5	4	5				49
	2012																
	2017	1 20'								1							1
7/2-3/	1108																
73	1113	10'*M									2	2	2				6
	1108																
	1113	1M10'			1		1	2		14	13	15	18	6	4	1	75
	1421																
	1426	1M0'												4	7	203	214

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1421																
	1426	20'											1	4		4	9
	1451																
	1456	10'*M															0
	1451																
	1456	1M10'							1		1	1	4	1	7	5	20
	1905																
	1910	10'*M							1			3	2	1		2	9
	1905																
	1910	1M10'							11	29	17	34	86	57	63	40	337
	2207																
	2212	40'															0
	2230																
	2235	1M									1		6	6	3	16	32
	2254																
	2259	1M20'														189	189
	0045																
	0050	10'*M										3	7	9	9	22	50
	0045																
	0050	1M10'									317					42	359
7/17-18	1002																
73	1007	1M10'											1	1	2	4	8
	1024																
	1029	10'*M															0
	1024																
	1029	1M10'															0
	1547																
	1552	10'*M															0
	1547																
	1552	1M10'															0
	1540																
	1845	1M0'											1		1		2

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1840																
73	1845	1M0'															0
	1539																
	1544	10'*M															0
	1535																
	1544	1M10'															0
	2300																
	2305	1M0'															0
	2300																
	2305	1M20'														10	10
	0024																
	0029	10'*M														2	2
	0024																
	0029	1M10'									12					10	22
	0603																
	0608	1M0'														2	2
	0603																
	0608	1M20'													1		1
7/31-	1020																
8/1/73	1025	1M10'															0
	2042																
	2045	1M10'															0
	0035																
	0040	1M														4	4
	0035																
	0040	1M20'									1					6	7
	0103																
	0108	10'*M														1	1
	0103																
	0108	1M10'														5	5
	0523																
	0528	1M														2	2

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-8/1/73	0523-0528	1M20'														19	19
8/14-15/73	1008-1013	10'*M															0
	0302-0307	1M10'															0
	0553-0558	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1028																
	1033	S															0
3/21/73	1436																
	1441	SIM															0
	1450																
	1456	BIM															0
4/11/73	0945																
	0950	SlM															0
5/10/73	1028																
	1033	SIM															0
	1052																
	1057	10'															0
	1929																
	1938	S															0
	1945																
	1950	10'															0
5/22-23	1145																
73	1150	S								1	5	22	40	2			70
	1740																
	1745																0
	1740																
	1745	10'															0
	0025																
	0030	10'						1		1							2
	0345																
	0359	S								4							4
	0354																
	0359	10'							1	2							3
	0436																
	0441	20'															0
6/8/73	0318																
	0323	1M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/8/73	0318																
	0323	10'															0
	0440																
	0445	20'															0
	0440																
	0445	30'															0
6/19/73	1045																
	1050	1M									2					18	20
	1045																
	1050	30'															0
	1100																
	1105	10'															0
	1100																
	1105	20'															0
	1930																
	1935	1M															0
	1930																
	1935	1MB															0
	1930																
	1935	30'															0
	2012																
	2017	10'															0
	2012																
	2017	1M20'															0
7/2-3/73	1108																
	1113	10'*M															0
	1108																
	1113	1M10'															0
	1421																
	1426	1M0'															0
	1421																
	1426	20'															0

* - ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1451																
	1456	10'*M															0
	1451																
	1456	1M10'															0
	1905																
	1910	10'*M															0
	1905																
	1910	1M10'															0
	2207																
	2212	40'															0
	2230																
	2235	1M															0
	2254																
	2259	1M20'															0
	0045																
	0050	10'*M															0
	0045																
	0050	1M10'															0
	1002																
	1007	1M10'															0
7/17-18	1024																
73	1029	10'*M															0
	1024																
	1029	1M10'															0
	1547																
	1552	10'*M															0
	1547																
	1552	1M10'															0
	1840																
	1845	1M10'															0
	1840																
	1845	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1939																
73	1944	10'*M															0
	1939																
	1944	1M10'															0
	2300																
	2305	1M0'															0
	2300																
	2305	1M20'															0
	0024																
	0029	10'*M															0
	0024																
	0029	1M10'															0
	0603																
	0608	1M0'															0
	0603																
	0608	1M20'															0
	1020																
	1025	1M10'															0
	2042																
	2047	1M10'															0
	0035																
	0040	1M															0
	0035																
	0040	1M20'															0
	0103																
	0108	10'*M															0
	0103																
	0108	1M10'															0
	0523																
	0528	1M															0
	0523																
	0528	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	1008																
73	1013	10'*M															0
	0302																
	0307	1M10'															0
	0553																
	0538	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1029																
	1033	S															0
3/21/73	1435																
	1441	SIM															0
	1450																
	1456	BIM															0
4/11/73	0945																
	0950	SIM															0
5/10/73	1029																
	1033	SIM															0
	1052																
	1057	10'															0
	1929																
	1934	S															0
	1945																
	1950	10'															0
5/22-23	1145																
73	1150	S															0
	1740																
	1745																0
	1740																
	1745	10'															0
	0025																
	0030	10'		1													1
	0334																
	0339	S		2		1											3
	0334																
	0339	10'															0
	0436																
	0441	20'															0
6/8/73	0318																
	0323	1M	1	5	12	23	24										63

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/8/73	0318																
	0323	10'	1	2	7	3											13
	0440																
	0445	20			1	2											3
	0440																
	0445	30'		1	1	2											4
6/19/73	1045																
	1050	1M															0
	1045																
	1050	30'					1		1	1							3
	1100																
	1105	10'				1	2	2									5
	1100																
	1105	20'															0
	1930																
	1935	1MB					3	3	3	14	14	16	11	15	4	7	90
	1930																
	1935	30'			2	7	17	9	2								37
	2012																
	2017	10'				1											1
	2012																
	2017	1M20															0
7/2-3/73	1108																
	1113	10'*M															0
	1108																
	1113	10'M															0
	1421																
	1426	1M0'															0
	1421																
	1426	20'											1				1
	1451																
	1456	10'*M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1451																
	1456	10'M															0
	1905																
	1910	10'*M															0
	1905																
	1910	1M10'															0
	2207																
	2212	40'															0
	2230																
	2235	1M															0
	2254																
	2259	1M20'														1	1
	0045																
	0050	10'*M				1	1			1		5				2	10
	0045																
	0050	1M10'						2	2	1	1	1	1		2		10
7/17-18/	1002																
73	1007	1M10'															0
	1024																
	1029	10'*M															0
	1024																
	1029	1M10'															0
	1547																
	1552	10'*M															0
	1547																
	1552	1M10'															0
	1840																
	1845	1M0'															0
	1840																
	1845	1M20'							1								1
	1939																
	1944	10'*M															0

not

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	1939																
73	1944	1M10'															0
	2300																
	2305	1M0'															0
	2300																
	2305	1M20'														2	2
	0024																
	0029	10'*M															0
	0024																
	0029	1M10'					1					1		2	1	3	8
	0003																
	0008	1M0'															0
	0003																
	0008	1M20'										1	1				2
7/31-	1020																
8/1/73	1025	1M10'															0
	2042																
	2045	1M10'															0
	0035																
	0040	1M															0
	0035																
	0040	1M20'															0
	0103																
	0108	10'*M															0
	0103																
	0108	1M10'															0
	0523																
	0521	1M														2	2
	0523																
	0521	1M20'											1				1
8/14-15	1008																
73	1013	1M10'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15/	0302																
73	0307	1M10'															0
	0553																
	0558	1M20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1028																
	1033	S			2	2	17	9									30
3/21/73	1436																
	1441	SIM		1	3	30	11										45
	1450																
	1456	BIM				42	68	50									133
4/11/73	0945																
	0950	SIM															0
5/10/73	1028																
	1033	SIM															0
	1052																
	1051	10'															0
	1929																
	1934	S															0
	1945																
	1950	10'															0
5/22-23	1145																
73	1150	S															0
	1740																
	1745																0
	1740																
	1745	10'															0
	0025																
	0030	10'															0
	0354																
	0359	S															0
	0354																
	0359	10'															0
	0436																
	0441	20															0
6/8/73	0318																
	0323	1M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/8/73	0318																
	0323	10'															0
	0440																
	0445	20'															0
	0440																
	0445	30'															0
6/19/73	1045																
	1050	1M															0
	1045																
	1050	30'															0
	1100																
	1105	10'															0
	1100																
	1105	20'															0
	1930																
	1935	1M															0
	1930																
	1935	1MB															0
	1930																
	1935	30'															0
	2012																
	2017	10'															0
	2012																
	2017	1M20'															0
7/2-3/73	1108																
	1113	10'*M															0
	1108																
	1113	1M10'															0
	1421																
	1426	1M0'															0
	1421																
	1426	20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1451																
	1456	10'*M															0
	1451																
	1456	1M10'															0
	1905																
	1910	10'*M															0
	1905																
	1910	1M10'															0
	2207																
	2212	40'															0
	2230																
	2235	1M															0
	2254																
	2259	1M20'															0
	0045																
	0050	10'*M															0
	0045																
	0050	1M10'															0
7/17-18 73	1002																
	1007	1M10'															0
	1024																
	1029	10'*M															0
	1024																
	1029	1M10'															0
	1547																
	1552	10'*M															0
	1547																
	1552	1M10'															0
	1840																
	1845	1M0'															0
	1840																
	1845	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1939																
73	1944	10'*M															0
	1939																
	1944	1M10'															0
	2300																
	2305	1M0'															0
	2300																
	2305	1M20'															0
	0024																
	0029	10'*M															0
	0024																
	0029	1M10'															0
	0603																
	0608	1M0'															0
	0603																
	0608	1M20'															0
7/31-	1020																
8/1/73	1024	1M10'															0
	2042																
	2047	1M10'															0
	0035																
	0040	1M															0
	0035																
	0040	1M20'															0
	0103																
	0108	10'*M															0
	0103																
	0108	1M10'															0
	0523																
	0528	1M															0
	0523																
	0528	1M20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	1008																
73	1013	10'*M															0
	0302																
	0307	1M10'															0
	0553																
	0558	1M20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1028																
	1033	S															0
3/21/73	1436																
	1441	SIM															0
	1450																
	1451	BIM															0
4/11/73	0945																
	0950	SIM															0
5/10/73	1028																
	1033	SIM				1	2										3
	1052																
	1057	10'				3	2										5
	1929																
	1934	S															0
	1945																
	1950	10'															0
5/22-23/	1145																
73	1150	S															0
	1740																
	1745																0
	1740																
	1745	10'															0
	0025																
	0030	10'															0
	0354																
	0359	S															0
	0354																
	0359	10'															0
	0436																
	0441	20'															0
6/8/73	0318																
	0323				2												2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/8/73	0318																
	0323	10'		2	5	1											8
	0440																
	0445	20'			1												1
	0440																
	0445	30'				2											2
6/19/73	1045																
	1050	1M															0
	1045																
	1050	30'			4	8	7	3									22
	1100																
	1105	10'			3	4	3	2	1								13
	1100																
	1105	20'		1	5	3	5	1									15
	1930																
	1935	1M															0
	1930																
	1935	1MB															0
	1930																
	1935	30		6	2	14	19	11	3								55
	2012																
	2017	10'		1													1
	2012																
	2017	1M20			1			2									3
7/2-3/73	1108																
	1113	10' *M															0
	1108																
	1113	1M 10'		1	2		1										4
	1421																
	1426	1M 0'															0
	1421																
	1426	20'				1	6		1								8

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1451																
	1456	10'*M															0
	1451																
	1456	1M 10'															0
	1905																
	1910	10' *M															0
	1905																
	1910	1M 10'															0
	2207																
	2212	40'									1		2	4	3	3	21
	2230																
	2235	1M															0
	2254																
	2259	1M 02'								1			3	4	1	10	19
	0045																
	0050	10' *M									5	2	2	2			12
	0045																
	0050	1M 10'				1	4	2	2	6	6	10		7	4	5	54
7/17-18/73	1002																
	1007	1M 10'															0
	1024																
	1029	10' *M															0
	1024																
	1029	1M 10'														1	1
	1547																
	1552	10' *M															0
	1547																
	1552	1M 10'															0
	1840																
	1845	1M 0'															0
	1840																
	1845	1M 20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	1939																
73	1944	10' *M															0
	1939																
	1944	1M 10'														2	2
	2300																
	2305	1M 0'															0
	2300																
	2305	1M 20'															0
	0024																
	0029	10' *M										1			1		2
	0024																
	0029	1M 10'									3	11	6	5	5	5	35
	0603																
	0608	1M 0'															0
	0603																
	0608	1M 20'														1	1
7/31-	1020																
8/1/73	1025	1M 10'															0
	2042																
	2047	1M 10'															0
	0035																
	0040	1 20'												1	1	3	5
	0103																
	0108	10' *M															0
	0103																
	0108	1M 10'															0
	0523																
	0528	1M															0
	0523																
	0528	1M 20'														6	6

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDE **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	1008																
73	1013	1M 10'															0
	0302																
	0307	1M 10'															0
	0553																
	0558	1M 20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0932																
	0937	S															0
	1135																
	1140	M															0
5/10/73	1013																
	1018	S		1	4	35	24	15	3	1							83
	1124																
	1129	B			9	43	30										82
	1306																
	1311	B				91	199	42	7		3						342
	1417																
	1422	B				3	39	44	11	2	2	5					106
	1918																
	1923	S		1	2	4	13			1							21
	1957																
	2002	S			1	6	7										14
	2130																
	2135	M				2											2
	2156																
	2201	30'															0
	2338																
	2343	40'															0
	2354																
	2359	50'					3										3
5/22-23	1125																
73	1130	S		4		237	98	4			39	18	4				404
	1125																
	1130	10'				29	91	14	10	6							150
	1125																
	1130	30'			1	1											2
	1350																
	1355	40'			11	157	89	93	29		7		4				390

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1350																
73	1355	40'*			8	24	13		2	1							48
	1520																
	1525	10'			116	624	228	43	18		12						1041
	1520																
	1525	10'*				49	148	36									233
	1805																
	1810	0'				69	207	38	3			10	3				330
	1805																
	-810	10'		3	3	60	84	31	13	28	3	5	3				233
	2200																
	2205	20'															0
	2200																
	2205	30'		1		1		2	1								5
	2220																
	2225	40'															0
	0005																
	0010	10'															0
	0005																
	0010	20'			1												1
	0045																
	0050	0'*			10	3	1		1	1	1						17
	0045																
	0050	0'			39	36	11	4	7		4	7	5				113
	0316																
	0321	0'			26	26	21	47	125	135	73	109	145	5			712
	0316																
	0321	10'			9	30	33	58	39	51	21	30					271
	0436																
	0441	30'		9	23	22	20	21	6		3	1					324
	0456																
	0501	20'								6	136	322	252	52			768

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0456																
73	0501	30'				18	33	12	2	1							66
	0702																
	0707	40'			4	4	24	19	52	34	11	13	19				170
	0702																
	0707	50'	2	2	63	32	5	15	10	17	32	14	2				194
	0737																
	0742	0'			10	79	73	7	5		5	17	2				198
6/7-8/73	2328																
	2333	0'			5	3	2				4	3		2	2		21
	2328																
	2333	10'		2	1	3	2	1	1	2	1		3	1			17
	0015																
	0020	40'		1		6	1	2	4	9	11	7	5	2		1	50
	0015																
	0020	50'		1		3	3	1	1	1	1	1	4	6	2		24
	0424																
	0429	20'			10	2	6	6	13	6	19	19	8	8	10	15	120
	0424																
	0429	30'				5	14	16	10	14	8	10	26	5	3		111
6/19-20	1015																
73	1020	0'				12	18	20	20	20	28	32	58	52	15	10	285
	1015																
	1020	50'				1			3	1		2	2	1			10
	1120																
	1125	10'				4	2	6	13	33	6	25	27	13	4	2	135
	1120																
	1125	20'						3	2	5	4		1				15
	1320																
	1325	40'						4	4	32	32	27	32	33	2	8	164
	2202																
	2207	30'		2			3	7	21	43	32	28	10		3	5	154

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTA
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2340																
73	2345	50'								4	17	13	10	33	19	17	113
	2340																
	2345	0'								11	24	30	30	37	4	17	153
	0140																
	0145	10'									22	16	97	59	76	43	313
	0140																
	0145	20'					3	30	24	47	44	21	27	27	24	12	259
7/2-3/73	1232																
	1237	20'*								1	1						2
	1232																
	1237	20'M					2	5	6	12	14	17	28	2	6	1	93
	1352																
	1357	0'M						6	2	9	2	17	26	17	24	10	113
	1352																
	1357	40'								1				1	1	2	5
	1700																
	1705	20'*				2	1	1					3			1	8
	1700																
	1705	20'M				3	2	4	3		3	6	11	9	10	13	64
	2045																
	2050	20'M				1		3	1		4	2	2	7		12	32
	2045																
	2050	20'*M									1		1	1	4	9	16
	2207																
	2212	0'						1	1	1	3	7	6	5	4	31	59
	2227																
	2212	40'								4			7			215	226
	0320																
	0325	20'M										2	6	4	4	46	62
	0320																
	0325	20'*M															0

* = 1 meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1317																
73	1322	20'M														1	1
	1317																
	1322	20'*M															0
	1442																
	1447	0'M								1		1					2
	1442																
	1447	40'															0
	1720																
	1725	20'M															0
	1720																
	1725	20'*M															0
	2124																
	2135	20'M														6	6
	2120																
	2134	20'*M															0
	2240																
	2245	0'M															0
	2240																
	2245	40'														3	3
	0310																
	0315	20'M									6					16	22
	0310																
	0315	20'*M															0
7/31-	0928																
8/1/73	0933	40'M														1	1
	1448																
	1453	10'															0
	2104																
	2100	10'M														3	3
	0006																
	0011	0'M									2					2	4

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0006																
8/1/73	0011	20'M														6	6
	0006																
	0011	40'M															0
	0127																
	0132	10'M														4	4
	0127																
	0132	30'M														6	6
	0500																
	0505	30'M														20	20
	0500																
	0505	40'														6	6
	0618																
	0623	10'M														11	11
	0618																
	0623	30'M															0
8/14-15	2045																
73	2050	10'M															0
	2212																
	2217	40'M														3	3
	0212																
	0217	0'M															0
	0302																
	0307	10'M															0
	0537																
	0542	20'														4	4

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0932																
	0937	S															0
	1135																
	1140	M															0
5/10/73	1013																
	1018	S															0
	1124																
	1129	B															0
	1306																
	1311	B															0
	1417																
	1422	B															0
	1918																
	1923	S															0
	1957																
	2002	S															0
	2130																
	2135	M									1						1
	2156																
	2201	30'															0
	2338																
	2343	40'															0
	2354																
	2359	50'															0
5/22-23	1125																
73	1130	S															0
	1125																
	1130	10'															0
	1210																
	1215	20'															0
	1210																
	1215	30'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1350																
73	1355	40'						1									0
	1350																
	1355	40'*							1	4	2	1					8
	1520																
	1525	10'															0
	1520																
	1525	10'*						1	14	3	2						20
	1805																
	1810	0'															0
	1805																
	1810	10'															0
	2200																
	2205	20'															0
	2200																
	2205	30'															0
	2220																
	2225	40'															0
	0005																
	0010	10'															0
	0005																
	0010	20'															0
	0045																
	0050	0'*															0
	0045																
	0050	0'															0
	0316																
	0321	0'						1	1	11	28	15	3				59
	0316																
	0321	10'								2	7	1					10
	0436																
	0441	30'							1	1							2

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0456																
73	0501	20'							1	7	16	1					25
	0456																
	0501	30'							3	10	86	165	16	3			364
	0702																
	0707	40'								1	1	1					3
	0702																
	0707	50'							1	6	2	1					10
	0737																
	0742	0'															0
6/7-8/	2328																
73	2333	0'														1	1
	2328																
	2333	10'															0
	0015																
	0020	40'															0
	0015																
	0020	50'															0
	0424																
	0429	20'															0
	0424																
	0429	30'															0
6/19-20	1015																
73	1020	0'															0
	1015																
	1020	50'															0
	1120																
	1125	10'															0
	1120																
	1125	20'															0
	1320																
	1325	40'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2202																
73	2207	30'															0
	2340																
	2345	50'															0
	2340																
	2345	0'															0
	0140																
	0145	10'															0
	0140																
	0145	20'														1	1
7/2-3/73	1222																
	1237	20'*M															0
	1232																
	1237	20'*M															0
	1352																
	1357	0'M															0
	1352																
	1357	40'															0
	1700																
	1705	20'*M															0
	1700																
	1705	20'M															0
	2042																
	2051	20'M															0
	2045																
	2050	20'*M															0
	2207																
	2212	0'															0
	2207																
	2212	40'															0
	0320																
	0325	20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0320																
	0325	20'*M															0
7/17-18	1317																
73	1322	20'M					6	6	6		1	1		2			22
	1317																
	1322	20'*M															0
	1442																
	1447	0'M															0
	1442																
	1447	40'															0
	1720																
	1725	20'M															0
	1720																
	1725	20'*M															0
	2124																
	2135	0'M															0
	2129																
	2134	20'*M															0
	2240																
	2245	0'M															0
	2240																
	2245	40'															0
	0310																
	0315	20'M															0
	0310																
	0315	20'*M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0932																
	0937	S															0
	1135																
	1140	M															0
5/10/73	1013																
	1018	S															0
	1124																
	1129	B															0
	1306																
	1311	B															0
	1417																
	1422	B															0
	1918																
	1983	S															0
	1957																
	2002	S															0
	2130																
	2135	M															0
	2156																
	2201	30'															0
	2338																
	2343	40'															0
	2354																
	2357	50'															0
5/22-23	1125																
73	1130	S		1													1
	1125																
	1130	10'															0
	1210																
	1215	20'	1														1
	1210																
	1215	30'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1350																
73	1355	40'															0
	1350																
	1355	40'*															0
	1520																
	1525	10'															0
	1520																
	1525	10'*															0
	1805																
	1810	0'															0
	1805																
	1810	10'						1									1
	2200																
	2205	20'															0
	2200																
	2205	30'															0
	2220																
	2225	40'															0
	0005																
	0010	10'															0
	0005																
	0010	20'															0
	0045																
	0050	0'*															0
	0045																
	0050	0'															0
	0316																
	0321	0'															0
	0316																
	0321	10'															0
	0436																
	0441	30'		2													2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0456																
73	0501	20'															0
	0456																
	0501	30'															0
	0702																
	0707	40'															0
	0702																
	0707	50'	1														1
	0737																
	0742	0'															0
6/7-8	2328																
73	2333	0'		7	17	46	5										75
	2328																
	2333	10'		11	19	15											45
	0015																
	0020	40'		1	2	3	5										11
	0015																
	0020	50'	1	1	2	3											7
	0424																
	0429	20'		10	23	7											40
	0424																
	0429	30'		2	13	4											19
6/19-20	1015																
73	1020	0'					1										1
	1015																
	1020	50'					5	4									9
	1120																
	1125	10'					4										4
	1120																
	1125	20'			1	4	3	7									15
	1320																
	1325	40'					1		1								2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2202																
73	2207	30'					1	2									3
	2340																
	2345	50'				2		4	1								7
	2340																
	2345	0'			1	1											2
	0140																
	0145	10'				2	1	7		1							11
	0140																
	0145	20'				120	102	28	9								259
7/2-3/	1232																
73	1237	M20'*															0
	1232																
	1237	M20'															0
	1352																
	1357	0'M															0
	1352																
	1357	40'															0
	1700																
	1705	20'*M									1						1
	1700																
	1705	20'*M															0
	2045																
	2050	20'*M															0
	2045																
	2050	20'*m															0
	2207																
	2212	0'															0
	2207																
	2212	40'															0
	0320																
	0325	20'*M															0

*= ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1317																
73	1322	20*M											1		1		2
	1317																
	1322	20*m															0
	1442																
	1447	0'M															0
	1442																
	1447	40'										1			1		2
	1720																
	1725	20'M															0
	1720																
	1725	20*M															0
	2129																
	2134	20'M															0
	2129																
	2134	20*M															0
	2240																
	2245	0'M															0
	2240																
	2245	40'															0
	0310																
	0315	20'M											1	1		10	12
	0310																
	0315	20*M														1	1
7/31-	0928																
8/1/73	0933	40'M															0
	1448																
	1453	10'															0
	2104																
	2109	10'M															0
	0006																
	0011	0'M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0006																
8/1/73	0011	20'*															0
	0006																
	0011	40'M														5	5
	0127																
	0132	10'M															0
	0127																
	0132	30'M															0
	0500																
	0505	0'														1	1
	0500																
	0505	40'															0
	0618																
	0623	10'M		3													3
	0615																
	0623	30'M															0
8/14-15	2045																
73	2000	10'M															0
	2212																
	2217	40'M															0
	0212																
	0217	0'M															0
	0302																
	0307	40'M															0
	0537																
	0542	20'*														2	2

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0932																
	0937	S															0
	1135																
	1140	M															0
5/10/73	1013																
	1018	S															0
	1124																
	1129	B															0
	1306																
	1311	B															0
	1417																
	1422	B															0
	1918																
	1923	S															0
	1957																
	2002	S															0
	2130																
	2135	M															0
	2156																
	2201	30'															0
	2338																
	2343	40'															0
	2354																
	2359	50'															0
5/22-23/	1125																
73	1130	S															0
	1125																
	1130	10'															0
	1210																
	1215	20'															0
	1210																
	1215	30'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1350																
73	1355	40'															0
	1350																
	1355	40'*															0
	1520																
	1525	10'															0
	1520																
	1525	10'*															0
	1805																
	1810	0'															0
	1805																
	1810	10'															0
	2200																
	2205	20'															0
	2200																
	2205	30'															0
	2220																
	2225	40'															0
	0005																
	0010	10'															0
	0005																
	0010	20'															0
	0045																
	0050	0'*															0
	0045																
	0050	0'															0
	0316																
	0321	0'															0
	0316																
	0321	10'															0
	0436																
	0441	30'														9	9

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1232																
	1237	20'*M															0
	1232																
	1237	20'M															0
	1352																
	1357	0'M															0
	1352																
	1357	40'															0
	1700																
	1705	20'M															0
	1700																
	1705	20'M															0
	2045																
	2050	20'M															0
	2045																
	2050	20'*M															0
	2207																
	2212	0'															0
	2207																
	2212	40'															0
	0320																
	0325	20'															0
	0320																
	0325	20'*M															0
7/17-18/	1317																
73	1322	20'M															0
	1317																
	1322	20'*M															0
	1442																
	1447	0'M															0
	1442																
	1447	40'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													Others	TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14		
7/17-18/	1720																
73	1725	20'M															0
	1720																
	1725	20'*M															0
	2120																
	2134	20'M															0
	2129																
	2134	20'*M															0
	2240																
	2245	0'M															0
	2240																
	2245	40'															0
	0310																
	0315	20'M															0
	0310																
	0315	20'*M											*				0
7/31-	0928																
8/1/73	0933	40'M															0
	1448																
	1453	10'															0
	2104																
	2109	10'M															0
	0006																
	0011	20'M															0
	0006																
	0011	20'M															0
	0006																
	0011	40'M															0
	0127																
	0132	10'M															0
	0127																
	0132	30'M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0500																
8/1/73	0505	0'															0
	0500																
	0505	40'															0
	0618																
	0623	10'M															0
	0618																
	0623	30'M									1						1
8/14-15/	2045																
73	2050	10'M															0
	2212																
	2217	10'M															0
	0212																
	0217	0'M															0
	0302																
	0307	10'M															0
	0537																
	0542	20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0932																
	0937	S					1	1									2
	1135																
	1140	M															0
5/10/73	1013																
	1018	S					1	1									2
	1124																
	1120	B															0
	1306																
	1311	B					1										1
	1417																
	1422	B			1				1								2
	1918																
	1923	S															0
	1947																
	2002	S															0
	2130																
	2135	M															0
	2156																
	2201	30'															0
	2338																
	2343	40'															0
	2354																
	2339	50'															0
5/22-23	1125																
73	1130	S															0
	1125																
	1130	10'															0
	1210																
	1215	20'				1											1
	1210																
	1215	30'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1350																
73	1355	40'					1										1
	1350																
	1355	40'*															0
	1520																
	1525	10'															0
	1520																
	1525	10'*															0
	1805																
	1810	0'															0
	1805																
	1810	10'															0
	2200																
	2205	20'															0
	2200																
	2205	30'															0
	2220																
	2225	40'															0
	0005																
	0010	10'															0
	0005																
	0010	20'															0
	0045																
	0050	0'*															0
	0045																
	0050	0'															0
	0316																
	0321	0'															0
	0316																
	0321	10'		1													1
	0436																
	0441	30'	1	1	1												3

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0456																
73	0501	20'															0
	0456																
	0501	30'															0
	0702																
	0707	40'															0
	0702																
	0707	50'					1						1				1
	0737																
	0742	0'															0
6/7-8/73	2328																
	2333	0'															0
	2328																
	2333	10'															0
	0015																
	0020	40'															0
	0015																
	0020	50'		3													3
	0424																
	0429	20'		1	13	3											17
	0424																
	0429	30'	1														1
6/19-20	1015																
73	1020	0'		1	5		1										7
	1015																
	1020	50'			5	4	4	1									14
	1120																
	1125	10'		37	44	11											92
	1120																
	1125	20'			3	23	35	24									85
	1320																
	1325	40'		1	1	5	4	3									14

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2202																
73	2207	30'			1		1	1									3
	2340																
	2345	50'			9	17	12	7	3								48
	2340																
	2345	0'				3	1	2									6
	0140																
	0145	10'				2	4										6
7/2-3/73	1232																
	1237	20'*M															0
	1232																
	1237	20'M			1	1											2
	1352																
	1357	0'M															0
	1352																
	1357	40'				1	1		1			1	1		2	5	12
	1700																
	1705	20'*M															0
	1700																
	1705	20'M		1	1	1	1	1	1								6
	2045																
	2050	20'M					1									1	2
	2045																
	2050	20'*M		1													1
	2207																
	2212	0'									2		1		1		4
	2207																
	2212	40'															0
	0320																
	0325	20'M						1									1
	0320																
	0325	20'*M															0

* ≐ ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1317																
73	1322	20'M														4	4
	1317																
	1322	20'*M															0
	1442																
	1447	0'M															0
	1442																
	1447	40'								1			3				4
	1720																
	1725	20'M													3	5	8
	1720																
	1725	20'*M															0
	2129																
	2134	20'M														1	1
	2129																
	2134	20'*M															0
	2240																
	2245	0'M															0
	2240																
	2245	40'														1	1
	0310																
	0315	20'M													1	66	67
	0310																
	0315	20'*M														1	1
7/31-	0928																
8/1/73	0933	40'M															0
	1448																
	1453	10'															0
	2104																
	2109	10'M															0
	0006																
	0011	0'M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDECH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0006																
8/1/73	0011	20'M														1	1
	0006																
	0011	40'M														2	2
	0127																
	0132	10'M															0
	0127																
	0132	30'M															0
	0500																
	0505	0'															0
	0500																
	0505	40'														3	3
	0618																
	0623	10'M															0
	0618																
	0623	30'M											1		1	1	3
8/14-15	2045																
73	2050	10'M															0
	2212																
	2217	40'M															0
	0212																
	0217	0'M															0
	0302																
	0307	10'M															0
	0537																
	0542	20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0915																
	1920	1MS															0
	1115																
	1120	1M10'															0
5/10-11/	0949																
73	0954	1MS			7	50	15	1									73
	1135																
	1140	1M10'		2		7	79	41									129
	1230																
	1235	1M20'				10	7	1									18
	1246																
	1251	1M20'				81	133	3	3		2						222
	1324																
	1329	1M30'			13	44	12	2	2								73
	1400																
	1405	1M40'				1		14	8		1						24
	1430																
	1435	1M50'		2	1	1	2	1		1							8
	1605																
	1610	1M50'			2			2									4
	1905																
	1910	1MS				5	28	33	2								68
	2011																
	2016	1M10'			3	1				1							5
	2108																
	2113	1M20'		2			4	1									7
	2230																
	2235	1M30'															0
	2314																
	2319	1M40'	1	3	2	8	5	1									20
	0018																
	0023	1M50'					1										1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1045																
73	1050	1M0'			15	180	104	3			6	12					320
	1305																
	1310	1M20'			3	6	2	4	1	1							17
	1335																
	1350	40'*M				3	2	1	3	1							10
	1335																
	1350	1M40'		1	3	10	3	3	7	3	3	1				1	35
	1445																
	1450	20'*M			2	5			1								8
	1445																
	1450	1M20'			2	14	15	5	6	5		1					48
	1640																
	1645	1MS			3	17	11	1									32
	1640																
	1645	1M10'			6	11	3		1	1	1						23
	2050																
	2055	1M0'		7	28	27	4										66
	2050																
	2055	1M10'		1	6	20	5		1								35
	2115																
	2120	1M20'		4	1												5
	2115																
	2120	1M30'			1	1											2
	2245																
	2250	1M30'	7	19	23	12										3	64
	2245																
	2250	1M40'									2						2
	2340																
	2345	1M20'															0
	0248																
	0253	1M10'				7	29	9	4	13		4					66

* - ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	0517																
73	0522	1M20'			15	19	8	19	3	14	13	5					46
	0517																
	0522	1M30'			13	19	3	2	2		2	1					42
	0634																
	0644	1M40'		1	14	20	7	2		1							45
	0634																
	0644	1M50'	3	4	38	49	5	2					3				104
	0754																
	0759	1MS	2		7	35	38	8	2		2	2	2				98
	1305																
	1310	1M30'			20	22	2		2	3	1	6	1				57
6/7-8/73	2240																
	2245	1MS			4	2	19	37	41	25	6		10	8	10	4	166
	2240																
	2245	1M10'				5	19	15	5	1	1	14	1	1	2		64
	2240																
	2245	1M30'		4	5	9	3	2					1				24
	0035																
	0040	1M40'			3	4	6	5	7	2	5		4	4	4		44
	0035																
	0040	1M50'			8	22	2	1	3	2	1	4	2	3	2	1	51
	0405																
	0410	1M20'			7	18	12	12	6	1							56
6/19-20/	1145																
73	1150	1M10'					14	14	33	57	95	66	47	33	14	28	401
	1145																
	1150	1M20'			3	6	3	6	9	8	2	7	9	1			58
	1240																
	1245	1M40'				3	3	3	5	2	10	3	1	1			31
	1655																
	1700	1MS					2	1	1		2	3	1	2	4		16

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/73	1655																
	1700	1M50'															0
	0000																
	0005	1M0'															0
	0000																
	0005	1M50			3	3		3	3	18	13	31	31	18	13	18	54
	0057																
	0102	1M20					3	3	10	7	15	13	25	4	1	3	84
	0057																
	0102	1M10						4	4	6	10	14	7	14	66	32	97
7/2-3/73	1332																
	1337	1M0'					2	2	3	6	19	5	12	9	7	5	70
	1332																
	1337	40'M															0
	1638																
	1643	20'*M								1							1
	1638																
	1643	1M0							1	1	1	1	1	2			7
	2037																
	2042	M*											1			1	2
	2037																
	2042	1M0'													1	9	10
	2132																
	2137	1M0'			16	9	16	7	7	2	1	1	1	1	4		66
	2132																
	2137	1M40				1								1	1	42	45
	0241																
	0246	20'*M											2	1	2	10	15
	0241																
	0246	1M20										8	20	20	40	150	238
7/17-18/73	1300																
	1305	1M20															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	1300																
73	1305	1M20'															0
	1356																
	1401	1M0'															0
	1356																
	1401	1M40'															0
	1705																
	1710	20'*M															0
	1705																
	1710	20'*M															0
	2108																
	2113	20'*M															0
	2108																
	2113	1M20'														5	5
	2214																
	2218	1M0'										2	1		1		4
	2214																
	2218	1M40'														5	5
	0235																
	0240	20'*M											1		1	1	3
	0235																
	0240	1M20'											1	1		15	17
7/31-	0857																
8/1/73	0902	1M40'											1				1
	1300																
	1305	1M0'															0
	1657																
	1702	1M40'															0
	1826																
	1831	1M30'															0
	1937																
	1942	1M40'														1	1

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2142																
8/1/73	2147	1M30'															0
	2330																
	2335	1M0'															0
	2330																
	2335	1M20'															0
	2330																
	2335	1M40'									1					4	5
	0149																
	0154	1M10'															0
	0149																
	0154	1M30'														3	3
	0412																
	0417	1M0'														1	1
	0435																
	0440	1M40'									1	1	1				3
	0639																
	0644	1M30'															0
	2106																
	2111	1M10'															0
	2106																
	2111	1M20'														1	1
	2106																
	2111	1M30'															0
	2158																
	2203	1M20'															0
	0518																
	0523	1M20'															0
	0625																
	0630	1M30'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0915																
	0920	1MS															0
	1115																
	1120	1M10'															0
5/10-11/	0949																
73	0954	1MS															0
	1135																
	1140	1M10'															0
	1230																
	1235	1M20'															0
	1246																
	1251	1M20'															0
	1324																
	1329	1M30'															0
	1400																
	1405	1M40'															0
	1430																
	1435	1M50'										1					1
	1605																
	1610	1M50'															0
	1905																
	1910	1MS															0
	2011																
	2016	1M10'															0
	2108																
	2113	1M20'															0
	2230																
	2235	1M30'															0
	2314																
	2319	1M40'															0
	0015																
	0023	1M50'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1045																
73	1050	1M0'															0
	1305																
	1310	1M20'															0
	1335																
	1340	40'*M							1	1		3	1				6
	1335																
	1340	1M40'															0
	1445																
	1450	20'*M															0
	1445																
	1450	1M20'															0
	1640																
	1645	1MS									1	1					2
	1640																
	1645	1M10'								1							1
	2050																
	2055	1M0'															0
	2050																
	2055	1M10'									2						2
	2115																
	2120	1M20'															0
	2115																
	2120	1M30'															0
	2245																
	2255	1M30'															0
	2245																
	2245	1M40'															0
	2340																
	2345	1M20'															0
	0248																
	0253	1M10'							1	2	8	10	5	1			27

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	0517																
73	0522	1M20'							1	1							2
	0517																
	0522	1M30'									1						1
	2639																
	2644	1M40'															0
	2639																
	2644	1M50'								1	1	1					3
	0754																
	0759	1MS															0
	1305																
	1310	1M30'															0
6/7-8/73	2240																
	2245	1MS															0
	2240																
	2245	1M10'															0
	2240																
	2245	1M30'															0
	0035																
	0040	1M40'															0
	0035																
	0040	1M50'															0
	0405																
	0410	1M20'															0
6/19-20	1145																
73	1150	1M10'															0
	1145																
	1150	1M20'															0
	1240																
	1245	1M10'															0
	1655																
	1700	1MS															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	1655																
73	1700	1M50'															0
	0000																
	0005	1M0'															0
	0000																
	0005	1M50'															0
	0057																
	0102	1M20'															0
	0057																
	0102	1M10'															0
7/17-18	1300																
73	1305	1M20'															0
	1300																
	1305	1M20'															0
	1356																
	1401	1M0'															0
	1356																
	1401	1M40'															0
	1705																
	1710	20'*M															0
	1705																
	1710	20'*M															0
	2108																
	2113	20'*M															0
	2108																
	2113	20'															0
	2214																
	2218	0'															0
	2214																
	2218	1M0'															0
	2214																
	2218	40'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	2214																
73	2218	1M40'															0
	0235																
	0240	20'*M															0
	0235																
	0240	20'*M															0
	0235																
	0240	20'															0
	0235																
	0240	1M20'															0
7/31-	0857																
8/1/73	0902	1M40'															0
	0857																
	0902	1M40'															0
	1300																
	1305	0'															0
	1657																
	1702	40'															0
	1826																
	1831	1M30'															0
	1826																
	1831	1M30'															0
	1937																
	1942	40'															0
	1937																
	1942	1M40'															0
	2142																
	2147	1M30'															0
	2330																
	2335	0'															0
	2330																
	2335																0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2330																
8/1/73	2335	20'1M															0
	2230																
	2335	40'															0
	0149																
	0157	1M10'															0
	0149																
	0157	1M10'															0
	0149																
	0157	1M10'															0
	0412																
	0417	1M0'															0
	0412																
	0417	1MS															0
	0435																
	0440	1M40'															0
	0435																
	0440	40'															0
	0639																
	0644	1M30'															0
8/14/73	2106																
	2111	1M10'															0
	2106																
	2111	1M20'															0
	2106																
	2111	1M30'															0
	2158																
	2203	1M20'															0
	2158																
	2203	1M20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0915																
	0920	1MS															0
	1115																
	1120	1M10'															0
5/10-11	0949																
73	0954	1MS															0
	1135																
	1140	1M10'															0
	1230																
	1235	1M20'															0
	1246																
	1251	1M20'															0
	1324																
	1329	1M30'			1		1										2
	1400																
	1405	1M40'															0
	1430																
	1435	1M50'															0
	1605																
	1610	1M50'															0
	1925																
	1910	1MS															0
	2011																
	2016	1M10'															0
	2108																
	2113	1M20'															0
	2230																
	2235	1M30'															0
	2314																
	2319	1M40'				1											1
	0018																
	0023	1M50'			1												1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1045																
73	1050	1M0'	1	1													2
	1305																
	1310	1M20'															0
	1335																
	1340	40'*M															0
	1335																
	1340	1M40'															0
	1445																
	1450	20'*M															0
	1445																
	1450	1M20'															0
	1640																
	1645	1MS		1	2	11	9	2									25
	1640																
	1645	1M10'															0
	2050																
	2055	1M0'															0
	2050																
	2055	1M10'															0
	2115																
	2120	1M20'															0
	2115																
	2120	1M30'															0
	2245																
	2250	1M30'															0
	2245																
	2250	1M40'															0
	2340																
	2345	1M20'															0
	0248																
	0253	1M10'															0

* - 1 meter net.

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0517																
73	0522	1M20'															0
	0517																
	0522	1M30'															0
	0639																
	0644	1M40'															0
	0639																
	0644	1M50'															0
	0754																
	0759	1MS															0
	1305																
	1310	1M30'		1													1
6/7-8/73	2240																
	2245	1MS		562	138	171											361
	2240																
	2245	1M10'		47	33	237	30					3					350
	2240																
	2245	1M30'		3	22	202	50										277
	0035																
	0040	1M40'		5	32	122	21	2									122
	0035																
	0040	1M50'		8	19	103	6										136
	0404																
	0410	1M20'	7	28	78	17											130
6/19-20	1145																
73	1150	1M10'				3	1										4
	1145																
	1150	1M20'				10	10	5	2								27
	1240																
	1245	1M40'			1	1	6	5									13
	1655																
	1700	1MS															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	1655																
73	1700	1M50'					1	1									2
	0000																
	0005	1M0'					10	8	3								21
	0000																
	0005	1M50'			2	5	17	9									33
	0057																
	0102	1M20'							4								4
	0057																
	0102	1M10'			1		1										2
7/2-3/73	1332																
	1337	1M0'															0
	1332																
	1337	40'M						1				1					2
	1638																
	1643	20'*M															0
	1638																
	1643	20'M															0
	2037																
	2040	20'M															0
	2037																
	2042	20'M															0
	2132																
	2137	0'M															0
	2132																
	2137	10'M															0
	0241																
	0246	20'M															0
	0241																
	0246	20'M											1				1
7/17-18	1300																
73	1305	20'*M															0

1 meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1300																
73	1305	1M20'									1			1	1		3
	1356																
	1401	1M0'															0
	1356																
	1401	1M40'															0
	1705																
	1710	20'*M															0
	1705																
	1710	1M20'															0
	2108																
	2113	20'*M														2	2
	2108																
	2113	1M20'															0
	2214																
	2218	1M0'										1					1
	2214																
	2218	1M40'														1	1
	0235																
	0240	20'*M															0
	0234																
	0240	1M20'															0
7/31-	0857																
8/1/73	0902	1M40'															0
	1300																
	1305	1M 0'															0
	1657																
	1702	1M40'															0
	1826																
	1831	1M30'															0
	1937																
	1942	1M40'															0

*=½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2142																
8/1/73	2147	1M30'															0
	2330																
	2335	1M0'															0
	2330																
	2335	1M20;															0
	2330																
	2335	1M40'															0
	0149																
	0154	1M10'															0
	0149																
	0154	1M30'															0
	0412																
	0417	1M0'														1	1
	0435																
	0440	1M40'														1	1
	0639																
	0644	1M30'															0
8/14-15	2106																
73	2111	1M10'															0
	2106																
	2111	1M20''															0
	2106																
	2111	1M30'															0
	2158																
	2203	1M20'															0
	0518																
	0523	1M20'															0
	0625																
	0630	1M30'									1						1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0915																
	0920	1MS															0
	1115																
	1120	1M10'				1											1
5/10-11/	0949																
73	0954	1MS															0
	1135																
	1140	1M10'															0
	1230																
	1235	1M20'															0
	1246																
	1251	1M20'															0
	1324																
	1329	1M30'															0
	1400																
	1405	1M40'															0
	1430																
	1435	1M50'															0
	1605																
	1610	1M50'															0
	1905																
	1910	1MS															0
	2011																
	2016	1M10'															0
	2108																
	2113	1M20'															0
	2230																
	2235	1M30'															0
	2314																
	2319	1M40'															0
	0018																
	0023	1M50'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1045																
73	1050	1M0'															0
	1305																
	1310	1m20'															0
	1335																
	1340	40'*M															0
	1335																
	1340	1M40'															0
	1445																
	1450	20'*M															0
	1445																
	1450	1M20'															0
	1640																
	1645	1MS															0
	1640																
	1645	1M10'															0
	2050																
	2055	1M0'															0
	2050																
	2055	1M10'															0
	2114																
	2120	1M20'															0
	2115																
	2120	1M30'															0
	2245																
	2250	1M30'															0
	2245																
	2250	1M40'															0
	2340																
	2345	1M20'															0
	0248																
	0253	1M10'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** : Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0517																
73	0522	1M20'															0
	0517																
	0522	1M30'															0
	0639																
	0644	1M40'															0
	0539																
	0644	1M50'															0
	0754																
	0759	1MS															0
	1305																
	1310	1M30'															0
6/7-8/	2240																
73	2245	1MS															0
	2240																
	2245	1M10'															0
	2240																
	2245	1M30'															0
	0035																
	0040	1M40'															0
	0035																
	0040	1M50'															0
	0405																
	0410	1M20'															0
6/19-20	1145																
73	1150	1M10'															0
	1145																
	1150	1M20'															0
	1240																
	1245	1M40'															0
	1655																
	1700	1MS															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	1655																
73	1700	1M50'															0
	0000																
	0005	1M0'															0
	0000																
	0005	1M50'															0
	0057																
	0102	1M20'															0
	0057																
	0102	1M10'															0
7/2-3/73	1332																
	1337	1M0'															0
	1332																
	1337	1M40'															0
	1638																
	1643	20'*M															0
	1638																
	1643	1M30'															0
	2037																
	2042	40'*M															0
	2037																
	2042	1M20'															0
	2132																
	2137	1M0'															0
	2132																
	2137	1M40'															0
	0241																
	0246	30'*M															0
	0241																
	0246	1M20'															0
7/17-18	1300																
73	1305	20'*M															0

* - ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1300																
73	1305	1M20'															0
	1356																
	1401	1M0'															0
	1356																
	1401	1M20'															0
	1205																
	1210																0
	1205																
	1210																0
	2104																
	2113																0
	2104																
	2113																0
	2211																
	2218	0'															0
	2211																
	2218	1M0'															0
	2211																
	2218	10'															0
	2211																
	2218	10'															0
	0235																
	0240	1M20'															0
	0235																
	0240	20'*M															0
	0235																
	0240	20'															0
	0235																
	0240	1M0'															0
7/31-	0051																
8/1/73	0102	10'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** Tom Cod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-8/1/73	0051 0102 1300 1305																

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
4/11/73	0915																
	0920	1MS															0
	1115																
	1120	1M10'															0
5/10-11/	0949																
73	0954	1MS															0
	1135																
	1140	1M10'															0
	1230																
	1235	1M20'															0
	1246																
	1251	1M20'					1										1
	1324																
	1329	1M30'															0
	1400																
	1405	1M40'															0
	1430																
	1435	1M50'															0
	1605																
	1610	1M50'															0
	1905																
	1910	1MS					1										1
	2011																
	2016	1M10'															0
	2108																
	2113	1M20'															0
	2230																
	2235	1M30'															0
	2314																
	2319	1M40'															0
	0018																
	0023	1M50'		1													1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1045																
73	1050	1M0'															0
	1305																
	1310	1M20'															0
	1335																
	1340	40'*M															0
	1335																
	1340	1M40'															0
	1445																
	1450	20'*M															0
	1445																
	1450	1M20'															0
	1640																
	1645	1MS															0
	1640																
	1645	1M10'															0
	2050																
	2055	1M0'															0
	2050																
	2055	1M10'															0
	2115																
	2120	1M20'															0
	2115																
	2120	1M30'															0
	2245																
	2250	1M30'															0
	2245																
	2250	1M40'															0
	2340																
	2345	1M20'															0
	0248																
	0253	1M10'															0

*=½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0517																
73	0522	1M20'				1											1
	0517																
	0522	1M30'															0
	0639																
	0684	1M40'															0
	0639																
	0684	1M50'															0
	0754																
	0759	1MS															0
	1325																
	1310	1M30'															0
6/7-8/73	2240																
	2245	1MS		2	1												3
	2240																
	2245	1M10'			4	4											8
	2240																
	2245	1M30'			2												2
	0035																
	0040	1M40'		1													1
	0035																
	0040	1M50'	1	1													2
	0405																
	0410	1M20'	1													2	3
6/19-20	1145																
73	1150	1M10'		1	4	78	61	30									173
	1145																
	1150	1M20'			6	13	54	69	30								172
	1240																
	1245	1M40'				15	58	48	12	2							135
	1655																
	1700	1MS			3	5	5	5									18

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: White Peroh

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	1655																
73	1700	1M50'															0
	0000																
	0005	1M0'			1	1											2
	0000																
	0005	1M50'			1	1	3	3	1								9
	0057																
	0102	1M20'															0
	0057																
	0102	1M40'				2		1									3
7/2-3/73	1332																
	1337	1M0'															0
	1332																
	1337	40'M				1				1	5	1	1				9
	1638																
	1643	20'*M															0
	1638																
	1643	1M20'															0
	2037																
	2040	20'*M															0
	2037																
	2040	1M20'															0
	2132																
	2137	40'*															0
	2132																
	2137	1M40'				1											1
	0241																
	0246	20'*M															0
	0241																
	0246	1M20'								1			2				3

* - 1 meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	1300																
73	1305	20'*M															0
	1300																
	1305	1M20'												1		1	2
	1356																
	1401	1M0'															0
	1356																
	1401	1M40'															0
	1705																
	1710	20'*M															0
	1705																
	1710	1M20'												1	1		2
	2108																
	2113	20'*M															0
	2108																
	2113	1M20'												1			1
	2214																
	2218	0'											2				2
	2214																
	2218	1M0'															0
	2214																
	2218	40'															0
	2214																
	2218	1M40'															0
	0235																
	0240	20'*M															0
	0235																
	0240	20'*M															0
	0235																
	0240	1M20'				1	1	1				1	1				5
7/31-	0856																
8/1/73	0902	1M40'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0857																
8/1/73	0902	1M40'															0
	1300																
	1305	0'															0
	1657																
	1702	40'															0
	1826																
	1831	1M30'															0
	1826																
	1831	1M30'															0
	1937																
	1942	40'															0
	1937																
	1942	1M40'															0
	2142																
	2147	1M30'															0
	2330																
	2335	0'															0
	2330																
	2335	20'															0
	2330																
	2335	1M40'														1	1
	0149																
	0154	1M10'															0
	0149																
	0154	1M10'															0
	0149																
	0154	1M10'															0
	0412																
	0417	1M0'															0
	0412																
	0417	1MS															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDWCH

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0435																
8/1/73	0440	1M40'															0
	0435																
	0440	40''															0
	0639																
	0644	1M30'															0
8/14/73	2106																
	2111	1M10'															0
	2106																
	2111	1M20'															0
	2106																
	2111	1M30'															0
	2158																
	2203	1M20'														1	1
	2158																
	2203	1M20'															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1355																
	1400	1MBott															0
3/21/73	1412																
	1417	1MS															0
4/11/73	1412																
	1417	1MS															0
	1100																
	1105	10'1M															0
5/3/73	0835																
	0840	1S*M					1		1								2
	0845																
	0850	35"*M		3			1										4
	0933																
	0938	1MS	1		4	38	37	3								1	84
	1150																
	1155	10'1M			2	5	39	124	16								186
	1209																
	1214	20'1M				2	21	78	3		2	2					108
	1340																
	1345	30'1M				2	1										3
	1808																
	1813	1MS				4		2		1			1				8
	2028																
	2033	10'1M					1										1
	2044																
	2049	20'1M															0
	2257																
	2302	30'1M		1	5	5	3	1									15
5/10-11/73	0933																
	0938	surf 1M	1		4	38	37	3								1	84
	1150																
	1155	10' 1M			2	5	39	124	16								186

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/10-11/73	1209																
	1214	20' 1M				2	21	78	3		2	2					108
	1340																
	1345	30' 1M				2	1										3
	1808																
	1813	surf 1M				4		2		1			1				8
	2028																
	2033	10'1M					1										1
	2044																
	2049	20' 1M															0
	2257																
	2302	30' 1M		1	5	5	3	1									15
5/22-23/73	1010																
	1015	0'		2	5	22	51	5			5		2				192
	1010																
	1015	10'	1	1	12	24	3										41

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1620																
73	1625	0'		2	27	58	27	4	4	5							127
	1620																
	1625	10'			17	11	5	1	3	2	1						40
	2025																
	2030	0'		17	123	196	30										366
	2025																
	2030	10'	1	3	19	43	7				4	3	1				81
	2325																
	2330	10'		1													1
	2325																
	2330	20'		1		1											2
	0148																
	0153	0'		65	148	754	163	30		30	30	15	7	1	7		1256
	0148																
	0153	*M	2	17	23	83	45	13	7	5	12	7	7				221
	0230																
	0235	10'		5	8	45	19	14	3	22	30	30	8	3			193
	0556																
	0601	20'			5	31	45	19	3				2	3			108
	0556																
	0601	30'		11	46	192	16					3	3				271
	0619																
	0624	40'		5	7	15	4		1								32
	0619																
	0624	50'		23	74	31			2	2	2						134
	0809																
	0814	0'		1	5	43	31	4	1		2	3					90
6/7-8/	2124																
73	2129	20'	1	9	23	2	1		1	1							38
	2210																
	2215	0'					3										3

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	2210																
	2215	10'				4	1	2	1								8
	2210																
	2215	30'			4	9	2		1							5	21
6/19-20/	1205																
73	1210	10'				2	9	19	20	7	16	11	3	2	1		90
	1205																
	1210	20'			1	2	1	11	10	6	5	2					39
	1453																
	1458	0'				8		33	48	59	48	25	15	3	3		242
	1453																
	1458	30'						2	2	1	1						6
	0018																
	0023	S			2	2		4	9	27	20	27	33	16	4	12	156
	0018																
	0023	30'				2						4	16	26	35	35	118
	0037																
	0042	10'					1	4	4	6	4	11	9	2	6	32	79
	0037																
	0042	20'				6			6	2	2	2	11	29	16	80	154
7/2-3/73	1214																
	1219	10'*M															0
	1214																
	1219	10'									1		3	1	2	14	21
	1313																
	1318	0'				3				7	2		7	22	14	47	102
	1313																
	1318	20'															0
	1620																
	1625	10'	1										3	2	1		7
	1620																
	1625	10'*															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2008																
	2013	10*														3	3
	2008																
	2013	10	3	1	5	1			1	1		1	3	3	4		23
	0215																
	0220	10'										3	3	3	16	168	193
	0215																
	0220	10'*										2	1	1	1	6	11
	0400																
	0405	0									1	1	4	5	6	39	56
	0400																
	0405	20'									159					80	239
7/17-18	0812																
73	0817	0'				1		1	2	3	2			2			11
	0812																
	0817	20'															0
	1145																
	1150	10'*															0
	1145																
	1150	10'															0
	1338																
	1343	0'								1			5	1			7
	1338																
	1343	20'												1	1	2	4
	1459																
	1504	0'										1	1				2
	1459																
	1504	20'															0
	1539																
	1544	0'				1								1			2
	1539																
	1544	20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1648																
73	1653	10'*															0
	1648																
	1653	10'															0
	2050																
	2055	10'*															0
	2050																
	2055	10'															0
	2152																
	2157	10'										1	1				2
	2152																
	2157	20'														3	3
	0215																
	0220	10'									5					8	13
	0215																
	0220	10'*														2	2
	0428																
	0433	0'									1					1	2
	0428																
	0433	20'														3	3
7/31-	1240																
8/1/73	1245																0
	1918																
	1923	0'															0
	2203																
	2208	10'*														1	1
	2203																
	2208	10'									1					1	2
	2223																
	2228	0'														2	2
	2223																
	2228	20'														3	3

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0223																
8/1/73	0228	10											1			3	4
	0223																
	0228	10'*M															0
	0253																
	0258	0'															0
	0253																
	0258	20'														2	2
	0700																
	0705	10'														1	1
8/14-15/	0115																
73	0120	0															0
	0505																
	0510	20'														2	2

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/21/73	1355																
	1400	1m Bot															0
	1412																
	1417	1m surf															0
4/11	1412																
	1417	1m surf															0
	1100																
	1105	10 1m															0
5/3	0835	1 surf															
	0840	*m															0
	0845																
	0850	35'*m															0
5/10	0933																
	0938	surf 1m															0
	1150																
	1155	10' 1m															0
	1209																
	1214	20' 1m															0
	1340																
	1345	30' 1m															0
	1808																
	1813	surf 1m															0
	2028																
	2033	10'm															0
	2044																
	2049	20' 1m															0
	2257																
	2302	30' 1m															0
5/22-23	1010																
	1015	0'															0
	1010																
	1015	10'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1620																
	1625	0'								2	1	1					4
	1620																
	1625	10'								3							3
	2025																
	2030	0'								1	2	9					12
	2025																
	2030	10'															0
	2325																
	2330	10'															0
	2325																
	2330	20'															0
	0148																
	0153	0'								1	1						2
	0148																
	0153	*'m								1		2					3
	02030																
	0235	10'								2	3	2					7
	0556																
	0601	20'								1							1
	0556																
	0601	30'							1	2	1						4
	0619																
	0624	40'								2							2
	0619																
	0624	50'															0
	0809																
	0814	0'															0
6/7	2124																
	2129	20'															0
	2210																
	2215	0'														1	1

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: American Shad

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7/73	2210																
	2215	10'											1	1			2
	2210																
	2215	30'									1						1
6/19-20	1205																
	1210	10'															0
	1205																
	1210	20'															0
	1453																
	1458	0														1	1
	1453																
	1458	30'															0
	0018																
	0023	S														29	29
	0018																
	0023	30'															0
	0037																
	0042	10'															0
	0037																
	0042	20'															0
7/2	1214																
	1219	10'*m															0
	1214																
	1219	1m 10'															0
	1313																
	1318	0'															0
	1313																
	1318	20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/13/73	1355																
	1400	1m Bot															0
3/21/73	1412																
	1417	1m Surf															0
4/11/73	1412																
	1417	1m Surf															0
	1100																
	1105	10' m															0
5/3/73	0835	1 surf															
	0840	*m															0
	0845																
	0850	35'*m															0
5/10-11/73	0433																
	0438	*m20'															
	1150																
	1155	10'1m															0
	1209																
	1214	20'1m				1											1
	1340																
	1345	30'1m															0
	1808																
	1813	surf1m															0
	2028																
	2033	10'1m															0
	2044																
	2049	20'1m															0
	2251																
	2352	30'1m															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1010																
	1015	0'															0
	1010																
	1015	10'															0
	1620																
	1625	0'															0
	1320																
	1325	10'															0
	2025																
	2030	0'		1													1
	2025																
	2030	10'															0
	2325																
	2330	10'															0
	2325																
	2330	20'															0
	0148																
	0153	0'		1	1												2
	0148																
	0153	*'m															0
	02030																
	0235	10'															0
	0556																
	0601	20'			1												1
	0556																
	0601	30'		3													3
	0619																
	0624	40'															0
	0619																
	0624	50'															0
	0809																
	0814	0'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	2124																
	2129	20'	1	7	12	32	3										55
	2210																
	2215	0'		10	27	176	6										223
	2210																
	2215	10'	3	5	30	172	18										228
	2210																
	2215	30'	3		13	53	32	2									103
6/19-20	1205																
	1210	10'				1	1										2
	1205																
	1210	20'				4	4	1									9
	1453																
	1458	0'					1										1
	1453																
	1458	30'			1	2	1	1									5
	0018																
	0023	0'					1	2									3
	0018																
	0023	30'						1									1
	0037																
	0042	10'							1								1
	0037																
	0042	20'															0
7/2-3	1214																
	1219	*m 10'															0
	1214																
	1219	1m 10'							1		1						2
	1313																
	1318	0'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1313																
	1318	20'															0
	1620																
	1625	10'															0
	1620																
	1625	*m 10'															0
	2008																
	2013	10'															0
	2008																
	2013	10'															0
	0215																
	0220	10'															0
	0215																
	0220	* 10'															0
	0400																
	0405	0'															0
	0400																
	0405	20'									1	1	5	4	1	4	16
7/17-18	0812																
	0817	0'															0
	0812																
	1817	20'															0
	1145																
	1150	*m 10'															0
	1145																
	1150	10'															0
	1338																
	1343	0															0
	1338																
	1343	10'															0
	1459																
	1504	0'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1459																
	1504	20'												1		1	2
	1539																
	1544	0'															0
	1539																
	1544	20'											2				2
	1648																
	1653	10*															0
	1648																
	1653	10'															0
	2050																
	2055	10*															0
	2050																
	2055	10'															0
	2152																
	2157	10'															0
	2152																
	2157	20'														1	1
	0215																
	0220	10'															0
	0215																
	0220	10*															0
	0428																
	0433	0'															0
	0428																
	0433	20'															0
7/31-8/1	1240																
	1245	5'															0
	1918																
	1923	20'														1	1
	2203																
	2208	10*															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-8/1	2203																
	2208	10'															0
	2223																
	2228	0'															0
	2223																
	2228	20'															0
	2330																
	2335	20'															0
	0223																
	0228	10'															0
	0223																
	0228	*m 10'															0
	0253																
	0258	0'														1	1
	0253																
	0258	20'															0
	0700																
	0705	10'															0
8/15	0115																
	0120	0'															0
	0505																
	0510	20'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** : Tomcod

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/21/73	1355																
	1400	1M Bott			3	71	258	61									393
	1412	1M															
	1417	surface			9	67	165	49									290
4/11/73	0900																
	0905	1M surf															0
	1100																
	1105	10'1M															0
5/3/73	0835	1 surf															
	0840	*M															0
	0845																
	0850	35'*M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
3/21/73	1355																
	1400	1MBot															0
	1412																
	1417	1MS															0
4/11/73	1412																
	1417	1MS															0
	1100																
	1105	10'M															0
5/3/73	0835																
	0840	1S*M															0
	0845																
	0850	30'*M															0
5/10-11/73	0933																
	0938	1MS															0
	1150																
	1155	10'1M			1												1
	1209																
	1214	20'1M						2									2
	1340																
	1345	30'1M															0
	1808																
	1812	1MS															0
	2028																
	2033	10'1M															0
	2044																
	2049	20'1M															0
	2257																
	2352	30'1M															0
5/22-23/73	1010																
	1015	0'															0
	1010																
	1015	10'															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1620																
73	1625	0'															0
	1620																
	1625	10'															0
	2025																
	2030	0'															0
	2025																
	2030	10'															0
	2325																
	2330	10'															0
	2325																
	2330	20'															0
	0148																
	0153	0'															0
	0148																
	0153	*M															0
	0230																
	0235	10'															0
	0556																
	0601	20'															0
	0556																
	0601	30'															0
	0619																
	0624	40'															0
	0619																
	0624	50'															0
	0809																
	0814	0'															0
6/7/73	2124																
	2129	20'		1													1
	2210																
	2215	0'				2										2	4

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	2210																
	2215	10'			2	4											6
	2210																
	2215	30'					2										2
6/19-20	1205																
73	1210	10'		1	11	16	8										36
	1205																
	1210	20'		2	12	12	12	6									44
	1453																
	1458	0'		14	51	50	9										124
	1453																
	1458	30'			4	4	5		1								14
	0018																
	0023	S			1	3	5	1									10
	0018																
	0023	30'					1										1
	0037																
	0042	10'															0
	0037																
	0042	20'			1		2										3
7/2-3/73	1214																
	1219	10'*M															0
	1214																
	1219	10M			1	1											2
	1313																
	1318	0'															0
	1313																
	1318	20'															0
	1620																
	1625	10'										1					1
	1620																
	1625	10'*M															0

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2008																
	2013	10'*M															0
	2008																
	2013	10'															0
	0215																
	0220	10'									1		2	1		2	6
	0215																
	0220	10'*														1	1
	0400																
	0405	0'												1	1		2
	0400																
	0405	20'									1		2		4	2	9
7/17-18/	0812																
73	0817	0'															0
	0812																
	0817	20'														1	1
	1145																
	1150	10'*M															0
	1145																
	1150	10'															0
	1338																
	1343	0'															0
	1338																
	1343	20'										1					1
	1459																
	1504	0'															0
	1459																
	1504	20'										1	3	5		3	11
	1539																
	1544	0'														1	1
	1539																
	1544	20'												2		1	3

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1648																
73	1653	10'*															0
	1648																
	1653	10'															0
	2050																
	2055	10'*M															0
	2050																
	2055	10'															0
	2152																
	2157	0'															0
	2152																
	2157	20'														4	4
	0215																
	0220	10'														6	6
	0215																
	0220	10'*M														1	1
	0428																
	0433	0'												1		2	3
	0428																
	0433	20'												1		2	3
7/31-	1240																
8/1/73	1245	S															0
	1918																
	1923	20'															0
	2203																
	2208	10'*															0
	2203																
	2208	10'														1	1
	2223																
	2228	0'									1						1
	2223																
	2228	20'														1	1

* = ½ meter net

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: RDW

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2330																
8/1/73	2335	20'															0
	0223																
	0228	10'														1	1
	0223																
	0228	10'*M															0
	0253																
	0254	0'															0
	0253																
	0254	20															0
	0700																
	0705	10															0
8/15/73	0115																
	0120	0															0
	0505																
	0510	20															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	0925																
	0932	-	SAMPLE LOST														
	1908																
	1916	B½M															0
	2042																
	2047	B½M				3											3
	0856																
	0903	B½M			1	1		1									3
	1537																
	1544	B½M				2	1										3
7/2-3/73	0825																
	0835.5	M½M														2	2
	1233																
	1241	S½M									1						1
	1233																
	1241	M½M									1						1
	1443																
	1451	M½M															0
	1620																
	1623	S½M															0
	1736																
	1746	S½M												1			1
	1736																
	1746	M½M															0
	1807																
	1810	S½M													1	1	2
	1807																
	1810	B½														1	1
	2040																
	2050	S½													3	26	29
	2040																
	2050	S½M									1	1	2	2	4	52	62

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I. **SPECIES:** Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2040																
	2050	B½M											2	2		4	8
7/2-3/73	2115																
	2118	S½M												1		4	5
	2115																
	2118	B½M														5	5
	2250																
	2300	S½M						1		1		1		2	4	15	21
	2250																
	2300	M½M						1	1	1	1	2	1	4	4	22	37
	2250																
	2300	B½M											1			3	4
	2315																
	2318	S½M									1	1					2
	2315																
	2318	B½M									1		2		1	3	7
	0050																
	0100	S½M						1	1		1	4	1		1	5	14
	0050																
	0100	M½M			1		1			1	2	2	1	3	6	15	32
	0050																
	0100	B½M										1			1	5	7
	0110																
	0113	S½M												1		1	2
	0110																
	0113	B½M									1			1		4	6
	0237																
	0247	S½M													1	4	5
	0237																
	0247	M½M												1	1	15	17
	0237																
	0247	B½M									1					1	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0258																
	0301	S½M												1		4	5
	0540																
	0550	S½M														1	1
	0540																
	0550	M½M														5	5
	0540																
	0550	B½M															0
	0605																
	0608	B½M														1	1
7/17-18	0842																
73	0845	S½M															0
	0842																
	0845	B½M															0
	1039																
	1042	S½M															0
	1039																
	1042	B½M															0
	1210																
	1220	S½M															0
	1210																
	1220	M½M															0
	1210																
	1220	B½M															0
	1253																
	1256	S½M															0
	1253																
	1256	B½M															0
	1341																
	1351	S½M									1	2	2	1			6
	1341																
	1351	M½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1341																
73	1351	B½M															0
	1424																
	1427	S½M															0
	1424																
	1427	B½M															0
	1610																
	1613	S½M															0
	1610																
	1613	B½M															0
	1806																
	1809	S½M															0
	1806																
	1809	B½M															0
	2059																
	2102	S½M									1						1
	2059																
	2102	B½M															0
	2250																
	2253	S½M														2	2
	2250																
	2253	B½M														4	4
	2345																
	2355	S½M														5	5
	2345																
	2355	M½M													1	4	5
	2345																
	2355	B½M														1	1
	0100																
	0103	S½M														4	4
	0100																
	0103	B½M														2	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0135																
73	0145	S½M											1		1	3	5
	0135																
	0145	M½M														6	6
	0135																
	0145	B½M														3	3
	0235																
	0238	S½M														1	1
	0235																
	0238	M½M														2	2
	0504																
	0507	S½M														3	3
	0504																
	0507	B½M														3	3
7/31-	1159																
8/1/73	1201	B½M														1	1
	1830																
	1840	S½M															0
	2045																
	2047	B½M															0
	2135																
	2145	S½M															0
	2135																
	2145	B½M														2	2
	2150																
	2152	S½M														1	1
	2245																
	2247	B½M															0
	2330																
	2340	S½M															0
	2330																
	2340	B½M														1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2348																
8/1/73	2350	S½M															0
	0049																
	0059	S½M														1	1
	0049																
	0059	B½M														5	5
	0106																
	0108	S½M														1	1
	0106																
	0108	B½M														1	1
	0333																
	0343	S½M														3	3
	0333																
	0343	B½M														2	2
	0347																
	0349	B½M														1	1
	0530																
	0540	S½M														1	1
	0530																
	0540	B½M															0
8/14/73	2010																
	2017	B½M															0
	2230																
	2233	S½M														1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	0925																
	0932		SAMPLE LOST														
	1908																
	1916	B½M	1	2	2	5	1										11
	2042																
	2047	B½M		1	3		4										8
	0856																
	0903	B½M				6	7									3	16
	1537																
	1544	B½M		2	3	2	2										9
7/2-3/73	0520																
	0835.5	M½M															0
	1233																
	1241	S½M															0
	1233																
	1241	M½M												1			1
	1443																
	1451	M½M															0
	1736																
	1746	M½M								1		1	4				6
	1807																
	1810	S½M															0
	1807																
	1810	B½M															0
	2040																
	2050	S½M															0
	2040																
	2050	M½M												1			1
	2040																
	2050	B½M															0
	2115																
	2118	S½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2115																
	2118	B½M													1		1
	2250																
	2300	S½M															0
	2250																
	2300	M½_															0
	2250																
	2300	B½M															0
	2315																
	2318	S½M															0
	2315																
	2318	B½M															0
	0050																
	0100	S½M										1	2				3
	0050																
	0100	M½M						1									1
	0050																
	0100	B½M										1					1
	0110																
	0113	S½M															0
	0110																
	0113	B½M															0
	0237																
	0247	S½M															0
	0237																
	0247	M½M															0
	0237																
	0247	B½M															0
	0258																
	0301	S½M															0
	0504																
	0550	S½M												1	1		2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0504																
	0550	½M															0
	0504																
	0550	B½M															0
	0605																
	0608	B½M															0
7/17-18	0842																
73	0845	S½M															0
	0842																
	0845	B½M															0
	1039																
	1042	S½M															0
	1039																
	1042	B½M															0
	1210																
	1220	S½M															0
	1210																
	1220	M½M															0
	1210																
	1220	B½M															0
	1253																
	1256	S½M															0
	1253																
	1256	B½M															0
	1341																
	1351	S½M															0
	1341																
	1351	M½M															0
	1341																
	1351	B½M															0
	1424																
	1427	S½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1424																
73	1429	½B															0
	1610																
	1613	S½															0
	1610																
	1613	B½															0
	1806																
	18	S½															0
	1806																
	18	B½													2	1	3
	2050																
	21	S½															0
	2059																
	2102	B½															0
	2250																
	2253	S½M															0
	2250																
	2253	B½M															0
	2345																
	2355	S½M												2			2
	2345																
	2355	M½M															0
	2345																
	2355	B½M															0
	0100																
	0103	S½M															0
	0100																
	0103	B½M															0
	0135																
	0145	S½M														1	1
	0135																
	0145	M½M									2						2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0135																
73	0145	B½M												1			1
	0235																
	0238	S½M															0
	0235																
	0238	M½M															0
	0504																
	0507	S½M															0
	0504																
	0507	B½M															0
7/31-	1159																
8/1/73	1201	B½M															0
	1830																
	1840	S½M															0
	2045																
	2047	B½M															0
	2135																
	2145	S½M															0
	2135																
	2145	B½															0
	2020																
	2152	S½M															0
	2245																
	2247	B½M															0
	2330																
	2440	S½M															0
	2330																
	2440	B½M															0
	2348																
	2350	S½M															0
	0049																
	0059	S½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0049																
8/1/73	0059	S½M															0
	0049																
	0059	B½M															0
	0106																
	0108	S½M															0
	0106																
	0108	B½M															0
	0333																
	0343	S½M															0
	0333																
	0343	B½M															0
	0347																
	0349	B½M															0
	0530																
	0540	S½M															0
	0530																
	0540	B½M															0
	2010																
	2017	B½M															0
	2230																
	2233	S½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I. **SPECIES:** White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	0925																
	0932		SAMPLE LOST														
	1908																
	1916	B*															0
	2042																
	2047	B*			1												1
	0856																
	0903	B*														3	3
	1537																
	1544	B*															0
7/2-3/73	0828																
	0835.5	M*															0
	1233																
	1241	S*															0
	1233																
	1241	M*															0
	1443																
	1451	M*															0
	1620																
	1623	S*															0
	1736																
	1746	S*															0
	1736																
	1746	M*														1	1
	1807																
	1810	S*															0
	1807																
	1810	B*															0
	2040																
	2050	S*														1	1
	2040																
	2050	M*											2				2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2040																
	2050	B*															0
	2115																
	2118	S*													1		1
	2115																
	2118	B*															0
	2250																
	2300	S*													3		3
	2250																
	2300	M*															1
	2250																
	2300	B*															0
	2315																
	2318	S*															0
	2315																
	2318	B*															0
	0050																
	0100	S*									1		1			1	3
	0050																
	0100	M*														1	1
	0050																
	0100	B*														1	1
	0110																
	0113	S*													1		1
	0110																
	0113	B*														1	1
	0237																
	0247	S*															0
	0237																
	0247	M*															0
	0237																
	0247	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I. **SPECIES:** White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0258																
	0301	S*												1	1		2
	0540																
	0550	S*															0
	0540																
	0550	M*												1			1
	0540																
	0550	B*												1			1
	0605																
	0608	B*															0
7/17-18	0842																
73	0845	S*															0
	0842																
	0845	B*														1	1
	1039																
	1042	S*															0
	1039																
	1042	B*															0
	1210																
	1220	S*															0
	1210																
	1220	M*															0
	1210																
	1220	B*														3	3
	1253																
	1256	S*															0
	1253																
	1256	B*															0
	1341																
	1351	S*															0
	1341																
	1351	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I. SPECIES: White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1341																
73	1351	B*														1	1
	1424																
	1427	S*															0
	1424																
	1427	B*															0
	1610																
	1613	S*															0
	1610																
	1613	B*															0
	1806																
	1809	S*															0
	1806																
	1809	B*														2	2
	2059																
	2102	S*															0
	2059																
	2102	B*															0
	2250																
	2253	S*															0
	2250																
	2253	B*															0
	2345																
	2355	S*														2	2
	2345																
	2355	M*														4	4
	2345																
	2355	B*															0
	0100																
	0103	S*														1	1
	0100																
	0103	B*														2	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0135																
73	0145	S*														2	2
	0135																
	0145	M*									1					1	2
	0135																
	0145	B*														2	2
	0235																
	0238	S*														1	1
	0235																
	0238	M*															0
	0504																
	0507	S*														2	2
	0504																
	0507	B*														1	1
7/31-	1159																
8/1/73	1201	B*															0
	1830																
	1840	S*															0
	2045																
	2047	B*															0
	2135																
	2145	S*															0
	2135																
	2145	B*														2	2
	2150																
	2152	S*															0
	2245																
	2247	B*															0
	2330																
	2340	S*														1	1
	2330																
	2340	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.I.

SPECIES: White Perch

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	2348																
8/1/73	2350	S*															0
	0049																
	0059	S*														1	1
	0049																
	0059	B*															0
	0106																
	0108	S*															0
	0106																
	0108	B*															0
	0333																
	0343	S*															0
	0333																
	0343	B*															0
	0347																
	0349	B*															0
	0530																
	0540	S*															0
	0530																
	0540	B*														1	1
8/14/73	2010																
	2017	B*															0
	2230																
	2233	S*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D. SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	1927																
	1932	½M			1	4	1						1				7
	1954																
	1957	M			3		2	1									6
	2019																
	2025	MB		,	3	4		1	1		3		1		1		14
	1004																
	1012	½B			11	13		1	2								27
	1038																
	1041	½B		1	3	5											9
	1116																
	1120	B½M			8	4	2										14
	1334																
	1337	B			1	3	1										5
	1407																
			1	1	5	5						1				1	14
	1430																
	1432	M				1	2										3
	1445																
	1440	M				1	2										3
7/2-3/73	1046																
	1054	½B														1	1
	1356																
	14035	½B						1				1					2
	1836																
	1846	½B			2		3	1	9	3	6	5	9	6	3	4	51
	1855																
	1858	½B												2	1	8	11
	2145																
	2155	½B										3	2	2	6	82	95
	2204																
	2207	B								1			1	3	6	24	35

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0011																
	0014	½										1		2		8	11
	0147																
	0157	½B						3	1			4	6	8	8	39	69
	0205																
	0208	B										1		2		5	8
	0445																
	0445	½														44	44
	0500																
	0503	½B		1							10					13	24
7/17-18	0924																
73	0927	½MB															0
	1056																
	1059	½MS															0
	1233																
	1243	½MB										1	2				3
	1305																
	1308	½MB															0
	1407																
	1417	½MB															0
	1439																
	1442	½MB															0
	1638																
	1641	½MB															0
	1749																
	1751	½MB															0
	2046																
	2049	½MB															0
	0025																
	0035	½MB														11	11
	0040																
	0043	½MB														1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0213																
73	0216	½MB									4					2	6
	0447																
	0450	½MB															0
	0158																
	0208	½MB														11	11
7/31-	2245																
8/1/73	2247	B															0
	0010																
	0020	½MB														8	8
	0020																
	0028	½MB														1	1
	0403																
	0413	½MB															0
	0417																
	0419	½MB														5	5
	0615																
	0625	½MB														1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/7	1927																
	1932	*				3											3
	1954																
	1957	*					2										2
	2019																
	2025	B*				1	2										3
	1008																
	1012	B		1	2	9	8										20
	1038																
	1041	B	1	2	2	8	6										19
	1116																
	1120	B		1	6	7	11										25
	1334																
	1337	B		2	10	15		6									33.
	1407																
					1	2											3
	1430																
	1433	*															0
	1445																
	1449	*				1											1
7/2-3/	1046																
73	1051	B*															0
	1356																
	1403.5	B*											1				1
	1642																
	1647	B*										1					1
	1836																
	1846	B*					1				1						2
	1855																
	1858	B*									1						1
	2145																
	2155	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2204																
	2207	B*														1	1
	0011																
	0014	*															0
	0147																
	0157	B*								1	1					7	9
	0205																
	0208	B*															0
	0445																
	0455	*										1		2		6	9
	0500																
	0503	B*														1	1
7/17-18	0924																
73	0927	B*															0
	1056																
	1059	S*															0
	1233																
	1243	B*															0
	1305																
	1308	B*															0
	1407																
	1417	B*															0
	1439																
	1442	B*															0
	1638																
	1641	B*															0
	1749																
	1751	B*															0
	2046																
	2049	B*															0
	0025																
	0035	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0040																
73	0043	B*															0
	0158																
	0208	B*															0
	0213																
	0216	B*															0
	0445																
	0447	B*														3	3
7/31-	2245																
8/1/73	2247	B*															0
	0010																
	0020	B*															0
	0026																
	0028	B*															0
	0403																
	0413	B*															0
	0417																
	0419	B*															0
	0615																
	0625	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	1927																
	1932	½M		1													1
	1954																
	1957	½M		3													3
	2019																
	2025	½B		2													2
	1004																
	1012	½B															0
	1038																
	1041	B½M				1											1
	1115																
	1120	B½M		2	1	1	2										6
	1330																
	1337	B½M															0
	1407																
																	0
	1430																
	1433	½M				1											1
	1445																
	1449	½M															0
7/2-3/73	1046																
	1054	½B															0
	1356																
	1403.5	½B															0
	1642																
	1647	½B										1		1	3	1	6
	1836																
	1846	½B												3			3
	1855																
	1858	½B										1	1				2
	2145																
	2155	½B														2	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	2204																
	2207	½B														1	1
	0011																
	0014	½															0
	0147																
	0157	½B															0
	0205																
	0208	½B													1	1	2
	0445																
	0455	½									1		1	2	3	2	9
	0500																
	0503	½B					1							1	1	2	5
7/17-18	0924																
73	0927	½B															0
	1056																
	1059	½S															0
	1233																
	1243	½B													1	1	2
	1305																
	1308	½B												1			1
	1407																
	1417	½B														1	1
	1434																
	1442	½B														1	1
	1638																
	1641	½B															0
	1749																
	1751	½B															0
	2046																
	2049	½B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: R.D. **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0025																
73	0035	½B													1	9	10
	0040																
	0043	½B															0
	0213																
	0216	½B													1	7	8
	0447																
	0450	½B														1	1
	0158																
	0208	½B												3	1	14	18
7/31-	2245																
8/1/73	2247	B															0
	0010																
	0020	½B															0
	0026																
	0028	½B															0
	0403																
	0413	½B															0
	0413																
	0419	½B															2
	0615																
	0625	½B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1200																
73	1207	S			9	41	15	4	5	1	20	5					100
	1200																
	1207	B				43	22			7	11	33	10				126
	1330																
	1333	S		4	4	6	1	1	4	1	1	11	3				36
	1330																
	1333	B			2	1	1			1							5
	1332																
	13375	S*	1	1	2		1	1	1		3	3					13
	1330																
	1338	M*		1	5	1		2		3	2						14
	1330																
	1338	B*	2		2			1	6	2	7						20
	1515																
	1520	S*		1	1	3											5
	1515																
	1520	M*		2	6	1											9
	1515																
	1520	B*			1	5				1							7
	2100																
	2104	B*			5	5		3	1	1	2						17
	0000																
	00035	S*		3	3	30	5	1	1	2	3						48
	0000																
	00035	S			12	19	40	21	2	4	12	21	21	4	2		158
	0000																
	00035	M*		1	7	18	3			2		3				1	35
	0000																
	00045	B*				2	2	2	2	1		1					10
	0205																
	0208-5	S		13	84	225	30	40		17	47	128	50	34			668

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	0205																
73	0208-5	S*		1	3	38	25	3	5	18	10	1					104
	0205																
	0208-5	M*		1	3	58	17	3	3	25	19	6	1				136
	0205																
	0208-5	B*		3	11	40	15	3	4	1	5	11	3				96
	0325																
	0328-2	S*		1	9	81	34	7	2	4	7	9	1				155
	0325																
	0328	M*		3	6	38	6	2			5	3					63
	0325																
	0329	B*		1	5	19	11	2		2	1	1					42
	0525																
	0529	M*		2	3	21	15	2		1	2	2	1			1	50
	0835																
	0839	M*		2	4	50	37	7	4	2		1	1				108
6/7-8/	1655																
73	1700	S*			2	2			1								5
	1655																
	1700	M*				1				1							2
	1830																
	1832-5	B				1			1								2
	2207																
	2211	S*			1		1				1						3
	2207																
	2211	B*					2	1									3
	2315																
	2322	S			1	1	2	2		1	1	1	1	1	1	1	13
	2315																
	2322	B			10	9	10	8	4	2		2	1				46
	2319																
	2327	S*		2	6	4	2	2		2	1	1	1				21

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/	2319																
73	2327	M			1	1		1									3
	0034																
	0036	B	1	2	3	3	1					1					11
	0035																
	0037	B		3	6	5	1	2		1			1				19
	0215																
	0222	S				16	30	18	19	1	5		5	1		1	96
	0215																
	0222	B			10	19	9	8	7			2					55
	0215																
	0222	S*			4	14	14	1	4								37
	0215																
	0222	M*			4	4	2	2									12
	0215																
	0222	B*				2	6	3		2		1					14
	0325																
	0327	B			2	4	4	3	1	2					2		18
	0520																
	0522	B						2									2
	0802																
	0804	B		2	8	14	13	5	4	2	2	1					51
	1000																
	1002	S				4											4
	1000																
	1002	B		1							1	1					3
	1145																
	1148	B			1	1			1								3
	1145																
	1148	M				3	1		1	1							6
	1145																
	1148	B				1											1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/	1250																
73	1252	B					1	1									2
	1500																
	1504	M*			7		1				1						9
	1500																
	1504	B*					1					1					2
	1500																
	1504	B			17	28	6	3	2	1	3	1	2	1			64
	1530																
	1532	S*			1	1											2
	1530																
	1532	B		1	1						2		1				5
6/19-20	0195																
73	0197	B						1	1	1	1	1	1	1		5	12
	1106																
	1113	S*					1		3	4	6	13	15	12	4	10	68
	1106																
	1113	B*			2	10	8	28	25	45	50	15	10			2	195
	1106																
	1113	B*		4	4	34	61	26	12	45	49	83	45	34	27	42	466
	1131																
	1133	S*			4	6	1	7	6	4	4	1	2		1		36
	1131																
	1133	B				2	1	2	3	3	3	4	4	3	1	3	29
	1300																
	1307	S*						1				2				3	6
	1300																
	1307	M			1				2							1	4
	1300																
	1307	B					1	2	1	2	1		2			1	10
	1300																
	1307	B				2	1	2	5	2	1	3	2		1	4	23

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	1330																
73	1333	B			1	1	2	1	4	6	6	2	3	2	1	5	34
	1457																
	1504	M*						2		1	1	1			1		6
	1457																
	1504	S			1	2	3	7	4	7	6	6	5	7		12	60
	1540																
	1542	B*											1			1	2
	1736																
	1743	S				2	3	2	2	4	8	1	9	7	3	41	82
	1809																
	1811	B					1			2	1		1	2	1	4	12
	2025																
	2027	S			1	2		1	2	1							7
	2025																
	2027	B				3	3	2	2	2	2	1	2	4	4	3	28
	2207																
	2214	B					3		10		6	13	44	73	101	140	390
	2209																
	2216	S*					1	3	3	1	8	21	30	22	4	10	103
	2209																
	2216	B*					1				4	10	25	15	13	28	96
	2235																
	2237	B														2	2
	0055																
	0102	B						8	22	24	16	32	49	43	19	8	221
	0055																
	0102	S*					1	1	4	2	3	2	3			5	21
	0055																
	0102	B*		1	2	4	1	2	6	5	4	2	5	1	1		34
	0115																
	0117	S*			1	2	1		3			2	1			1	11
	0115																
	0117	B*							1	1	1	1		1			5

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	0445																
73	1447	S				1	1	3	1		1	2	1	1	1		12
	0445																
	0447	M					1			1		2				6	10
	0445																
	0447	B				1	1			1	5	1	2		1		12
	0710																
	0712	S*	1			3				1	2	2			3	2	14
	0710																
	0712	M*				1			1	2	2	5	3	4	1		19
	0710																
	0712	B*			2	8	1	5	7	8	1	7	6	2			47
7/2-3/73	0850																
	0852	B												1	4	74	79
	1047																
	1049	S														7	7
	1047																
	1049	B	1													11	12
	1154																
	1201	S	11													20	31
	1154																
	1201	B					1						2	2	2	5	12
	1156																
	1203	S*														2	2
	1156																
	1203	M*														2	2
	1156																
	1203	B*													3	2	5
	1223																
	1225	B														4	4
	1400																
	1407	S											1	1	2	12	16

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/	1400																
73	1407	B	5													15	20
	1402																
	1409	O*														1	1
	1402																
	1409	M*														1	1
	1402																
	1409	B														6	6
	1434																
	1436	O															0
	1434																
	1436	B*	1														1
	1746																
	1748	B*	5													68	73
	1946																
	1948	O*									1	2	1	1		2	7
	1946																
	1948	B*											1		2	4	7
	2137																
	2139	B									1	2	4	6	5	45	63
	2345																
	2350	O												1		2	3
	2345																
	2352	M												1	1	15	17
	2345																
	2352	B	5													3	8
	2345																
	2352	B								2	2	1	4		5	30	44
	0010																
	0013	O										1		1	1	2	5
	0010																
	0013	B	2														2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0137																
	0144	B						1			1	1	1	1	3	19	27
	0137																
	0144	O						4	1	1	1	1	4	1	3	2	18
	0137																
	0144	M												1		3	4
	0137																
	0144	B														6	6
	0200																
	0203	B															0
	0506																
	0507	S*														1	1
	0506																
	0507	B*									1	1	2		1	10	15
	0620																
	0622	O*										2	1	2	1	23	29
	0620																
	0623	MB*											1	1	1	21	24
7/17-18	0753																
73	0755	O*															0
	0753																
	0755	B*												1			1
	0921																
	0923	B*								1	1	2	1			1	6
	1041																
	1043	B*	1													6	7
	1101																
	1108	B*														2	2
	1104																
	1111	O*															0
	1104																
	1111	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/	1254																
73	1301	O'															0
	1254																
	1301	B															0
	1257																
	1304	O*															0
	1257																
	1304	M*															0
	1257																
	1304	B*															0
	1454																
	1501	O										1	1				2
	1454																
	1501	B									2	1					3
	1456																
	1503	O*															0
	1456																
	1503	M*										1					1
	1456																
	1503	B*															0
	1703																
	1705	B															0
	2005																
	2007	B														7	7
	2150																
	2157	B								1			1			4	6
	2152																
	2159	M*											1			2	3
	2152																
	2159	B*															0
	2205																
	2207	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0005																
73	0012	O*															0
	0005																
	0012	M*														1	1
	0007																
	0014	O'*														10	10
	0007																
	0014	B	5	7	1											1	14
	0045																
	0047	O'														2	2
	0045																
	0047	B															0
	0210																
	0217	O'															0
	0200																
	0217	M														1	1
	0200																
	0217	B															0
	0212																
	0219	O													1	13	14
	0212																
	0219	B	7														7
	0230																
	0232	O'														1	1
	0230																
	0232	B	2														2
	0640																
	0642	B													2	2	4
7/31-	0818																
8/1/73	0825	B														3	3
	0823																
	0830															1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0836																
8/1/73	0838	B															0
	0918																
	0925	B									1		1			1	3
	0920																
	0927	M*														2	2
	0920																
	0927															1	1
	1023																
	1030	S											1				1
	1437																
	1441														1		1
	1828																
	1835	B*													1		1
	1828																
	1835	B															0
	1847																
	1849	B													1	5	6
	2143																
	2150	B*														1	1
	2143																
	2150	M*															0
	2143																
	2150	B									3					1	4
	2350																
	2357	B*															0
	0017																
	0019	B														2	2
	0114																
	0121	B									1					10	11
	0114																
	0121	S*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0114																
8/1/73	0121	M*														1	1
	0114																
	0121	B*															0
	0431																
	0438	B*														1	1
	0431																
	0438	S														3	3
	0431																
	0438	B														5	5
	0457																
	0459	S														3	3
	0457																
	0459	B														4	4
8/14-15/	1540																
73	1547	S															0
	1540																
	1547	B															0
	1740																
	1747	S															0
	1740																
	1747	B															0
	2002																
	2009	B															0
	2115																
	2162	S															0
	2115																
	2122	B															0
	2117																
	2124	S*															0
	2117																
	2124	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	2338																
73	2345	S														59	59
	2338																
	2345	B														110	110
	0001																
	0003															2	2
	0001																
	0003	B															0
	0223																
	0230	B															0
	0325																
	0332	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1200																
73	1207	S															0
	1200																
	1207	B															0
	1330																
	1333	S															0
	1330																
	1333	B															0
	1330																
	13375	S*															0
	1330																
	1338	M*															0
	1338																
	1338	B*															0
	1515																
	1520	S*															0
	1515																
	1520	M*		1													1
	1515																
	1520	B*															0
	2100																
	2104	B															0
	0000																
	0003	S*															0
	0000																
	00035	S															0
	0000																
	00035	M															0
	0000																
	00045	B*		1													1
	0205																
	0209	S															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	0205																
73	0209	S*															0
	0205																
	0209	M*					1	1									2
	0205																
	0209	B*				1	1										2
	0325																
	03285	S															0
	0325																
	03285	S*															0
	0325																
	0329	M*															0
	0325																
	0329	B*															0
	0425																
	0428	S															0
	0525																
	0529	M*															1
	0625																
	0628	S															1
	0835																
	0839	M*															0
	0915																
	0922	S															1
6/7-8/73	1655																
	1700	S*															15
	1655																
	1700	M*															16
	1830																
	18325	S															1
	1830																
																	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

*1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	2207																
	2211	S*						1									1
	2207																
	2211	B*			1	4											5
	2315																
	2322	S	1	12	31	21											65
	2315																
	2322	B	3	19	18	21	3									3	67
	2319																
	2327	S*		3	5	10	8										26
	2319																
	2327	M*	3	6	7	7										1	24
	2319																
	2327	B*			2	2	7										11
	0034																
	0036	B	1	1	2		2										6
	0035																
	0037	B		1	15	5	3										24
	0215																
	0222	S	6	5	8	7	2									1	29
	0215																
	0222	B		3	14	14	2										33
	0215																
	0222	S*		1	2	1											4
	0215																
	0222	M*		1	2												3
	0215																
	0222	B*	1			6	1										8
	0325																
	0327	B			2	1	1										4
	0520																
	0527	B					5										1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	0802																
	0804	B		4		12	1	3									20
	1000																
	1002	S*															0
	1000																
	1002	B*															0
	1145																
	1148	S															0
	1145																
	1148	B															0
	1145																
	1148	M*															0
	1145																
	1148	B*															0
	1250																
	1252	B															0
	1500																
	1504	M*															0
	1500																
	1504	B*			1												1
	1500																
	1504	B															0
	1530																
	1532	S*															0
	1530																
	1532	B*															0
6/19-20	0915																
73	0917	B															0
	1106																
	1113	S*															0
	1106																
	1113	B*		2	6	3											11

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	1106																
73	1113	B				4		2									6
	1131																
	1133	S*															0
	1131																
	1133	B*					2	2									4
	1300																
	1307	S*															0
	1300																
	1307	M*				1											1
	1300																
	1307	B*							1								1
	1300																
	1307	B				1	2										3
	1330																
	1333	B				1	1										2
	1457																
	1504	M*						1	2								3
	1457																
	1504	S				1	3			1							5
	1540																
	1542	S*						1									1
	1540																
	1542	B*					1	1									2
	1736																
	1743	S		2	2	9	3	3	1	2							22
	1809																
	1811	B															0
	2025																
	2027	S*															0
	2025																
	2027	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2207																
73	2214	B								1	1						2
	2209																
	2216	S*															0
	2209																
	2216	B*															0
	2235																
	2237	B			1												1
	0055																
	0102	B					1	1		1							3
	0055																
	0102	S*															0
	0055																
	0102	B*															0
	0115																
	0117	S*															0
	0115																
	0117	B*															0
	0445																
	0447	S*						1	1								2
	0445																
	0447	M*							1								1
	0445																
	0447	B*				1			1								2
	0710																
	0712	S*															0
	0710																
	0712	M*															0
	0710																
	0712	B*					1										1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0850																
	0852	B															0
	1047																
	1049	S*															0
	1047																
	1049	B*															0
	1154																
	1201	S														2	2
	1154																
	1201	B									1		1		2	2	6
	1157																
	1203	S*															0
	1156																
	1203	M*															0
	1156																
	1203	B*															0
	1223																
	1225	B															0
	1400																
	1407	S										1	1		1		3
	1400																
	1407	B									6	2	1		1	2	12
	1402																
	1409	S*															0
	1402																
	1409	M*															0
	1402																
	1409	B*															0
	1434																
	1436	S*															0
	1434																
	1436	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1746																
	1748	B															0
	1946																
	1948	S*															0
	1946																
	1948	B*															0
	2137																
	2139	B										1	1				2
	2345																
	2350	S*															0
	2345																
	2352	M*														3	3
	2345																
	2352	B*												1	2	2	5
	2345																
	2352	B														3	3
	0010																
	0013	S*															0
	0010																
	0013	B*															0
	0137																
	0144	B											1	1		1	3
	0137																
	0144	S*														1	1
	0137																
	0144	M*												1			1
	0137																
	0144	B*											1		1		2
	0200																
	0203	B*															0
	0506																
	0507	S*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/	0506																
73	0507	B*															0
	0620																
	0622	S*															0
	0620																
	0623	MB*															0
7/17-18	0753																
73	0755	S*															0
	0753																
	0753	B*															0
	0921																
	0923	B															0
	1041																
	1043	B															0
	1101																
	1108	B															0
	1104																
	1111	S*															0
	1104																
	1111	B*															0
	1254																
	1301	S															0
	1254																
	1301	B															0
	1257																
	1304	S*															0
	1257																
	1304	M*															0
	1257																
	1304	B*															0
	1454																
	1501	S											1			1	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1454																
73	1501	B											1		3	3	7
	1457																
	1503	S*															0
	1456																
	1503	M*															0
	1456																
	1503	B*													1		1
	1703																
	1705	B*															0
	2005																
	2007	B															0
	2150																
	2157	B							1				1		1	2	5
	2152																
	2159	M*															0
	2152																
	2159	B*															0
	2205																
	2207	B*															0
	0005																
	0012	S*															0
	0005																
	0012	M*															0
	0007																
	0014	S															0
	0007																
	0014	B														4	4
	0045																
	0047	S*															0
	0045																
	0047	B*															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0210																
73	0217																0
	0210																
	0217															2	2
	0210																
	0217															2	2
	0212																
	0219															2	2
	0212																
	0219															1	1
	0230																
	0232																0
	0230																
	0232													1			1
	0640																
	0642																0
7/31-	0818																
8/1/73	0825																0
	0823																
	0830																0
	0836																
	0838																0
	0918																
	0925																0
	0920																
	092-																0
	0920																
	0927																0
	1023																
	1030																0
	1437																
	1441																0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	1828																
8/1/73	1835	B*															0
	1828																
	1835	B															0
	1847																
	1849	B															0
	2143																
	2150	B*															0
	2143																
	2150	M*															0
	2143																
	2150	B															0
	2350																
	2357	B*															0
	0017																
	0019	B															0
	0114																
	0121	B															0
	0114																
	0121	S*															0
	0114																
	0121	M*															0
	0114																
	0121	B*															0
	0431																
	0438	B*															0
	0431																
	0438	S														1	1
	0431																
	0438	B															0
	0457																
	0459	S															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: Striped Bass

* 1/2 meter

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0457																
8/1/73	0459	B															0
8/14-15	1540																
73	1547	S															0
	1540																
	1547	B															0
	1740																
	1747	S															0
	1740																
	1747	B															0
	2002																
	2009	B															0
	2115																
	2122	S															0
	2115																
	2122	B															0
	2117																
	2124	S*															0
	2117																
	2124	B*															0
	2338																
	2345	S															0
	2338																
	2345	B															0
	0001																
	0003																0
	0001																
	0003	B															0
	0223																
	0230	B															0
	0325																
	0332	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1200																
73	1207	O'															0
	1200																
	1207	B															0
	1330																
	1333	O'															0
	1330																
	1333	B															0
½ meter	1330																
	1337.5	O'															0
	1330																
	1338	M															0
	1330																
	1338	B'															0
	1515																
	1520	O	1														1
	1515																
	1520	M															0
	1515																
	1520	B	1														1
	2100																
	2104	B															0
½ meter	0000																
	0003.5	S		1													1
	0000																
	0003.5	S															0
	0000																
	0003.5	M															0
½ meter	0000																
	0004.5	B															0
	0205																
	0208.5	S	1					1									2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	0205																
73 ½	0208.5	S															0
½	0205																
	0208.5	M															0
½	0205																
	0208.5	B															0
½	0325																
	0328.5	S	1	2	1												4
	0325																
	0328.5	S		1													1
½	0235																
	0329	M															0
½	0235																
	0329	B		1													1
½	0425																
	0428	S														1	1
	0525																
	0529	½M															0
	0625																
	0628	S															0
	0835																
	0839	½M															0
	0915																
	0922	S															0
6/7-8/73	1655																
	1700	½S															0
	1655																
	1700	½M	1	2													3
	1830																
	1832.5	S															0
	1830																
	1832.5	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/	2207																
73	2211	½S															0
	2207																
	2211	½B		1													1
	2315																
	2322	S	2	2		1											5
	2315																
	2322	B															0
	2319																
	2327	½S															0
	2319																
	2327	½M															0
	2319																
	2327	½B															0
	0034																
	0036	B				1											1
	0035																
	0037	B															0
	0215																
	0222	S			1												1
	0215																
	0222	B															0
	0215																
	0222	½S			3											1	4
	0215																
	0222	½M															0
	0215																
	0222	½B		1													1
	0325																
	0327	B															0
	0520																
	0522	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/	0802																
73	0804	B															0
	1000																
	1002	½S															0
	1000																
	1002	½B															0
	1145																
	1148	S															0
	1145																
	1148	B															0
	1145																
	1148	½M															0
	1145																
	1148	½B															0
	1250																
	1252	B															0
	1500																
	1504	½M	1														1
	1500																
	1504	½B															0
	1500																
	1504	B	4	1												1	6
	1530																
	1532	½S	1														1
	1530																
	1532	½B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	0915																
73	0917	B		1													1
	1106																
	1113	½S			1	2											3
	1106																
	1113	½B	4	4		1											9
	1106																
	1113	B	3	26	25	13	1										68
	1131																
	1133	½S	1	1	1												3
	1131																
	1133	½B			1												1
	1300																
	1307	½S															0
	1300																
	1307	½M															0
	1300																
	1307	½B	1						1								2
	1300																
	1307	B	1	1	3	1											6
	1330																
	1333	B				1	1										2
	1457																
	1504	½M			2	1											3
	1457																
	1504	S		3	5	11	9	2									30
	1540																
	1542	½S				1	1										2
	1540																
	1542	½B			1	2	1										4
	1736																
	1743	S		1	2	5	1										9

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	1809																
73	1811	B			1												1
	2025																
	2027	½S															0
	2025																
	2027	½B				1											1
	2207																
	2214	B															0
	2209																
	2216	½S															0
	2209																
	2216	½B															0
	2235																
	2237	B				1											1
	0055																
	0102	B															0
	0055																
	0102	½S			1												1
	0055																
	0102	½B						1									1
	0115																
	0117	½S															0
	0115																
	0117	½B															0
	0445																
	0447	½S				1											1
	0445																
	0447	½M															0
	0445																
	0447	½B				1											1
	0710																
	0712	½S															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	0710																
73	0712	½M															0
	0710																
	0712	½B			1												1
	0850																
	0852	B															0
	1047																
	1049	½O'														1	1
	1047																
	1049	B															0
	1154																
	1201	O'															0
	1154																
	1201	B														3	3
	1156																
	1203	½O'															0
	1156																
	1205	½M												1			1
	1156																
	1205	½B											1		1	5	7
	1223																
	1225	B							1				1			1	3
	1400																
	1407	O'											2	3			5
	1400																
	1407	B									1	4	5	4	7	3	24
	1402																
	1409	½O'											1				1
	1402																
	1409	½M											1	1		1	3
	1402																
	1409	½B											4	3	7	5	13

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1434																
	1436	½0'															0
	1434																
	1436	½B														1	1
	1746																
	1748	B															0
	1946																
	1948	½0'															0
	1946																
	1948	½B															0
	2137																
	2139	B													1		1
	2345																
	2350	½0'															0
	2345																
	2352	½M															0
	2345																
	2352	½B														1	1
	2345																
	2352	B														1	1
	0010																
	0013	½0'															0
	0013																
	0013	½B															0
	0137																
	0144	B												1	2		3
	0137																
	0144	½0'															0
	0137																
	0144	½M													1		1
	0137																
	0144	½B												1		2	3

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	0200																
	0203	½B														1	1
	0506																
	0507	½0															0
	0506																
	0507	½B															0
	0620																
	0622	½0															0
	0620'																
	0622	½MB															0
7/17-18/	0753																
73	0755	½0															0
	0753																
	0755	½B															0
	0921																
	0923	B													1	1	2
	1041																
	1043	B															0
	1101																
	1108	B															0
	1104																
	1111	½0															0
	1104																
	1111	½B															0
	1254																
	1301	0															0
	1254																
	1301	B														1	1
	1257																
	1304	½0															0
	1257																
	1304	½M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	1257																
73	1384	½B															0
	1454																
	1501	0'															0
	1454																
	1501	B										1		1		1	3
	1456																
	1503	½0															0
	1456																
	1503	½M														1	1
	1456																
	1503	½B															0
	1703																
	1705	½B														1	1
	2005																
	2007	B															0
	2150																
	2157	B														1	0
	2152																
	2159	½M															0
	2152																
	2159	½B														4	4
	2205																
	2207	½B														2	2
	0005																
	0012	½0															0
	0005																
	0012	½M															0
	0007																
	0014	S														1	1
	0007																
	0014	B														14	14

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0045																
73	0047	½0															0
	0045																
	0047	½B														2	2
	0210																
	0217	½0'															0
	0210																
	0217	½M														2	2
	0210																
	0217	½B														3	3
	0212																
	0219	0'														4	4
	0212																
	0218	B												1		8	9
	0230																
	0232	0'															0
	0230																
	0232															1	1
	0640																
	0642	B															0
7/31-	0818																
8/1/73	0825	B															0
	0823																
	0830	½M															0
	0836																
	0838	B															0
	0918																
	0925	B															0
	0920																
	0937	½M															0
	0?0																
	0937	½B														1	1

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I. **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	1023																
8/1/73	1038	B															0
	1437																
	1441	B															0
	1828																
	1835	½B															0
	1828																
	1835	B															0
	1847																
	1849	B															0
	2143																
	2150	½B														1	1
	2143																
	2150	½M														2	2
	2143																
	2150	B														3	3
	2350																
	2357	½B														2	2
	0017																
	0019	B															0
	0114																
	0121	B															0
	0114																
	0121	½S															0
	0114																
	0121	½M															0
	0114																
	0121	½B														1	1
	0431																
	0438	½B															0
	0431																
	0438	S															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0431																
8/1/73	0438	B															0
	0457																
	0459	S														1	1
	0457																
	0459	B														1	1
8/14-15	1540																
73	1547	S															0
	1540																
	1547	B															0
	1740																
	1747	S															0
	1740																
	1747	B															0
	2002																
	2009	B															0
	2115																
	2122	S															0
	2115																
	2122	B															0
	2117																
	2124	S															0
	2117																
	2124	B															0
	2338																
	2345	S															0
	2338																
	2345	B															0
	0001																
	0003																0
	0001																
	0003	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.I.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	0223																
73	0230	B															0
	0325																
	0332	B															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1037																
73	1044	1M B	2		61	91	17	2		8	38	13	6	2			240
	1245																
	1252			3	6	22	7	14	8	10	5	6	4				85
	1640																
	1647		1	3	3	3	3		1		2						16
	1826																
	1833		2	14	18	5				2	4						45
	1958																
	2001			1	5	20	3		4	5	8	11	1				58
	2145																
	2152				5	5	1		1								12
	0412																
	0415			5	13	11				1							30
	0511																
	0545		1		7												8
	1623																
	1633			6	46	31	2	4		7	7	1					104
	0710																
	0720			2	20	73	5			3	3						106
	0813																
	0823		2	3	11	14			1	1		1					33
6/7-8/73	1845																
	1848							1	1								2
	2355																
	0002				10	14	2	3	3	1	2	1					36
	0250																
	0253			1	1	7	1	1			1						12
	0520																
	0522					1	1		2								4
	0532																
	0534				1	4	2		2								9

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	0722																
	0729	1M B		1	5	7	1			2	1						17
	1300																
	1303			1	18	15	15	5	2	1	1	2					60
	1645																
	1700		1	2	5	2		1	1	3		1					16
6/19-20	1012																
73	1019								35	9	53	18	62	92	66	175	510
	1035																
	1037				1	1	2	5	3	3	4	7	15	12	8	12	73
	1210																
	1212				1	1	1	1	8	6	10	7	7	5	4	15	66
	1402																
	1409							1							1		2
	1650																
	1652				1								1				2
	1910																
	1912		1														1
	2103																
	2110					1	1	4	7	6	5	7	12	7	10	74	134
	2115																
	2117										1	1	4	5	13	38	62
	2345																
	2352															301	301
	0011																
	0013															36	36
	0320																
	0322				4	4	9	11	7	5	2	3	5	4	7	15	76
	0550																
	0552					1	5	4	7	7	3	7	6	2	2	23	67
7/2-3/73	0940																
	0942						1						1	2	1	15	20

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/2-3/73	1115																
	1122	1M B	7													24	31
	1130																
	1132							1			1				1	6	9
	1245															1	1
	1252																
	1332											1				1	2
	1334																
	1843		1													3	4
	1845																
	2034														1	1	2
	2036																
	2230											1	1		3	10	15
	2237																
	2246													2		8	10
	2248																
	0020										41					19	60
	0027																
7/17-18/	2045																
73	2047			3													3
	2235																
	2242															2	2
	2245																
	2247															1	1
	0105																
	0112											1				5	6
	0301																
	0303															4	4
	0530																
	0532															1	1
	0720																
	0727										3					1	4

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Alosa

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS													TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	0722																
8/1/73	0729	1M B														1	1
	0849																
	0856															2	2
	0901																
	0903															1	1
	1118																
	1122															1	1
	1656																
	1703															1	1
	1920																
	1927										1	1	1	1			4
	1932																
	1934											1			1	4	6
	2303																
	2310															3	3
	2322																
	2324				1												1
	0040																
	0047										2					3	5
	0155																
	0202															1	1
	0206																
	0208										1					1	2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23	1037																
73	10445	1MB															0
	1037																
	10445	1MB															0
	1245																
	12525	1MB															0
	1245																
	12525	1MB															0
	1640																
	1647	1MB															0
	1826																
	1832	1MB															0
	1948																
	2001	1MB															0
	2145																
	2154	1MB															0
	0412																
	04155	1MB															0
	0511																
	05145	1MB															0
	0623																
	0633	1MB															0
	0710																
	0720	1MB															0
	0813																
	0823	1MB															0
6/7-8/73	1645																
	1700	1MB		4	13	20	3										40
	1845																
	1848	1MB				3	5										8
	2220																
	2222	1MB															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/73	2355																
	0002	1MB	1	3	13	26	1										44
	0250																
	0253	1MB			2												2
	0430																
	0437	1MB		1	2	3											6
	0520																
	0522	1MB				1	1										2
	0532																
	0534	1MB			1												1
	0722																
	0729	1MB				3	2										5
	1300																
	1303	1MB															0
	1430																
		1MB															0
6/19-20	1012																
73	1019	1MB			1	8	18	6	1								34
	1035																
	1037	1MB															0
	1210																
	1212	1MB				1											1
	1402																
	1409	1MB															0
	1420																
	1422	1MB															0
	1650																
	1752	1MB				5	1	1									7
	1910																
	1912	1MB				1											1
	2103																
	2110	1MB		1		1	1	1									4

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20/	2115																
73	2117								1								1
	2345																
	2352					2											2
	0011																
	0013																0
	0320																
	0322					6	5	7	3	2	3						26
	0550																
	0552		1	3	2	1	2	4	3	1							17
7/2-3/73	0940																
	0942																0
	1115																
	1122												1				1
	1130																
	1132													1	1		2
	1245																
	1252											1	1	1		1	4
	1332																
	1334																0
	1843																
	1845																0
	2034																
	2036																0
	2230																
	2237																0
	2246																
	2248																0
	0020																
	0027										1	1		1		3	6

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18/73	1158																0
	1205																
	1359																0
	1406																
	1418																0
	1420.5																
	2045																0
	2047																
	2235																0
	2242																
	2245																0
	2247																
	0105															1	1
	0112																
	0301															3	3
	0303																
	0530																0
	0532																
	0720																0
	0727																
7/31-8/1/73	0722																0
	0729																
	0849																0
	0856																
	0901																0
	0903																
	1105															1	1
	1112																
	1118																0
	1122																
	1656																0
	1703																

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: Striped Bass

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	1920																
8/1/73	1927	1M															0
	1932																
	1934	1M															0
	2303																
	2310	1M															0
	2322																
	2324	1M															0
	0040																
	0047	1MB															0
	0155																
	0202	1M															0
	0206																
	0208	1MB															0
	0539																
	0541	1M															0
8/14-15	1415																
73	1422	1MB															0
	1830																
	1832	1MB															0
	2030																
	2037	1MB														1	1
	2047																
	2049	1MB															0
	2117																
	2124	½MM1D															0
	2153																
	2200	1MB															0
	0027																
	0034	1MB															0
	0040																
	0047	1MB															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
5/22-23/	1037																
73	10445	1MB															0
	1037																
	10445	1MB															0
	1245																
	12525	1MB		1													1
	1245																
	12525	1MB															0
	1640																
	1647	1MB															0
	1826																
	1833	1MB															0
	1958																
	2001	1MB															0
	2145																
	2154	1MB															0
	0412																
	04155	1MB															0
	0511																
	05145	1MB															0
	0623																
	0633	1MB															0
	0710																
	0720	1MB															0
	0813																
	0823	1MB															0
6/7-6/	1645																
73	1700	1MB															8
	1845																
	1848	1MB															0
	2220																
	2222	1MB															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/7-8/	2355																
73	0002	1MB			2	8	2										12
	0250																
	0253	1MB		1													1
	0430																
	0437	1MB		1	1												2
	0520																
	0522	1MB															0
	0532																
	0534	1MB		1													1
	0722																
	0729	1MB															0
	1300																
	1303	1MB		1		1	1										3
	1430																
		1MB															0
6/19-20	1012																
73	1019	1MB			26	13	11	1									51
	1035																
	1037	1MB		1	3	4	2										10
	1210																
	1212	1MB	1	2	7	5	1										16
	1402																
	1409	1MB															0
	1420																
	1422	1MB															0
	1650																
	1652	1MB	1		1	1											3
	1910																
	1912	1MB															0
	2103																
	2110	1MB				2											2

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
6/19-20	2115																
73	2117	1MB															0
	2345																
	2352	1MB				1											1
	0011																
	0013	1MB		1													1
	0320																
	0322	1MB		2	4	18	8	2									34
	0550																
	0552	1MB	1	1	6	11	5	2			1						27
7/2-3/73	0940																
	0942	1MB															0
	1115																
	1122	1MB															0
	1130																
	1132	1MB															0
	1245																
	1252	1MB										1				6	7
	1332																
	1334	1MB															0
	1843																
	1845	1MB															0
	2034																
	2036	1MB															0
	2230																
	2237	1MB															0
	2246																
	2248	1MB															0
	0020																
	0027	1MB											5	5	8	2	20

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D. **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/17-18	0833																
73	0835	1MB															0
	1158																
	1205	1MB											1				1
	1359																
	1406	1MB															0
	1418																
	14205	1MB														1	1
	2045																
	2047	1MB															0
	2235																
	2242	1MB														2	2
	2245																
	2247	1MB															0
	0105																
	0112	1MB															0
	0301																
	0303	1MB														1	1
	0530																
	0532	1MB															0
	0720																
	0727	1MB															0
7/31-	0722																
8/1/73	0729	1MB															0
	0849																
	0856	1MB															0
	0901																
	0903	1M															0
	1105																
	1112	1MB															0
	1118																
	1122	1M															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D. **SPECIES:** White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
7/31-	1656																
8/1/73	1703	1M															0
	1920																
	1927	1M															0
	1932																
	1934	1M															0
	2303																
	2310	1M														2	2
	2322																
	2324	1M														1	1
	0045																
	0047	1MB	1	1	1												3
	0155																
	0202	1M															0
	0206																
	0208	1MB														1	1
	0539																
	0541	1M															0
8/14-15	1415																
73	1422	1MB															0
	1830																
	1832	1MB															0
	2030																
	2037	1MB															0
	2047																
	2049	1MB															0
	2117																
	2124	½MMID															0
	2153																
	2200	1MB															0
	0027																
	0034	1MB															0

ROSETON-DANSKAMMER FISH LARVAE
LENGTH FREQUENCY, DATA
1973

LOCATION: D.D.

SPECIES: White Perch

DATE	TIME	DEPTH	NUMBER OF LARVAE BY 1 mm SIZE GROUPS														TOTAL
			2	3	4	5	6	7	8	9	10	11	12	13	14	Others	
8/14-15	0040																
73	0047	1MB															0

APPENDIX VI-A

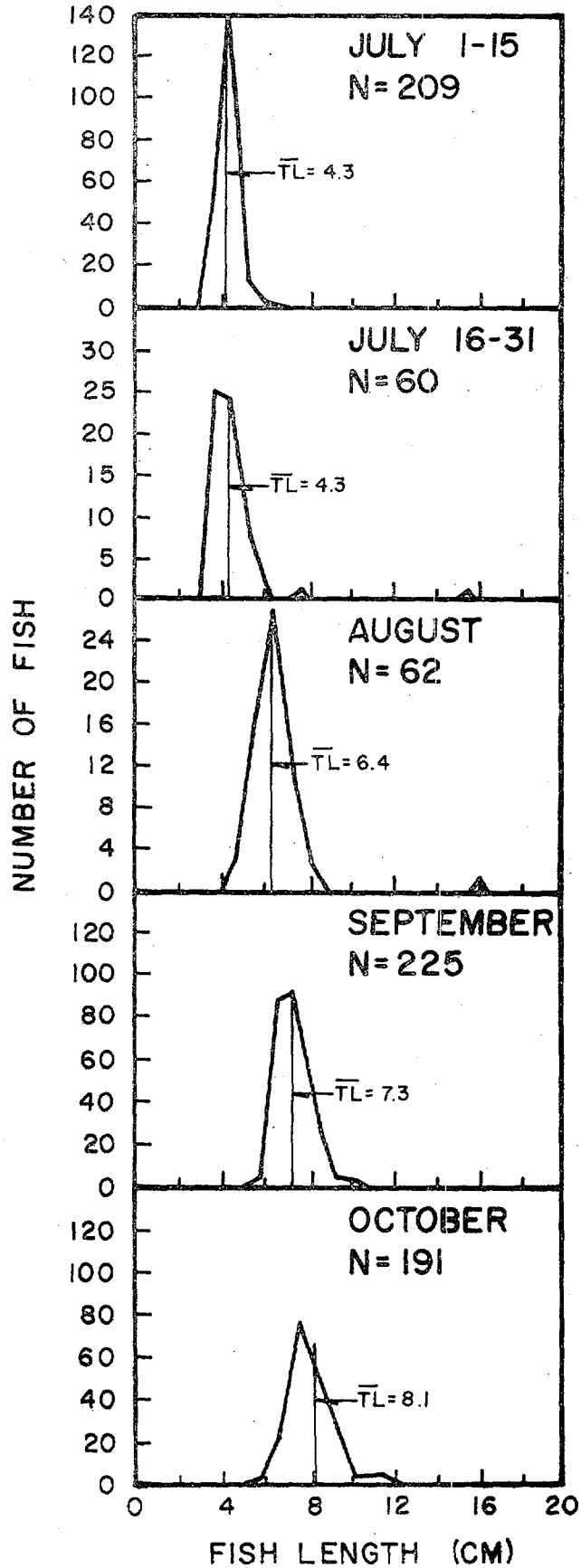
APPENDIX VI-A

FISH LENGTH FREQUENCY
FOR
ECOLOGICAL AND IMPINGEMENT SAMPLING
AT
ROSETON AND DANSKAMMER POINT GENERATING STATIONS

LENGTH-FREQUENCY OF ALEWIFE IMPINGED
AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Frequency (cm)	Number of Fish in Each Length Interval				
	July 1-15	July 16-31	Aug	Sept	Oct
1.1 - 2.0					
2.1 - 3.0					
3.1 - 4.0	57	25			
4.1 - 5.0	140	24	3		
5.1 - 6.0	11	8	17	4	3
6.1 - 7.0	1	1	27	90	23
7.1 - 8.0		1	11	93	77
8.1 - 9.0			3	28	53
9.1 - 10.0				5	26
10.1 - 11.0				3	3
11.1 - 12.0					4
12.1 - 13.0					1
13.1 - 14.0				1	
14.1 - 15.0					
15.1 - 16.0		1	1		1
16.1 - 17.0					
17.1 - 18.0					
18.1 - 19.0				1	
19.1 - 20.0					
20.1 - 21.0					
21.1 - 22.0					
22.1 - 23.0					
23.1 - 24.0					
24.1 - 25.0					
25.1 - 26.0					

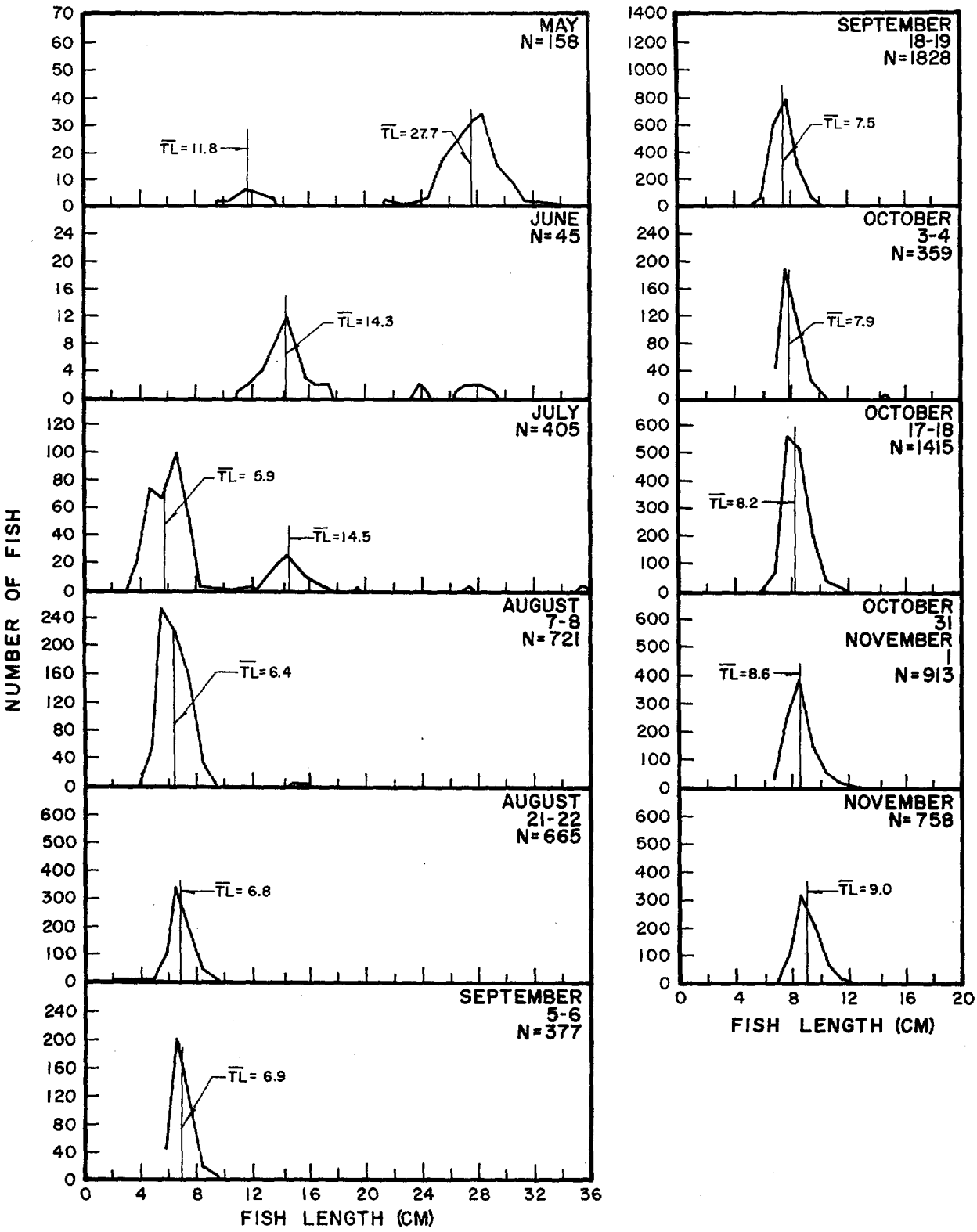
LENGTH DISTRIBUTION (CM) OF ALEWIFE COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973



LENGTH-FREQUENCY OF ALEWIFE IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval										
	MAY	JUNE	JULY	AUG 7-8	AUG 21-22	SEPT 5-6	SEPT 18-19	OCT 3-4	OCT 17-18	OCT 31-NOV 1	NOV
1.1 - 2.0					1						
2.1 - 3.0			1		1						
3.1 - 4.0			20	1							
4.1 - 5.0			75	52	5		3				
5.1 - 6.0			68	253	97	44	59		2		
6.1 - 7.0			101	223	341	198	589	44	82	27	3
7.1 - 8.0			55	152	166	106	798	189	565	257	109
8.1 - 9.0			3	33	42	18	301	96	520	392	320
9.1 -10.0	2			1	6	5	62	23	195	152	219
10.1 -11.0	2	1	1				7	2	38	56	74
11.1 -12.0	6	2	3						11	19	23
12.1 -13.0	5	4	1					2	1	4	4
13.1 -14.0	3	8	21				3				1
14.1 -15.0		14	26	3	3	2	2	3		1	
15.1 -16.0		3	11	2	1	2	3				1
16.1 -17.0		2	4	1	1	2	1			1	
17.1 -18.0		2	2		1						2
18.1 -19.0									1	3	2
19.1 -20.0			2							1	
20.1 -21.0											
21.1 -22.0	2		1								
22.1 -23.0	1										
23.1 -24.0	1	2	1								
24.1 -25.0	3	1	1								
25.1 -26.0	17		1								
26.1 -27.0	24	1									
27.1 -28.0	31	2	3								
28.1 -29.0	34	2									
29.1 -30.0	15	1									
30.1 -31.0	9		1								
31.1 -32.0	2										
32.1 -33.0											
33.1 -34.0	1										
34.1 -35.0											
35.1 -36.0			1								
36.1 -37.0			3								
37.1 -38.0			2								
38.1 -39.0											

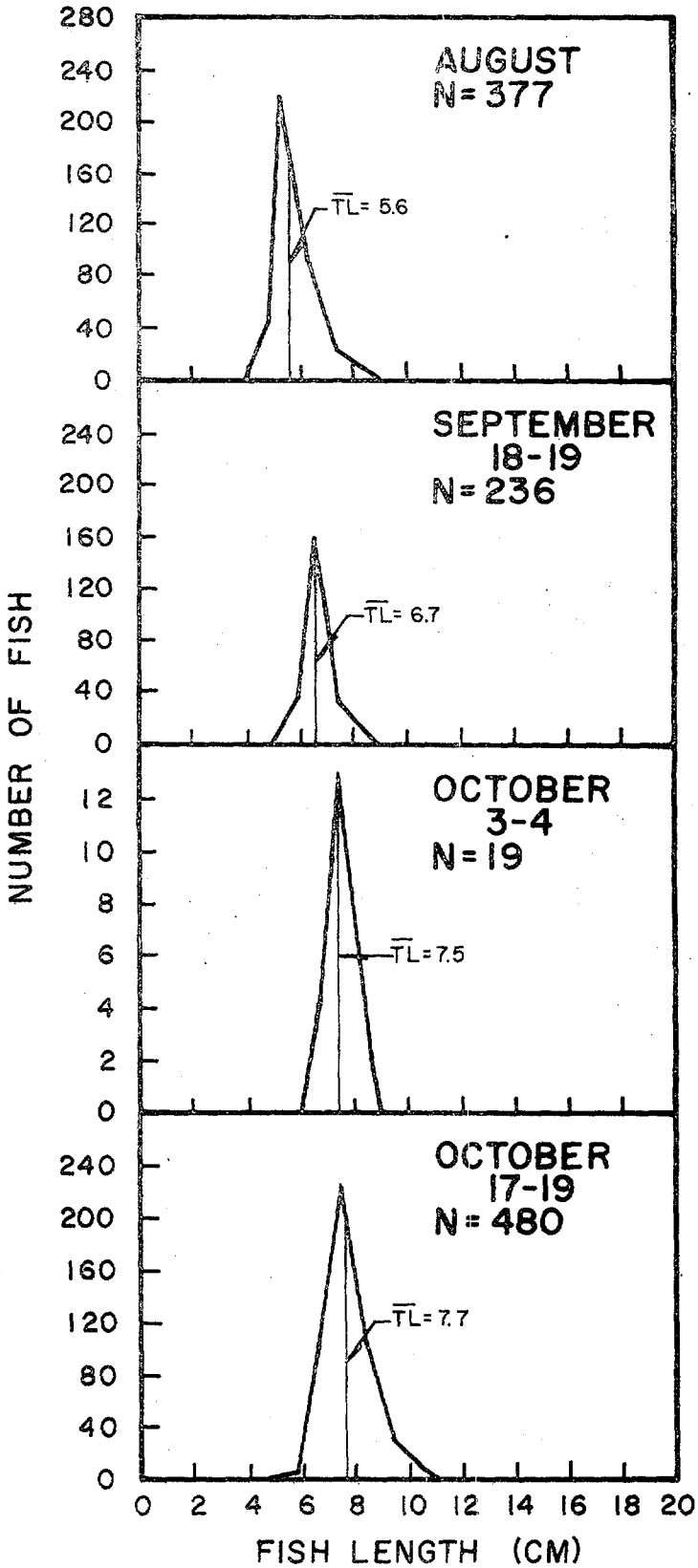
LENGTH DISTRIBUTION (CM) OF ALEWIFE FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973



LENGTH-FREQUENCY OF ALEWIFE IMPINGED
AT ROSETON GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval			
	August N=377	Sept 15-19 N=236	Oct 3-4 N=19	Oct 17-19 N=480
1.1 - 2.0				
2.1 - 3.0				
3.1 - 4.0				
4.1 - 5.0	43			
5.1 - 6.0	222	34		3
6.1 - 7.0	89	159	4	104
7.1 - 8.0	21	34	13	228
8.1 - 9.0	2	9	2	106
9.1 - 10.0				29
10.1 - 11.0				10
11.1 - 12.0				
12.1 - 13.0				
13.1 - 14.0				
14.1 - 15.0				
15.1 - 16.0				
16.1 - 17.0				
17.1 - 18.0				
18.1 - 19.0				
19.1 - 20.0				
20.1 - 21.0				
21.1 - 22.0				
22.1 - 23.0				
23.1 - 24.0				
24.1 - 25.0				

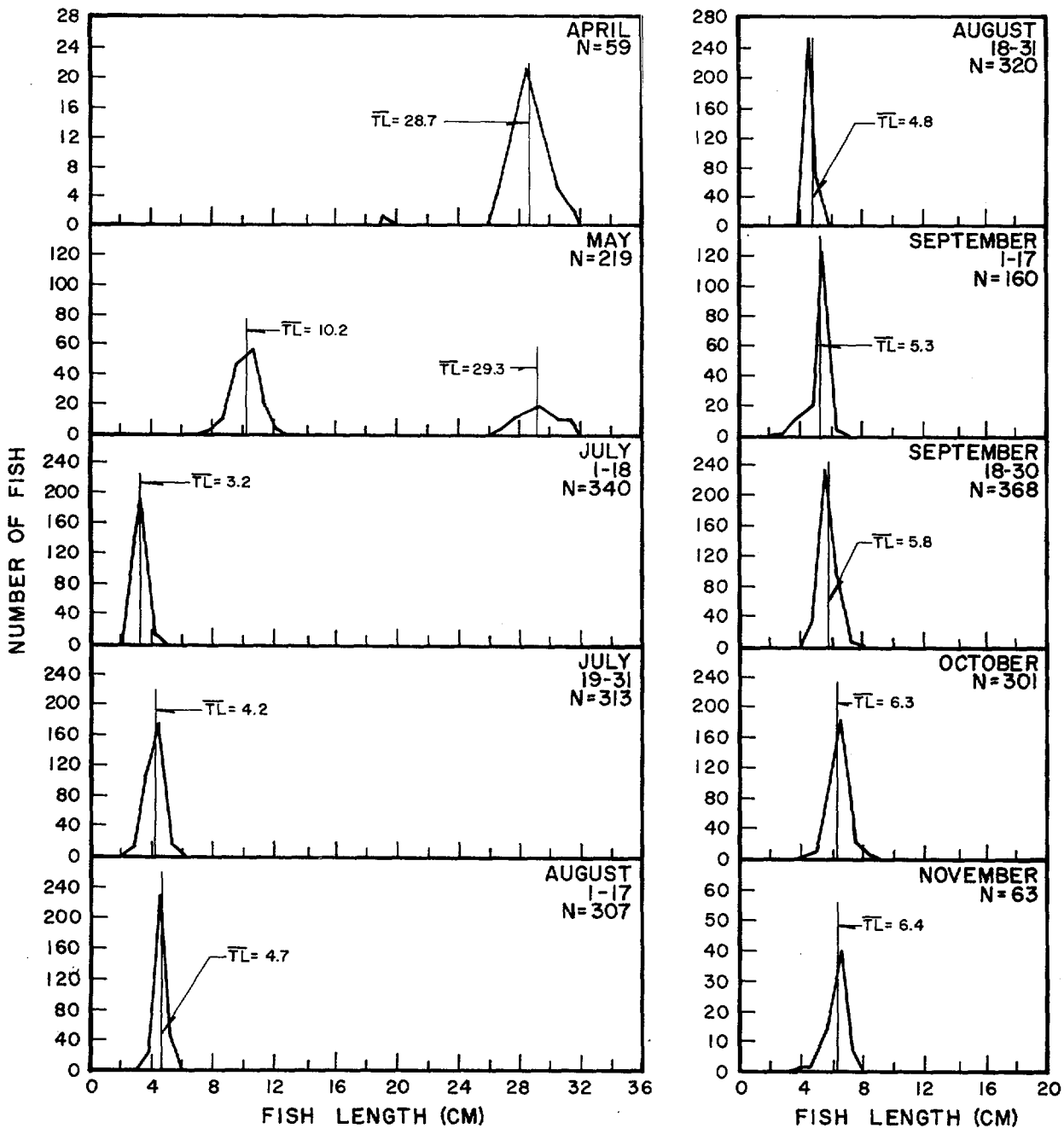
LENGTH DISTRIBUTION (CM) OF ALEWIFE FROM IMPINGEMENT SAMPLES AT ROSETON GENERATING STATION DURING 1973



LENGTH-FREQUENCY OF BLUEBACK HERRING IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval									
	April	May	July 1-18	July 19-31	Aug 1-17	Aug 18-31	Sept 1-17	Sept 18-31	Oct	Nov
1.1 - 2.0									1	
2.1 - 3.0			133	11			1			
3.1 - 4.0			192	108	22	2	11	1	1	1
4.1 - 5.0			13	177	240	252	21	31	7	1
5.1 - 6.0				15	45	66	124	229	89	14
6.1 - 7.0				1						
7.1 - 8.0		3								
8.1 - 9.0		11								
9.1 - 10.0		48								
10.1 - 11.0		58								
11.1 - 12.0		21								
12.1 - 13.0		3		1						
13.1 - 14.0										
14.1 - 15.0										
15.1 - 16.0										
16.1 - 17.0										
17.1 - 18.0										
18.1 - 19.0										
19.1 - 20.0										
20.1 - 21.0										
21.1 - 22.0										
22.1 - 23.0										
23.1 - 24.0										
24.1 - 25.0										
25.1 - 26.0										
26.1 - 27.0		4	4	1						
27.1 - 28.0		13	12							
28.1 - 29.0		21	17							
29.1 - 30.0		13	20							
30.1 - 31.0		5	11							
31.1 - 32.0		2	11							

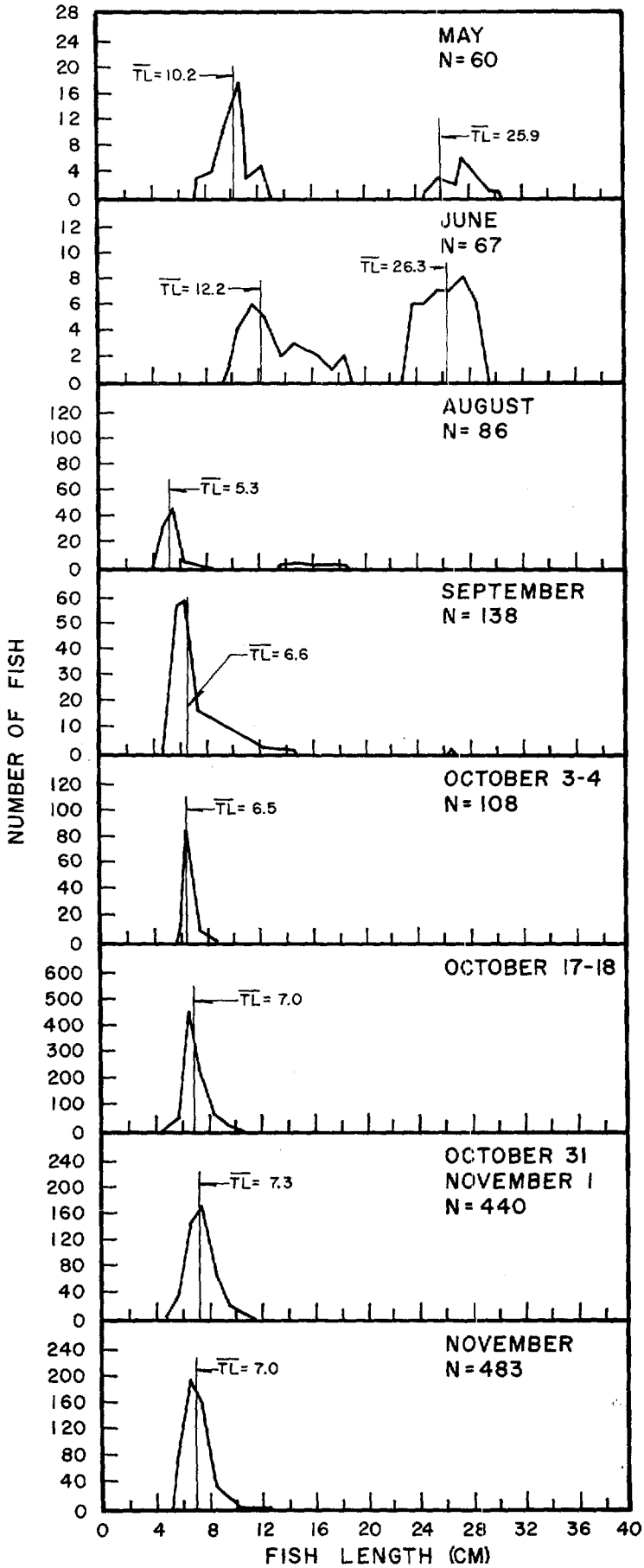
LENGTH DISTRIBUTION (CM) OF BLUEBACK HERRING COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973



LENGTH-FREQUENCY OF BLUEBACK HERRING IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval							
	MAY	JUNE	AUG	SEPT	OCT 3-4	OCT 17-18	OCT 31	NOV
1.1 - 2.0								
2.1 - 3.0						1		
3.1 - 4.0								
4.1 - 5.0			31	4		1	4	1
5.1 - 6.0			45	57	13	44	33	78
6.1 - 7.0			4	59	85	450	142	193
7.1 - 8.0	3			16	8	235	172	160
8.1 - 9.0	4		1		1	57	69	32
9.1 - 10.0	10	1				19	18	16
10.1 - 11.0	18	4				3		1
11.1 - 12.0	3	6				1	2	1
12.1 - 13.0	5	5		2				1
13.1 - 14.0		2	1		1	1		
14.1 - 15.0		3	2	1				
15.1 - 16.0						1		
16.1 - 17.0		2	1					
17.1 - 18.0		1				1		
18.1 - 19.0		2	1					
19.1 - 20.0								
20.1 - 21.0								
21.1 - 22.0								
22.1 - 23.0								
23.1 - 24.0		6						
24.1 - 25.0	1	6						
25.1 - 26.0	3	7						
26.1 - 27.0	2	7		1				
27.1 - 28.0	6	8						
28.1 - 29.0	3	6						
29.1 - 30.1	1	1						
30.1 - 31.0	1							

LENGTH DISTRIBUTION (CM) OF BLUEBACK HERRING FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973

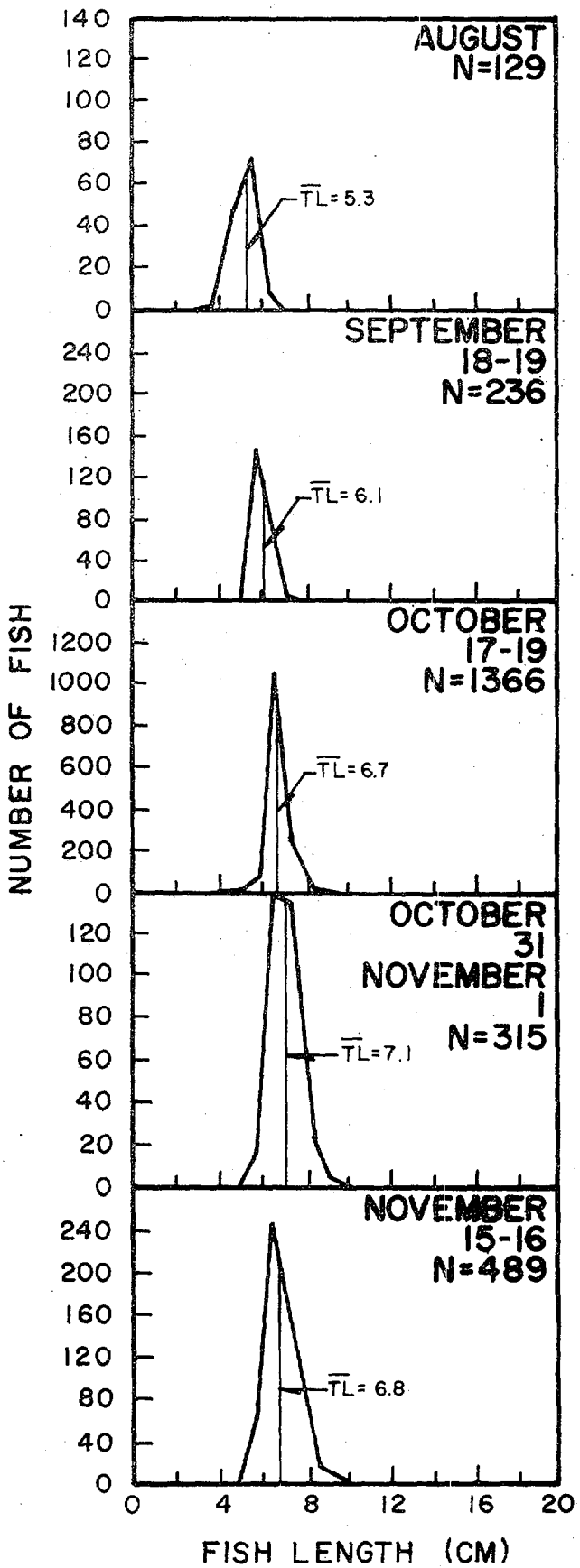


LENGTH-FREQUENCY OF BLUEBACK HERRING IMPINGED
AT ROSETON GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval				
	August N=129	Sept 18-19 N=236	Oct 17-19 N=1366	Oct 31-Nov 1 N=315	Nov 15-16 N=489
1.1 - 2.0		1			1
2.1 - 3.0					1
3.1 - 4.0	1				
4.1 - 5.0	47		5		2
5.1 - 6.0	73	146	79	15	63
6.1 - 7.0	7	85	1010	139	246
7.1 - 8.0		4	255	135	152
8.1 - 9.0			12	22	16
9.1 - 10.0			5	4	8
10.1 - 11.0					
11.1 - 12.0					
12.1 - 13.0					
13.1 - 14.0					
14.1 - 15.0					
15.1 - 16.0					
16.1 - 17.0					
17.1 - 18.0					
18.1 - 19.0					
19.1 - 20.0					
20.1 - 21.0					
21.1 - 22.0					
22.1 - 23.0					
23.1 - 24.0	1				
24.1 - 25.0					

FIGURE VI-A-7

LENGTH DISTRIBUTION (CM) OF BLUEBACK HERRING FROM IMPINGEMENT SAMPLES AT ROSETON GENERATING STATION DURING 1973

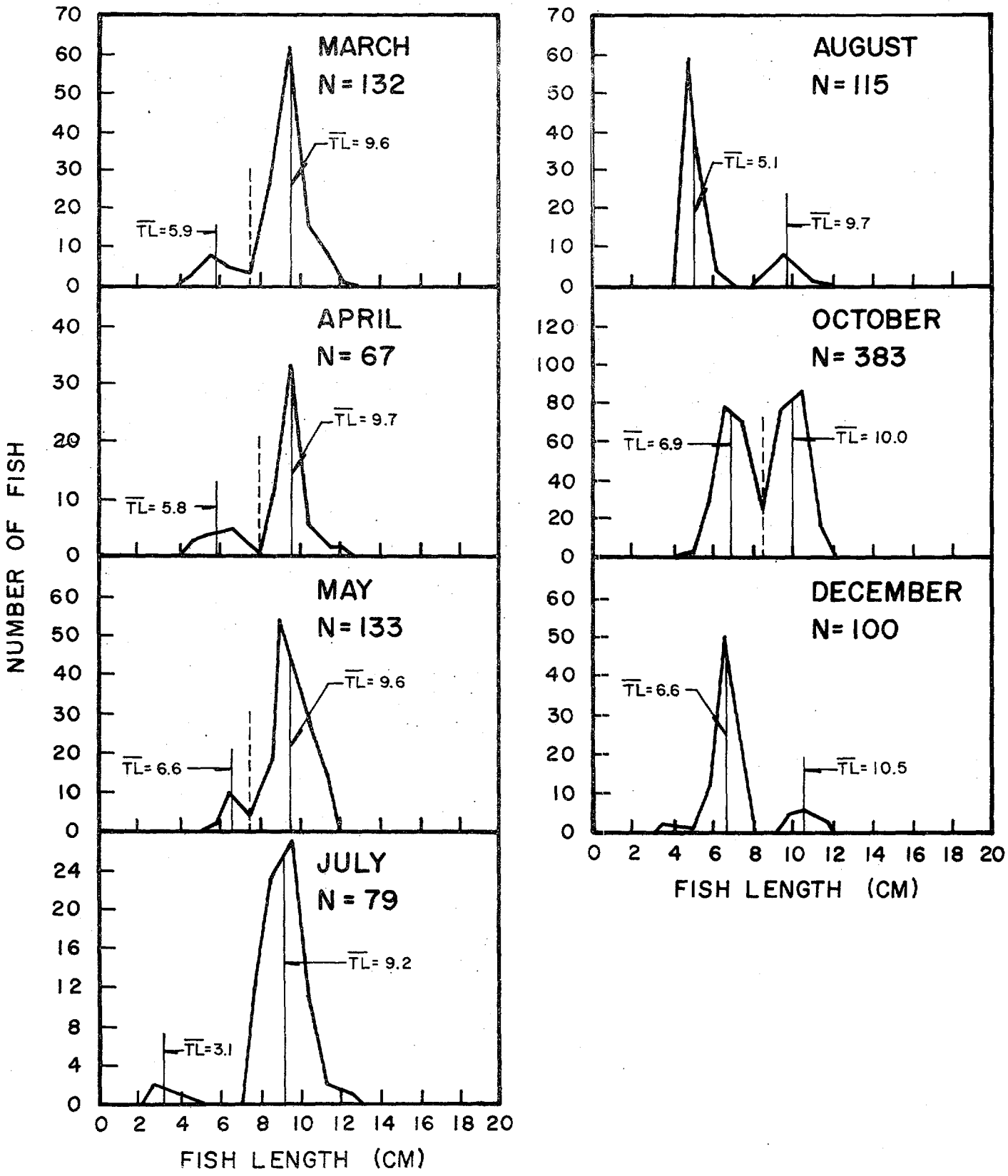


LENGTH-FREQUENCY OF SPOTTAIL SHINER IMPINGED
AT DANSKAMMER POINT GENERATING STATION DURING 1973

	Number of Fish in Each Length Interval						
Length Interval (cm)	Mar	Apr	May	July	Aug	Oct	Dec
1.1 - 2.0							
2.1 - 3.0				2			
3.1 - 4.0				1			2
4.1 - 5.0	3	3			59	3	1
5.1 - 6.0	8	4	2		36	28	12
6.1 - 7.0	5	5	10		4	78	49
7.1 - 8.0	3	1	4	12		69	22
8.1 - 9.0	26	11	19	23	3	24	
9.1 - 10.0	62	33	54	27	8	76	5
10.1 - 11.0	16	6	29	11	4	87	6
11.1 - 12.0	8	2	15	2	1	17	3
12.1 - 13.0	1	2					
13.1 - 14.0							
14.1 - 15.0							
15.1 - 16.0							
16.1 - 17.0							
17.1 - 18.0							
18.1 - 19.0							
19.1 - 20.0							
20.1 - 21.0							
21.1 - 22.0							
22.1 - 23.0							
23.1 - 24.0							
24.1 - 25.0							
25.1 - 26.0							
26.1 - 27.0							

LENGTH DISTRIBUTION (CM) OF SPOTTAIL SHINER COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973

(DOTTED LINE REPRESENTS CUT-OFF POINT BETWEEN AGE GROUPS WHERE CONTINUOUS DISTRIBUTION IS PRESENT)

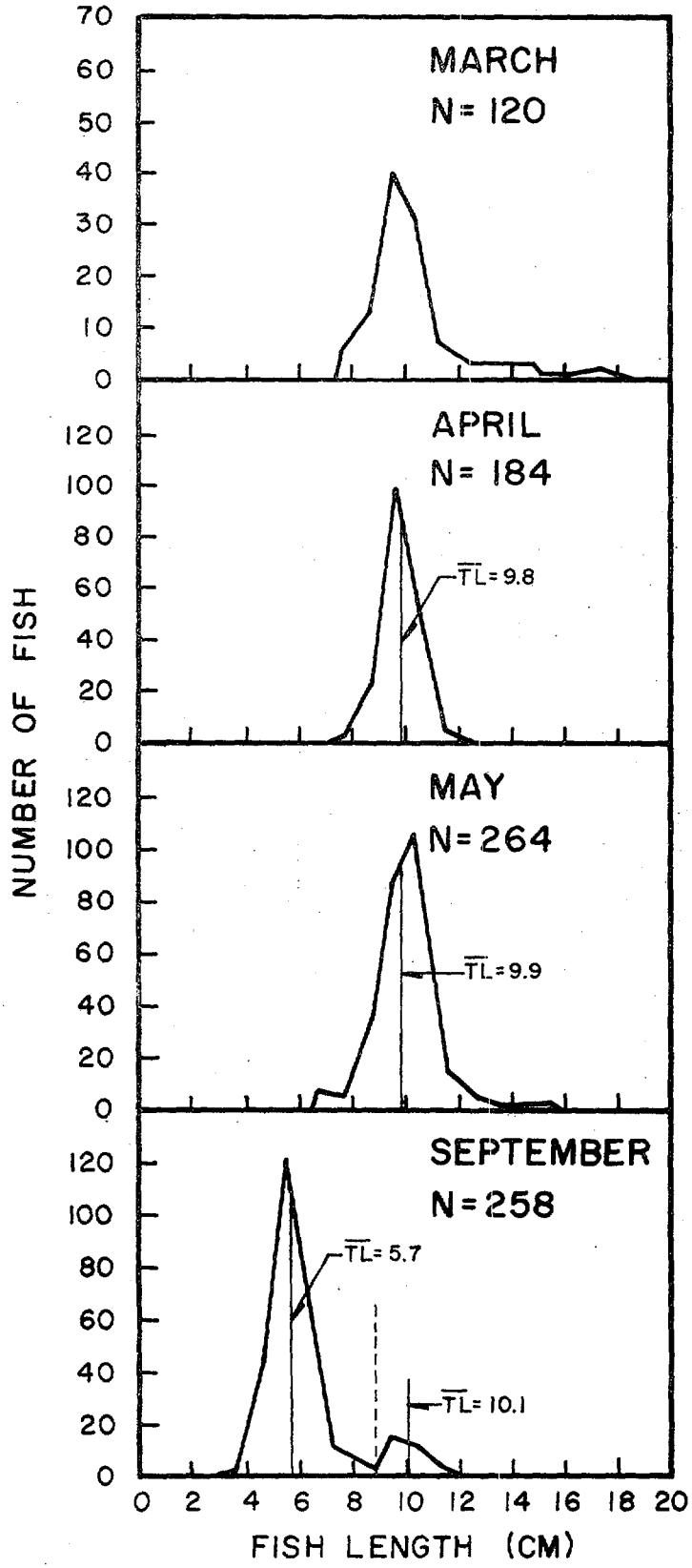


LENGTH-FREQUENCY OF SPOTTAIL SHINER IMPINGED
AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval		
	MARCH	APRIL	MAY
1.1 - 2.0			
2.1 - 3.0			
3.1 - 4.0			
4.1 - 5.0			
5.1 - 6.0			
6.1 - 7.0			7
7.1 - 8.0	5	3	5
8.1 - 9.0	13	23	35
9.1 - 10.0	40	99	88
10.1 - 11.0	32	52	107
11.1 - 12.0	7	6	14
12.1 - 13.0	3	1	4
13.1 - 14.0	3		1
14.1 - 15.0	3		1
15.1 - 16.0	1		2
16.1 - 17.0	1		
17.1 - 18.0	2		
18.1 - 19.0	1		
19.1 - 20.0			
20.1 - 21.0			
21.1 - 22.0			
22.1 - 23.0			
23.1 - 24.0			
24.1 - 25.0			

LENGTH DISTRIBUTION (CM) OF SPOTTAIL SHINER FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973

(DOTTED LINE REPRESENTS CUT-OFF POINT BETWEEN AGE GROUPS WHERE CONTINUOUS DISTRIBUTION IS PRESENT)

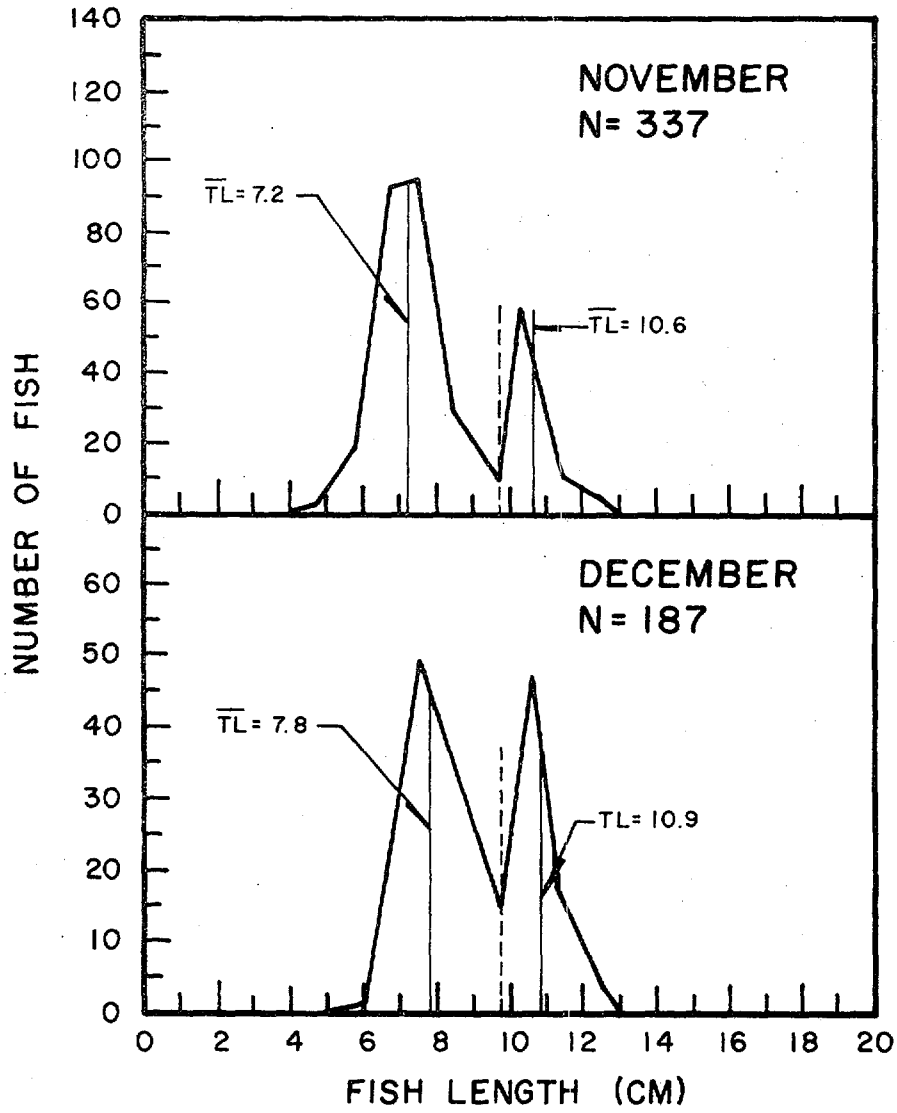


LENGTH-FREQUENCY OF SPOTTAIL SHINER IMPINGED AT ROSETON GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval	
	November N=337	December N=187
1.1 - 2.0		
2.1 - 3.0		
3.1 - 4.0	2	
4.1 - 5.0	4	
5.1 - 6.0	20	1
6.1 - 7.0	94	19
7.1 - 8.0	96	49
8.1 - 9.0	32	36
9.1 - 10.0	11	14
10.1 - 11.0	60	47
11.1 - 12.0	12	17
12.1 - 13.0	6	4
13.1 - 14.0		
14.1 - 15.0		
15.1 - 16.0		
16.1 - 17.0		
17.1 - 18.0		
18.1 - 19.0		
19.1 - 20.0		
20.1 - 21.0		
21.1 - 22.0		
22.1 - 23.0		
23.1 - 24.0		
24.1 - 25.0		

LENGTH DISTRIBUTION (CM) OF SPOTTAIL SHINER FROM IMPINGEMENT SAMPLES AT ROSETON GENERATING STATION DURING 1973

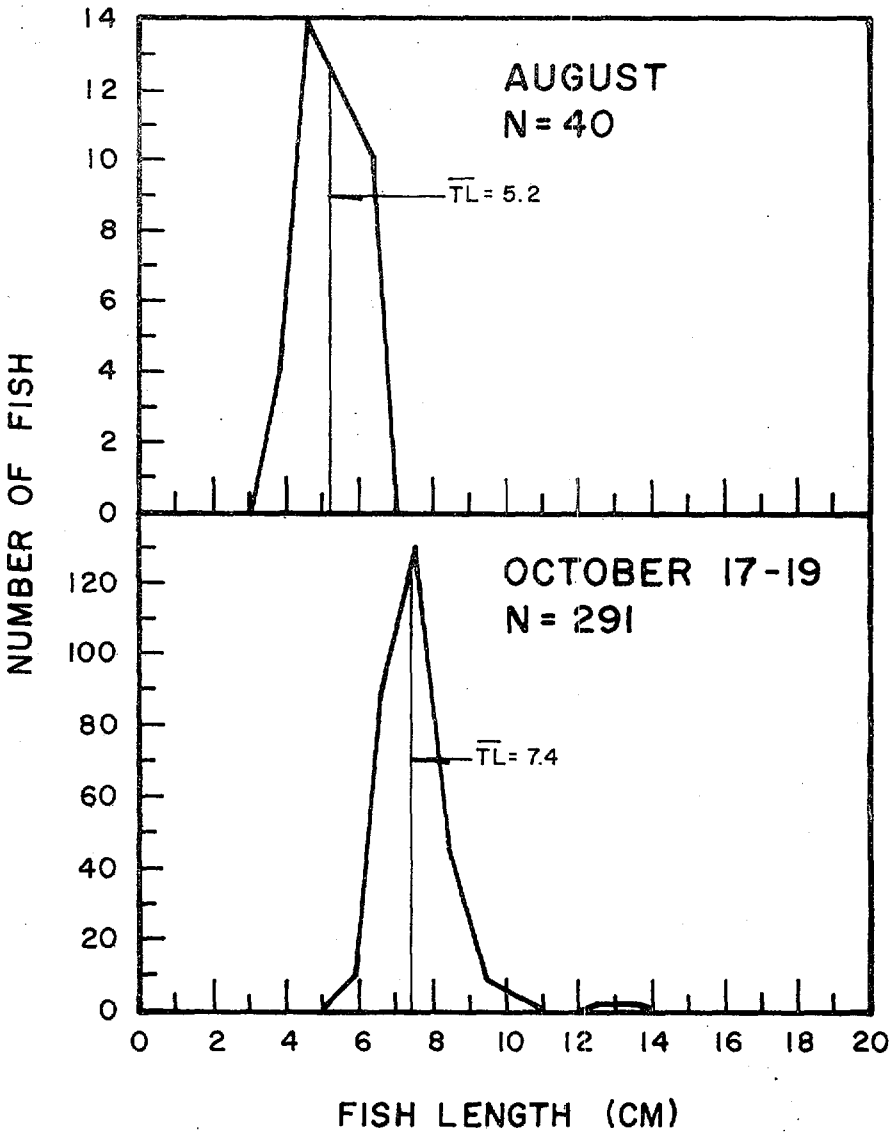
(DOTTED LINE REPRESENTS CUT-OFF POINT BETWEEN AGE GROUPS WHERE CONTINUOUS DISTRIBUTION IS PRESENT)



LENGTH-FREQUENCY OF STRIPED BASS IMPINGED AT ROSETON GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval	
	August N=40	October 17-19 N=291
1.1 - 2.0		
2.1 - 3.0		
3.1 - 4.0	4	
4.1 - 5.0	14	
5.1 - 6.0	12	10
6.1 - 7.0	10	88
7.1 - 8.0		131
8.1 - 9.0		46
9.1 - 10.0		9
10.1 - 11.0		3
11.1 - 12.0		
12.1 - 13.0		2
13.1 - 14.0		2
14.1 - 15.0		
15.1 - 16.0		
16.1 - 17.0		
17.1 - 18.0		
18.1 - 19.0		
19.1 - 20.0		
20.1 - 21.0		
21.1 - 22.0		
22.1 - 23.0		
23.1 - 24.0		
24.1 - 25.0		

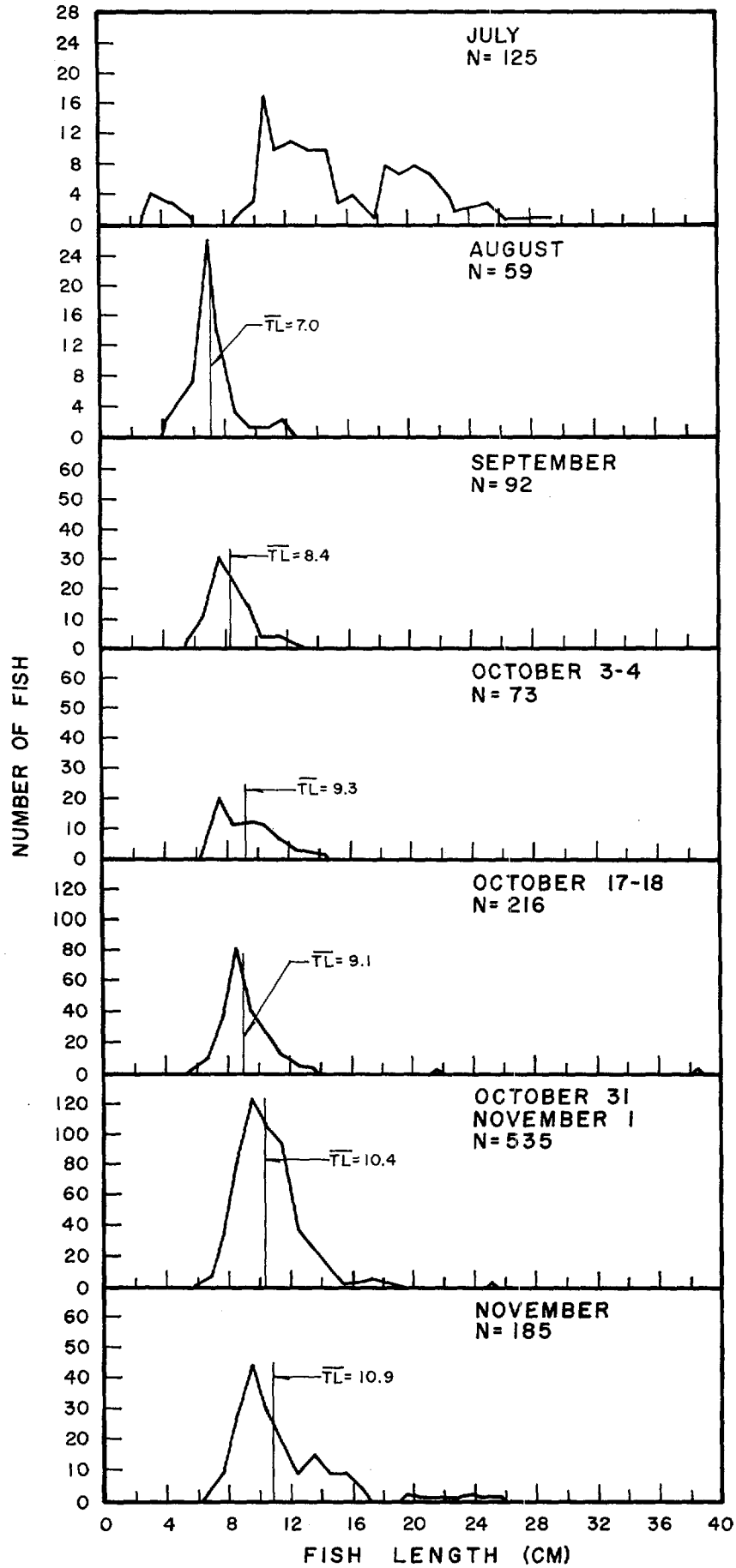
LENGTH DISTRIBUTION (CM) OF STRIPED BASS FROM IMPINGEMENT SAMPLES AT ROSETON GENERATING STATION DURING 1973



LENGTH-FREQUENCY OF STRIPED BASS IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval						
	JULY	AUG	SEPT	OCT 3-4	OCT 17-18	OCT 31 -NOV 1	NOV
1.1 - 2.0							
2.1 - 3.0	1						
3.1 - 4.0	4	1					
4.1 - 5.0	3	2					
5.1 - 6.0	1	7	3		1	1	
6.1 - 7.0		26	10	6	9	6	1
7.1 - 8.0		14	31	20	37	36	9
8.1 - 9.0	1	3	22	11	81	81	28
9.1 -10.0	3	1	15	12	41	124	44
10.1 -11.0	17	1	4	11	25	106	30
11.1 -12.0	10	2	4	7	13	94	17
12.1 -13.0	15			3	4	38	9
13.1 -14.0	10		1	2	3	25	15
14.1 -15.0	10			1		12	9
15.1 -16.0	3					2	9
16.1 -17.0	4		1			3	4
17.1 -18.0	1					5	1
18.1 -19.0	8					1	
19.1 -20.0	7		1				2
20.1 -21.0	8						1
21.1 -22.0	7				1		1
22.1 -23.0	4	1					1
23.1 -24.0	2						2
24.1 -25.0						1	1
25.1 -26.0	3						1
26.1 -27.0	1						
27.1 -28.0							
28.1 -29.0	1						
29.1 -30.0							
30.1 -31.0							
31.1 -32.0							
32.1 -33.0							
33.1 -34.0							
34.1 -35.0							
35.1 -36.0							
36.1 -37.0							
37.1 -38.0							
38.1 -39.0					1		

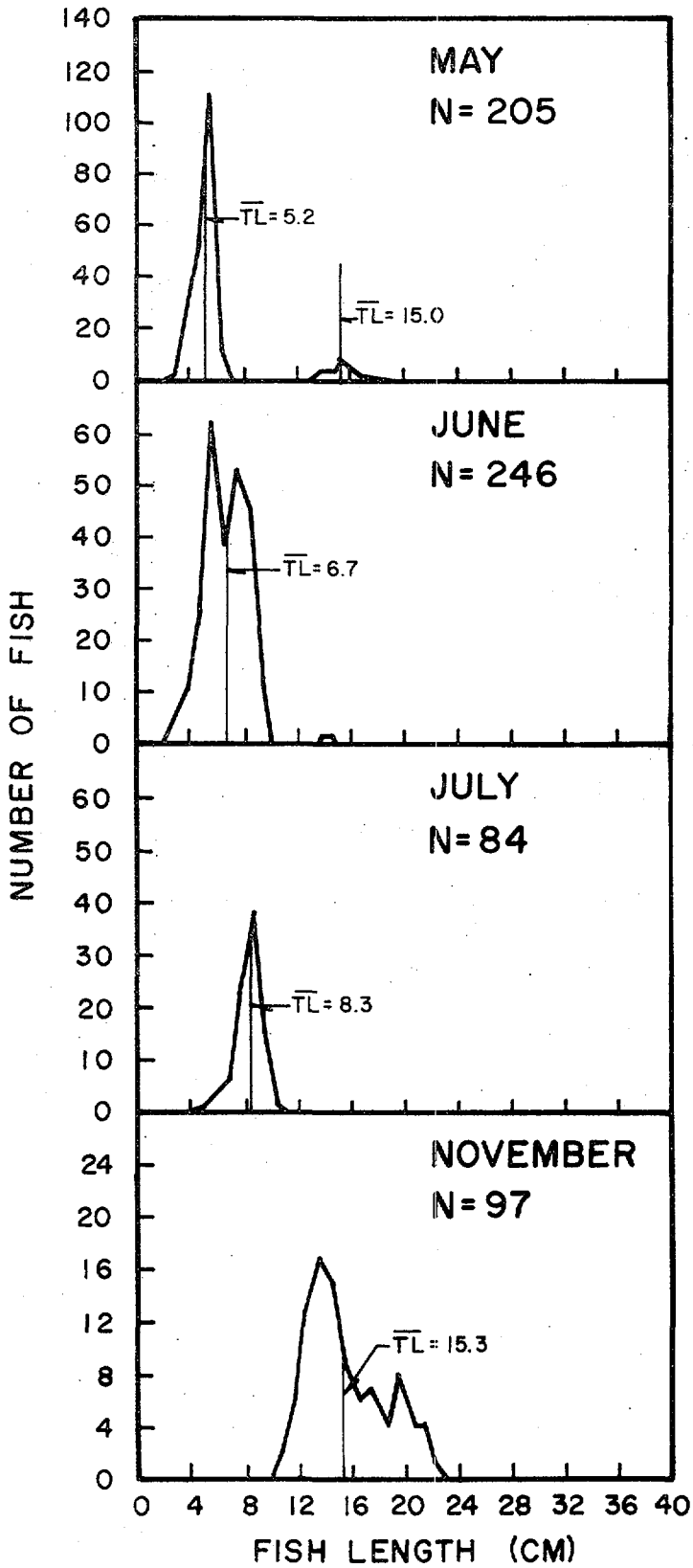
LENGTH DISTRIBUTION (CM) OF STRIPED BASS FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973



LENGTH-FREQUENCY OF TOMCOD IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval							
	Jan 5 N=1050	Jan 11 N=3027	Jan 18 N=2301	Jan 31 N=1965	Feb 8 N=1748	Feb 15 N=2065	Feb 22 N=1006	Feb 28 N=1101
1.1 - 2.0								
2.1 - 3.0								
3.1 - 4.0								
4.1 - 5.0								
5.1 - 6.0								
6.1 - 7.0	1							
7.1 - 8.0			1		3			
8.1 - 9.0	3	3	2	3	4			
9.1 - 10.0	36	74	42	19	13	20	6	5
10.1 - 11.0	135	308	119	65	39	55	18	17
11.1 - 12.0	191	562	260	155	85	138	42	46
12.1 - 13.0	208	673	368	255	167	270	114	129
13.1 - 14.0	165	503	387	350	290	363	192	200
14.1 - 15.0	93	283	269	330	253	330	158	190
15.1 - 16.0	50	150	180	250	220	238	134	142
16.1 - 17.0	43	135	163	178	148	213	119	127
17.1 - 18.0	39	97	126	145	150	156	86	82
18.1 - 19.0	25	78	97	84	118	119	52	78
19.1 - 20.0	14	43	76	30	83	73	31	31
20.1 - 21.0	13	30	46	20	47	29	18	14
21.1 - 22.0	11	23	33	25	35	25	11	16
22.1 - 23.0	10	16	53	23	26	12	7	11
23.1 - 24.0	4	15	32	19	27	5	13	3
24.1 - 25.0	4	13	25	3	14	6	1	7
25.1 - 26.0	3	12	16	7	13	7		
26.1 - 27.0	1	7	3	4	10	3	2	1
27.1 - 28.0	1	2			3	3	1	1
28.1 - 29.0		2						
29.1 - 30.0			1				1	
31.1 - 32.0			1					
32.1 - 33.0								
33.1 - 34.0								
34.1 - 35.0			1					
35.1 - 36.0								
36.1 - 37.0						-		

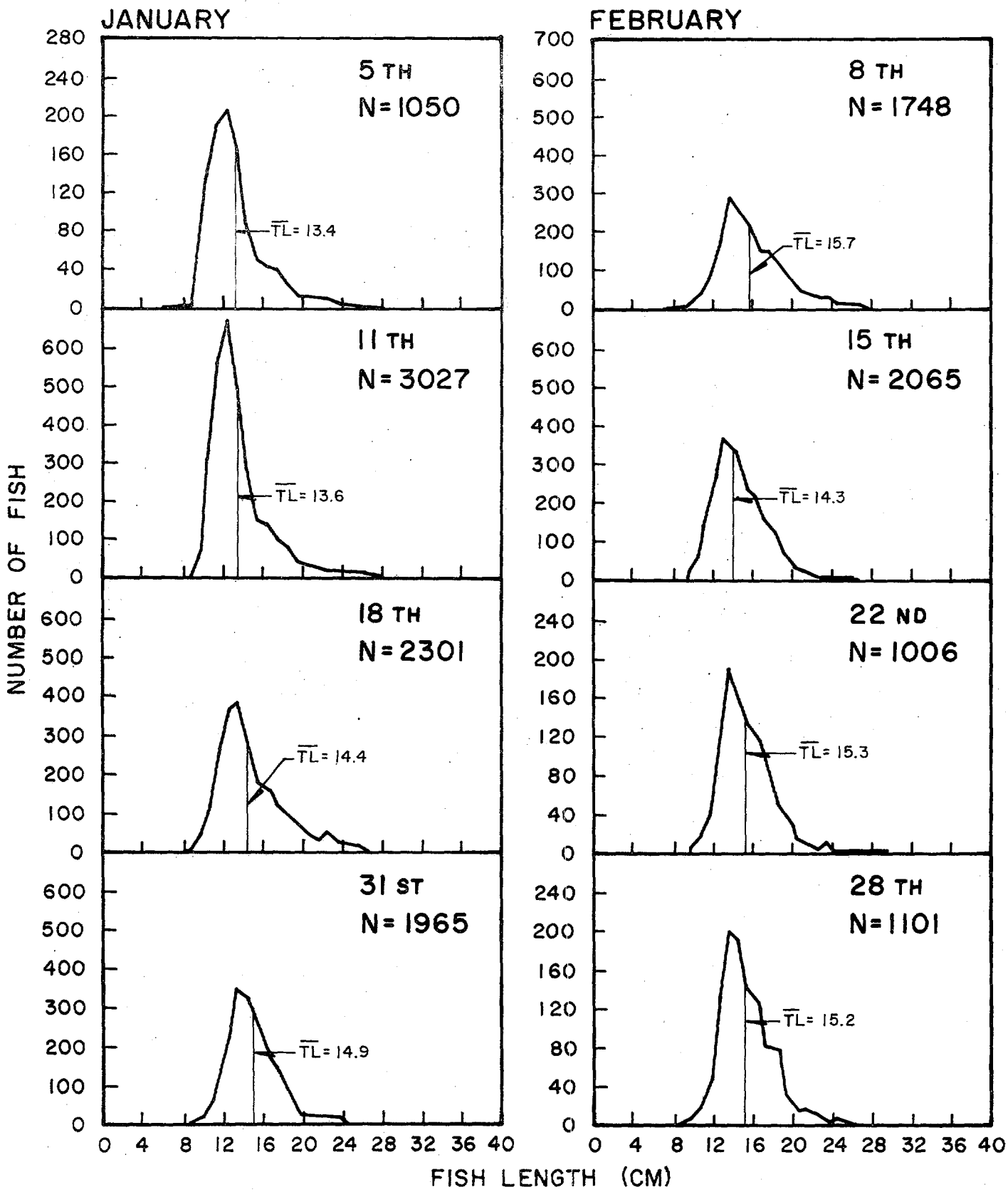
LENGTH DISTRIBUTION (CM) OF TOMCOD COLLECTED FROM THE ROSETON/DANSKAMMER POINT VICINITY DURING 1973



LENGTH-FREQUENCY OF TOMCOD IMPINGED AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish In Each Length Frequency			
	MAY	JUNE	JULY	NOV
1.1 - 2.0				
2.1 - 3.0	2			
3.1 - 4.0	17	10		
4.1 - 5.0	51	24		
5.1 - 6.0	109	62	1	
6.1 - 7.0	12	38	6	
7.1 - 8.0		53	23	
8.1 - 9.0		45	38	
9.1 - 10.0		12	15	
10.1 - 11.0			1	2
11.1 - 12.0				6
12.1 - 13.0				13
13.1 - 14.0	3	1		17
14.1 - 15.0	3	1		15
15.1 - 16.0	7			9
16.1 - 17.0	1			6
17.1 - 18.0				7
18.1 - 19.0				4
19.1 - 20.0				8
20.1 - 21.0				4
21.1 - 22.0				4
22.1 - 23.0				1
23.1 - 24.0				
24.1 - 25.0				
25.1 - 26.0				
26.1 - 27.0				

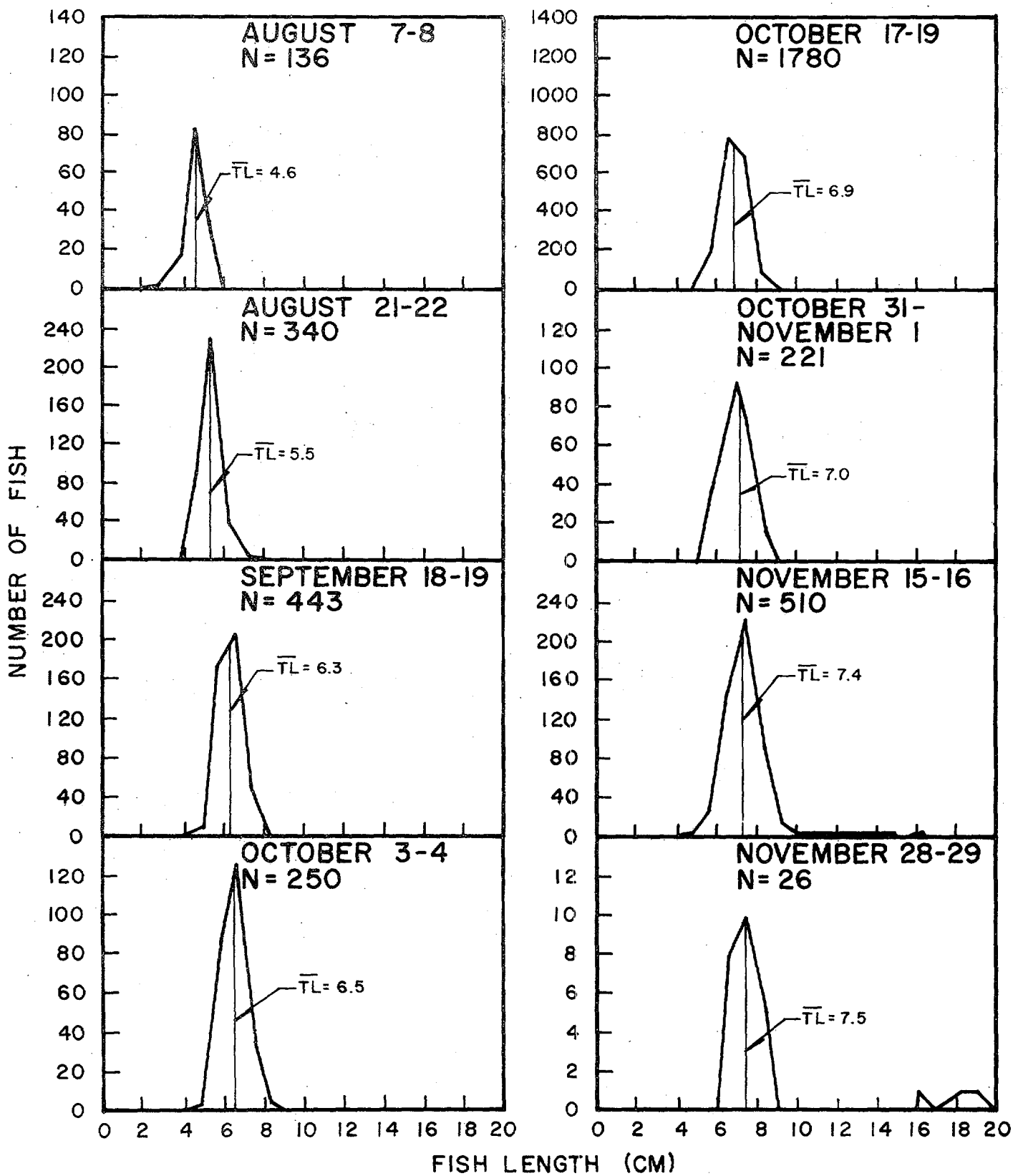
LENGTH DISTRIBUTION (CM) OF TOMCOD FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973



LENGTH-FREQUENCY OF WHITE PERCH IMPINGED
AT ROSETON GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval							
	Aug 7-8 N=136	Aug 21-22 N=340	Sept 18-19 N=443	Oct 3-4 N=250	Oct 17-19 N=1780	Oct 31 Nov 1 N=221	Nov 15-16 N=510	Nov 28-29 N=26
1.1 - 2.0								
2.1 - 3.0	1							
3.1 - 4.0	18	4						
4.1 - 5.0	85	66	10	3	8	1	2	
5.1 - 6.0	32	226	174	83	192	37	26	
6.1 - 7.0		42	205	126	792	93	144	8
7.1 - 8.0		2	52	34	700	74	222	10
8.1 - 9.0			2	4	84	15	89	5
9.1 - 10.0					4		13	
10.1 - 11.0							1	
11.1 - 12.0							2	
12.1 - 13.0							2	
13.1 - 14.0							2	
14.1 - 15.0							3	
15.1 - 16.0							1	
16.1 - 17.0							3	1
17.1 - 18.0								
18.1 - 19.0								1
19.1 - 20.0								1
20.1 - 21.0								
21.1 - 22.0								
22.1 - 23.0								
23.1 - 24.0								
24.1 - 25.0								

LENGTH DISTRIBUTION (CM) OF WHITE PERCH FROM IMPINGEMENT SAMPLES AT ROSETON GENERATING STATION DURING 1973



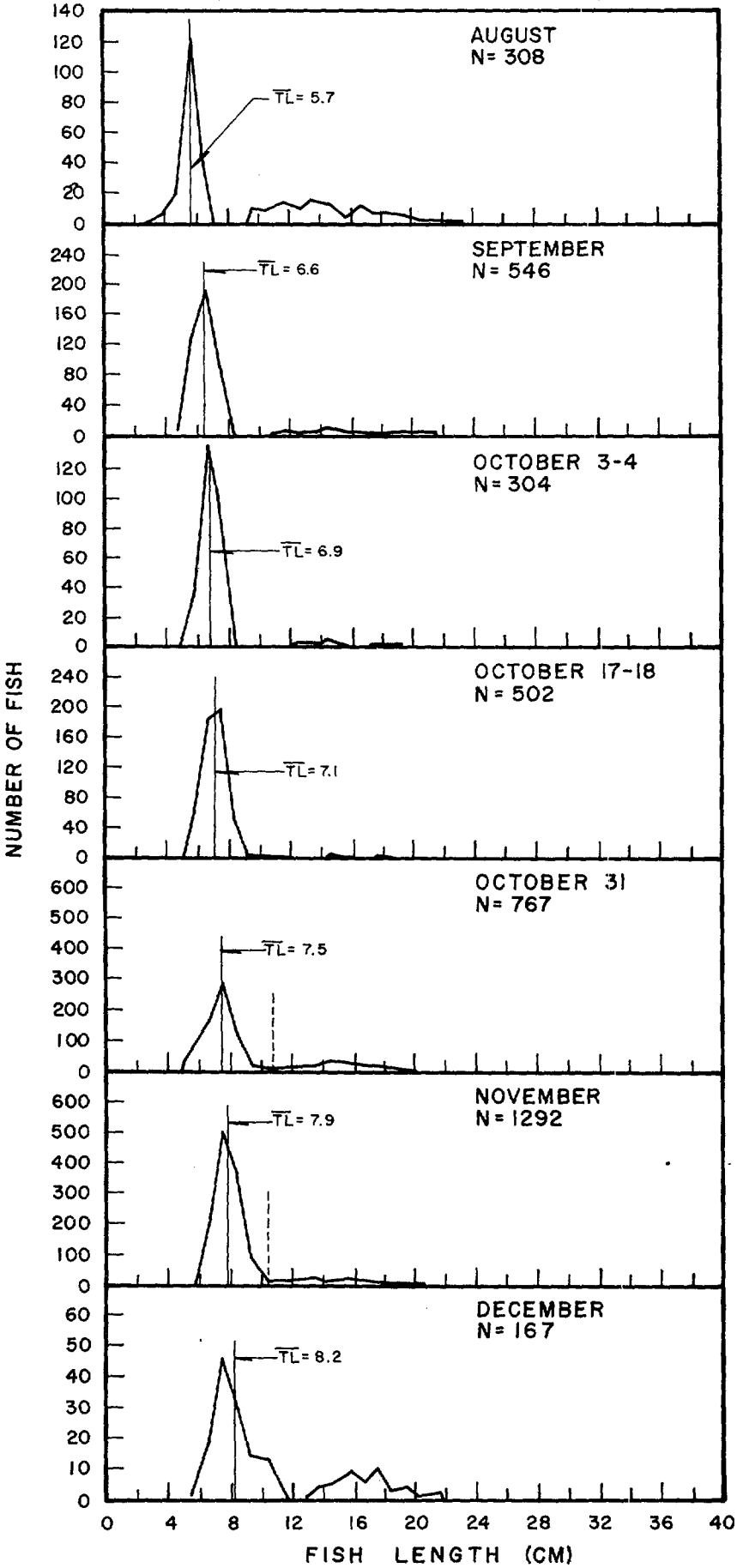
LENGTH-FREQUENCY OF WHITE PERCH IMPINGED
AT DANSKAMMER POINT GENERATING STATION DURING 1973

Length Interval (cm)	Number of Fish in Each Length Interval						
	AUG	SEPT	OCT 3-4	OCT 17-18	OCT 31	NOV	DEC
1.1 - 2.0							
2.1 - 3.0	1						
3.1 - 4.0	6						
4.1 - 5.0	20	7	2				
5.1 - 6.0	123	130	33	45	30	19	1
6.1 - 7.0	46	235	136	185	165	200	17
7.1 - 8.0	1	118	106	199	287	478	46
8.1 - 9.0		9	30	52	117	369	32
9.1 - 10.0	10			3	14	90	14
10.1 - 11.0	9	3		2	4	10	13
11.1 - 12.0	14	4	1	2	8	12	1
12.1 - 13.0	10	3	3	1	12	16	1
13.1 - 14.0	15	5	3		18	21	4
14.1 - 15.0	13	9	5	5	33	9	5
15.1 - 16.0	4	5	2	3	28	19	7
16.1 - 17.0	12	4	1	1	20	13	6
17.1 - 18.0	7	3	2	3	17	6	10
18.1 - 19.0	7	3			9	4	3
19.1 - 20.0	5	4	2		2	3	4
20.1 - 21.0	2				3	3	1
21.1 - 22.0	1	4		1			2
22.1 - 23.0	1						
23.1 - 24.0	1						
24.1 - 25.0							

FIGURE VI-A-16

LENGTH DISTRIBUTION (CM) OF WHITE PERCH FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973

(DOTTED LINE REPRESENTS CUT-OFF POINT BETWEEN AGE GROUPS WHERE CONTINUOUS DISTRIBUTION IS PRESENT)

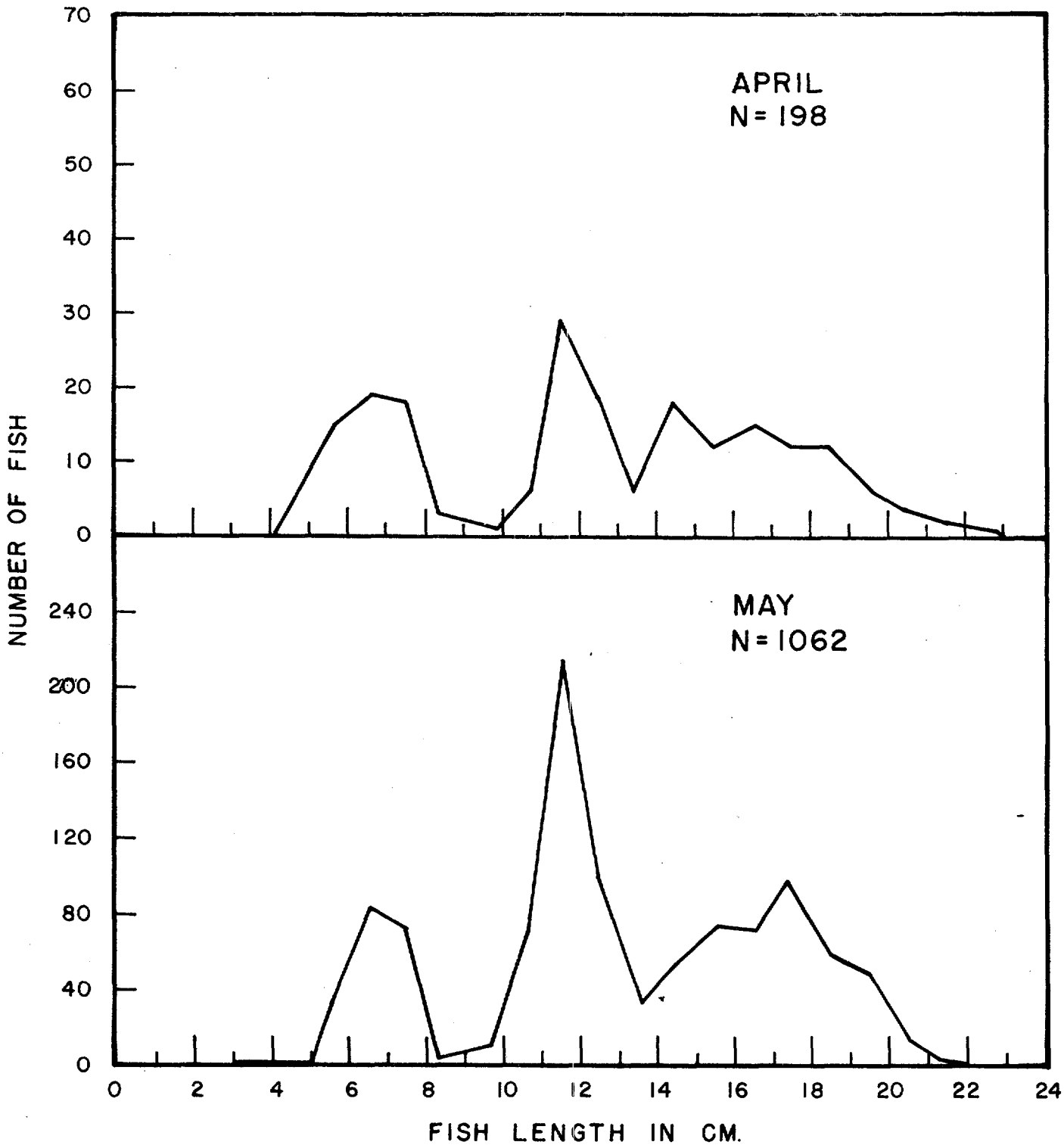


LENGTH-FREQUENCY OF WHITE PERCH IMPINGED
AT DANSKAMMER POINT GENERATING STATION DURING 1973

	Number of Fish in Each Length Interval	
Length Frequency (cm)	April	May
1.1 - 2.0		
2.1 - 3.0		
3.1 - 4.0		1
4.1 - 5.0		1
5.1 - 6.0	15	34
6.1 - 7.0	19	84
7.1 - 8.0	18	74
8.1 - 9.0	3	4
9.1 - 10.0	1	11
10.1 - 11.0	6	72
11.1 - 12.0	29	215
12.1 - 13.0	19	100
13.1 - 14.0	6	34
14.1 - 15.0	18	55
15.1 - 16.0	12	75
16.1 - 17.0	15	73
17.1 - 18.0	12	99
18.1 - 19.0	12	60
19.1 - 20.0	6	51
20.1 - 21.0	4	15
21.1 - 22.0	2	4
22.1 - 23.0	1	
23.1 - 24.0		
24.1 - 25.0		

FIGURE VI-A-17

LENGTH DISTRIBUTION (CM) OF WHITE PERCH FROM IMPINGEMENT SAMPLES AT DANSKAMMER POINT GENERATING STATION DURING 1973



APPENDIX VI-B

APPENDIX VI-B

TRAWL, SEINE, TRAP & GILL NET DATA
FOR
ROSETON AND DANSKAMMER POINT GENERATING STATION

COLLECTION METHOD ABBREVIATIONS

ABBREVIATION	EXPLANATION
BGN Exp.	Experimental bottom gill net
BGN 3"	Bottom gill net with 1.5 inch square mesh
BGN 5"	Bottom gill net with 2.5 inch square mesh
BT	Bottom trawl
FN	Fyke Net
S 50'	Seine - 50 foot
S 100'	Seine -100 foot
SGN Exp.	Experimental surface gill net
SGN 3"	Surface gill net with 1.5 inch square mesh
SGN 5"	Surface gill net with 25 inch square mesh
ST	Surface trawl
TN	Trap Net

TRAWLS

ROSETON/DANSKAMMER POINT FISH SAMPLING

	3-21-73							4-25-73		
STATIONS	DC-30	DC-10	DC-10	DC-30	DC-DCN	DC-30	RDN	DC-30	DC-20	DC-20
METHOD	BT	BT	BT	BT	ST	ST	BT	BT	BT	ST
DURATION (MINS)	10	10	10	4	15	10	15	3	7	7
Blueback herring										
White perch	9	4	5		NC*	NC*	7	31	44	3
Spottail shiner		110	26		NC*	NC*		26		
Striped bass										
Alewife								5	1	
Alosa sp.										
Atlantic tomcod		1		1			6			
Brown bullhead										
American shad										
Golden shiner		4								
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter		9	1					3		
Banded killifish										
White catfish									1	
American eel							1			
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	4-25-73	5-3-73			5-18-73					
STATIONS	RNCW	RNCW	RDW	RDW	DC-30	RDW	RDW	DC-30	RDW	RDW
METHOD	BT	ST	BT	BT	ST	BT	BT	BT	ST	ST
DURATION (MINS)	10	10	10	10	10	10	10	10	10	10
Blueback herring					2					
White perch	23	NC*	16	24		4	2	2	NC*	NC*
Spottail shiner		NC*				1		1	NC*	NC*
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod						11	1	21		
Brown bullhead							1			
American shad										
Golden shiner										
Hogchoker						1		3		
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon							1			
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker	1									
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

5-31-73

STATIONS	RSCW	RSCW	RNCW	DC-20	RSCE	RNCE	RNCE	RSCW	RNCW	RDE
METHOD	BT	BT	BT	BT	BT	BT	ST	ST	BT	BT
DURATION (MINS)	10	5	10	10	10	10	10	10	10	2
Blueback herring								NC*	NC*	NC*
White perch	74	11	1	3	5			NC*	NC*	NC*
Spottail shiner	2	1		9	1					
Striped bass										
Alewife							4			
Alosa sp.										
Atlantic tomcod	19	13	36	10	28	4				
Brown bullhead		12			5					
American shad										
Golden shiner										
Hogchoker	4		5		3					
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel	1	1	2		1					
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon				1						
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

5-31-73

STATIONS	RNCW	RDE	RDW	RDW	RNCE	DC-20	RDE	RSCW	RNCE	RSCW
METHOD	ST	BT	BT	BT	BT	BT	ST	BT	BT	ST
DURATION (MINS)	10	2	10	10	10	10	10	10	10	10
Blueback herring	NC*	NC*	NC*		NC*	1		3	3	2
White perch	NC*	NC*	NC*		NC*	28	1	2		
Spottail shiner						4		3	1	
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod				40		26		67	65	
Brown bullhead										
American shad										
Golden shiner										
Hogchoker						4		5	3	
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish								1		
American eel						2		3	1	
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon						1		2	6	
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

5-31-73

STATIONS	RSCE	RSCE	DC-10	RDE	RDW	RNCE	RDW	DC-10	RNCE	RNCW
METHOD	ST	ST	ST	ST	ST	ST	ST	ST	ST	BT
DURATION (MINS)	10	10	10	10	10	10	10	10	10	10
Blueback herring	4	1	1	3	1	1	8	1	4	
White perch										1
Spottail shiner							1			3
Striped bass										
Alewife		1								
Alosa sp.										
Atlantic tomcod		1								26
Brown bullhead										
American shad										
Golden shiner										
Hogchoker										1
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										1
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

6-13-73

STATIONS	DD-20	DC-20	DC-30	DD-20	DC-20	DC-30	DC-10	DD-30	DD-30	DC-20
METHOD	BT	BT	BT	ST	ST	ST	ST	ST	BT	BT
DURATION (MINS)	5	5	5	5	5	5	5	5	5	5
Blueback herring				NC*	NC*	NC*	NC*			
White perch	20	26	4						5	4
Spottail shiner	13	4								6
Striped bass										
Alewife	1									
Alosa sp.										
Atlantic tomcod	5								5	
Brown bullhead		2	1							2
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel	1								2	
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp								1		
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	6-18-73			6-26-73						
STATIONS	RSCE	DC-20	DC-20	RDE	RDE	RDE	DC-20	RDW	RNCE	RNCW
METHOD	BT	ST	BT	ST	BT	ST	BT	BT	BT	BT
DURATION (MINS)	10	10	5	10	2	10	5	10	5	1
Blueback herring										
White perch	12	1	3	1	5	2	1	1	1	21
Spottail shiner										
Striped bass										
Alewife	2									
Alosa sp.										
Atlantic tomcod	16							21		
Brown bullhead	93								1	
American shad										
Golden shiner										
Hogchoker							1	1		
Goldfish	5		2							
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

6-26-73

STATIONS	RSCE	DC-20	RDW	RNCW	RNCW	DC-10	RSCE	RSCW	RDW	RNCW
METHOD	BT	ST	ST	ST	BT	ST	ST	ST	BT	ST
DURATION (MINS)	8	5	10	10	2	5	10	10	10	10
Blueback herring					NC*	1	NC*	NC*	NC*	NC*
White perch	96					1				
Spottail shiner										
Striped bass						1				
Alewife										
Alosa sp.		37	6	55		13				
Atlantic tomcod	60									
Brown bullhead										
American shad										
Golden shiner										
Hogchoker	2									
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish	4									
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.	1									
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	6-26-73					7-10-73				
STATIONS	RNCE	RDW	DC-10	RDW	DD-30	DD-30	DD-20	DC-30	DC-10	DD-20
METHOD	ST	ST	ST	BT	BT	ST	BT	BT	ST	ST
DURATION (MINS)	15	10	10	10	4	5	4	5	5	4
Blueback herring		NC*	NC*						407	214
White perch				16	7	1	152	19	5	1
Spottail shiner							7		1	
Striped bass						1	2			
Alewife							6		115	49
Alosa sp.	2					251				
Atlantic tomcod				30	13			37		1
Brown bullhead							3		2	
American shad										
Golden shiner										
Hogchoker				3			1			
Goldfish										
Pumpkinseed										
Bay anchovy									1	
Bluegill sunfish									2	
Tessellated darter									1	
Banded killifish										
White catfish							3	4		
American eel				1						1
Gizzard shad										
Morone sp.							4		19	
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	7-10-73			7-12-73					7-25-73
STATIONS	DC-30	DC-20	DC-20	DC-20	DD-30	RSCE	RDW		RSCE
METHOD	ST	BT	ST	BT	BT	BT	BT		BT
DURATION (MINS)	5	5	5	5	5	10	10		10
Blueback herring	18	2	450						
White perch		63		1	8	141	11		17
Spottail shiner				1		10			1
Striped bass						12			
Alewife	24		124			68			
Alosa sp.									
Atlantic tomcod				8	22		17		2
Brown bullhead		3		1	1	18			
American shad									
Golden shiner						2			
Hogchoker									
Goldfish		17		1					
Pumpkinseed						5			
Bay anchovy						3			
Bluegill sunfish									
Tessellated darter						1			
Banded killifish									
White catfish		4		1	1	1			
American eel									2
Gizzard shad									
Morone sp.			2			9			
Notropis sp.									
Carp									
Atlantic sturgeon									
Largemouth bass									
Rainbow smelt									
Silvery minnow									
Redbreasted sunfish									
White sucker									1
Cravelle jack									
Black crappie									
White mullet									
Shortnose sturgeon									
Yellow perch									
Atlantic menhaden									
Smallmouth bass									
White crappie									
Fourspine stickleback									
Cyprinid									

ROSETON/DANSKAMMER POINT FISH SAMPLING

7-25-73

STATIONS	RSCW	RNCE	RDE	DC-20	RSCE	DC-20	RNCW	RNCE	DC-20	RDE
METHOD	BT	BT	ST	ST	ST	ST	BT	BT	BT	SW
DURATION (MINS)	10	10	10	10	10	5	10	10	10	10
Blueback herring					NC*	NC*	NC*	NC*	NC*	NC*
White perch	20	6	1	4						
Spottail shiner										
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod	1									
Brown bullhead	1									
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish	3									
American eel		1								
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

7-25-73

STATIONS	RDW	RSCW	RSCE	RNCN	RDW	RNCE	DC-10	RSCW	RSCE	RNCE
METHOD	BT	BT	BT	BT	ST	ST	ST	ST	ST	ST
DURATION (MINS)	10	10	5	10	10	10	10	10	10	10
Blueback herring	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*
White perch	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*
Spottail shiner										
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	7-25-73								8-7-73	
STATIONS	RNCW	RSCW	RNCW	DC-20					DD-20	DD-30
METHOD	ST	ST	ST	BT					BT	ST
DURATION (MINS)	10	10	10	5					5	5
Blueback herring	NC*	NC*	NC*							
White perch									6	1
Spottail shiner				2						
Striped bass									1	
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead				2						
American shad										
Golden shiner										
Hogchoker				1						
Goldfish				12					1	
Pumpkinseed				2					1	
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										1
White catfish									1	
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

8-7-73

STATIONS	DD-30	DC-30	DC-20	DC-20	DC-10	DC-20	DC-30	DC-20	DC-20	DC-10
METHOD	BT	BT	BT	BT	ST	ST	ST	ST	ST	ST
DURATION (MINS)	5	5	5	5	5	5	5	5	5	5
Blueback herring					NC*	NC*	NC*	NC*	NC*	NC*
White perch	2	2	3	16						
Spottail shiner										
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod				1						
Brown bullhead	1			1						
American shad										
Golden shiner										
Hogchoker										
Goldfish			2	5						
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp			1							
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catcb

ROSETON/DANSKAMMER POINT FISH SAMPLING

8-21-73

STATIONS	RSCW	RSCW	RNCW	DC-10	DC-20	DC-20	RSCW	RNCE	RSCE	RNCW
METHOD	BT	ST	ST	BT	BT	ST	ST	ST	ST	BT
DURATION (MINS)	10	10	10	5	5	5	10	10	10	5
Blueback herring			NC*	NC*	NC*	NC*	NC*	NC*		
White perch	78								1	3
Spottail shiner										
Striped bass										
Alewife		7								
Alosa sp.										
Atlantic tomcod										
Brown bullhead	1									
American shad		1								
Golden shiner										
Hogchoker	1									
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

8-21-73

STATIONS	RDW	RSCE	RNCW	RDW	RNCE	RSCE	RSCW	RNCE	RNCE	DC-20
METHOD	BT	BT	BT	BT	BT	BT	BT	BT	ST	BT
DURATION (MINS)	10	10	10	10	10	10	10	10	10	5
Blueback herring										
White perch	9	1	68	5	44	29	17	17	1	10
Spottail shiner			1							2
Striped bass						1				
Alewife										3
Alosa sp.										
Atlantic tomcod										
Brown bullhead					12	5		11		
American shad									1	
Golden shiner										
Hogchoker			1			2				
Goldfish			2							
Pumpkinseed										1
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel						2				
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp					1					
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker								2		
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	8-21-73		9-5-73							
STATIONS	RSCE	RDW	DC-20	DC-30	DC-20	DC-30	DC-10	DC-10	DC-20	DC-30
METHOD	ST	ST	ST	ST	ST	ST	ST	ST	BT	BT
DURATION (MINS)	10	10	5	5	5	5	5	5	5	5
Blueback herring	1	12	NC*	NC*	NC*	NC*		NC*	1	
White perch		13					1		111	150
Spottail shiner							2		53	51
Striped bass	1	7							4	2
Alewife	6	7							2	9
Alosa sp.										
Atlantic tomcod										
Brown bullhead										1
American shad										
Golden shiner										
Hogchoker							2			
Goldfish									3	1
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish									1	
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	9-5-73				9-18-73					
STATIONS	DC-30	DC-20	RNCW	DC-10	RNCE	RNCW	DC-20	DC-20	RNCW	RDW
METHOD	BT	BT	BT	ST	BT	BT	BT	ST	ST	ST
DURATION (MINS)	5	5	10	5	5	10	5	5	10	10
Blueback herring		1	66	1					NC*	NC*
White perch	22	160	20		21	22	12			
Spottail shiner	8	42	1	2	12					
Striped bass	4	12	1				3			
Alewife	14	6	12	1		5	2			
Alosa sp.										
Atlantic tomcod							1			
Brown bullhead	5				43		1			
American shad	14		1			1				
Golden shiner				16						
Hogchoker	1		1		2					
Goldfish	2	1			1		2			
Pumpkinseed		1		1						
Bay anchovy	6		2			1	1	1		
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish					5	1				
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt						4				
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	9-18-73				10-3-73					
STATIONS	RNCE	DC-20	DC-20	RNCW	RNCE	DD-20	DD-20	RD-30	DC-20	DC-30
METHOD	ST	BT	ST	ST	BT	BT	ST	ST	ST	ST
DURATION (MINS)	10	4	5	10	10	5	5	5	5	5
Blueback herring	NC*				24			NC*	NC*	NC*
White perch		70	1	1	45	49				
Spottail shiner		7	1		3					
Striped bass		2			4	10				
Alewife		27			21					
Alosa sp.										
Atlantic tomcod										
Brown bullhead		1	1		2					
American shad		1			1					
Golden shiner			3				1			
Hogchoker		2			6					
Goldfish		2								
Pumpkinseed										
Bay anchovy		22					1			
Bluegill sunfish										
Tessellated darter					1					
Banded killifish										
White catfish		1								
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp						1				
Atlantic sturgeon					1					
Largemouth bass										
Rainbow smelt		1								
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-3-73

STATIONS	DD-30	DD-20	DD-20	DC-10	DD-20	RD-30	DC-30	DC-30	DC-20	DD-30
METHOD	ST	ST	ST	BT	BT	BT	BT	BT	BT	BT
DURATION (MINS)	5	5	5	5	5	5	5	5	5	5
Blueback herring	NC*	NC*	NC*							
White perch	NC*	NC*	NC*	18	5	3	4	2	4	3
Spottail shiner				1						
Striped bass				1	20					
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead					2		5	2		1
American shad										
Golden shiner										
Hogchoker						1	1	3		2
Goldfish							2		2	2
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish									1	2
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon								1		
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	10-3-73						10-9-73			
STATIONS	DC-30	DC-20	DD-30	DD-30	DC-10	RNCE	DC-30	RNCE	RNCE	DC-20
METHOD	ST	BT	BT	ST	BT	BT	BT	BT	BT	BT
DURATION (MINS)	5	5	5	5	5	10	10	10	10	2
Blueback herring	NC*									
White perch		26	5	1	2	5	6	1	10	52
Spottail shiner										
Striped bass										4
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead		1				8		1	5	
American shad		1								
Golden shiner										
Hogchoker			2						1	
Goldfish										1
Pumpkinseed										2
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish									1	
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*NC-No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	10-9-73				10-17-73					
STATIONS	DC-20	DD-30	DC-10	DC-20	RDW	RNCW	RNCW	RSCW	RSCW	DC-10
METHOD	BT	BT	ST	ST	ST	ST	ST	ST	ST	ST
DURATION (MINS)	10	10	5	5	10	10	10	10	10	5
Blueback herring		1	1	4	3	9	1	2	8	2
White perch	94	16								207
Spottail shiner	1									38
Striped bass	4	42		1		2	1	1	1	32
Alewife		12	7	1		3	18	12		7
Alosa sp.										
Atlantic tomcod										
Brown bullhead	2	1								
American shad		1		3	1	27			2	7
Golden shiner										
Hogchoker		1								
Goldfish		1								1
Pumpkinseed		1								
Bay anchovy				1	1	13	48	10	31	1
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										1
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass	1									
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-18-73

STATIONS	RDW	RDW	RE	RDE	RSCE	RNCE	RSCE	DC-20	RSCW	DC-20
METHOD	ST	ST	ST	ST	ST	BT	BT	BT	BT	BT
DURATION (MINS)	10	10	10	10	10	4	10	5	10	5
Blueback herring			NC*	NC*	NC*					
White perch						50	7	9	2	3
Spottail shiner						2				
Striped bass	1						1			
Alewife	1	3								
Alosa sp.										
Atlantic tomcod										
Brown bullhead						119	1	10	1	
American shad										
Golden shiner										
Hogchoker							6			
Goldfish								8		
Pumpkinseed										
Bay anchovy	4	1						1		
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish						9	1			2
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Pedbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-18-73

STATIONS	RDW	RNCE	RNCW	RNCE	RSCE	DC-20	RSCW	RNCE	RNCW
METHOD	BT	ST	BT	ST	ST	ST	BT	BT	BT
DURATION (MINS)	10	10	10	10	10	5	10	10	5
Blueback herring						1	2	3	2
White perch	6	2	36			2	4	1	5
Spottail shiner									
Striped bass							1		
Alewife	1			3	2	6			
Alosa sp.									
Atlantic tomcod							2		
Brown bullhead								3	
American shad							1		
Golden shiner									
Hogchoker	3		5						1
Goldfish							1		
Pumpkinseed									
Bay anchovy		1				1			1
Bluegill sunfish									
Tessellated darter									
Banded killifish									
White catfish			1						1
American eel									
Gizzard shad									
Morone sp.									
Notropis sp.									
Carp									
Atlantic sturgeon	2								
Largemouth bass									
Rainbow smelt							1		
Silvery minnow									
Redbreasted sunfish									
White sucker			1						
Cravelle jack									
Black crappie									
White mullet									
Shortnose sturgeon									
Yellow perch									
Atlantic menhaden									
Smallmouth bass									
White crappie									
Fourspine stickleback									
Cyprinid									

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-31-73

STATIONS	DC-30	DC-30	DC-30	DC-30	DC-20	DC-20	DC-20	DC-20	DC-10	DC-10
METHOD	ST	ST	BT	BT	ST	ST	BT	BT	ST	ST
DURATION (MINS)	5	5	5	5	5	5	5	10	5	5
Blueback herring		NC*				NC*				
White perch		NC*	19	44		NC*	123	92	1	NC*
Spottail shiner			1	10			5	75		NC*
Striped bass			1	4			48	21		
Alewife					77					
Alosa sp.	8		12	5			6		30	
Atlantic tomcod			1							
Brown bullhead				2			1	1		
American shad										
Golden shiner										
Hogchoker										
Goldfish				2			17			
Pumpkinseed										
Bay anchovy			1				1			
Bluegill sunfish								1		
Tessellated darter				1						
Banded killifish										
White catfish				1						
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp				3				4		
Atlantic sturgeon			1							
Largemouth bass										
Rainbow smelt			1							
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon			1							
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	10-31-73							11-5-73		
STATIONS	DD-30	DD-30	DD-20	DD-20				DC-W		
METHOD	ST	BT	ST	BT				ST		
DURATION (MINS)	5	5	5					5		
Blueback herring										
White perch	2	3		219						
Spottail shiner				12				1		
Striped bass	2		1	23						
Alewife										
Alosa sp.	49		29	18						
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner				1						
Hogchoker										
Goldfish				1						
Pumpkinseed										
Bay anchovy				3						
Bluegill sunfish										
Tessellated darter				1						
Banded killifish										
White catfish		3		1						
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

11-15-73

STATIONS	RNCE	RDWN	RNCE	RNCE	RDW	RSCW	DC-20	RSCW	RNCW	DC-10
METHOD	ST	BT	BT	ST	ST	ST	ST	BT	ST	ST
DURATION (MINS)	10	5	10	10	10	10	5	7	10	5
Blueback herring									NC*	NC*
White perch		4	13							
Spottail shiner										
Striped bass										
Alewife				4	1	3				
Alosa sp.							1			
Atlantic tomcod		21								
Brown bullhead			12							
American shad		1								
Golden shiner							1			
Hogchoker		1						1		
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish	1							1		
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

11-15-73

STATIONS	RDE	DC-10	RDE	RDW	RNCW	RDWS	DC-20	RSCE	RSCW	RNCW
METHOD	ST	ST	ST	ST	ST	BT	BT	ST	BT	BT
DURATION (MINS)	10	5	10	10	10	5	5	5	10	10
Blueback herring	NC*	NC*	NC*							1
White perch					1	31	5	1	2	11
Spottail shiner						2	1			
Striped bass				1						
Alewife							1			
Alosa sp.										
Atlantic tomcod						1	1		3	2
Brown bullhead								2		
American shad										
Golden shiner								1		
Hogchoker										
Goldfish								1		
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish									1	1
American eel										1
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon							1			
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										5
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	11-5-73									11-28-73
STATIONS	DC-20	RSCE	RSCW	RDWS	RDWN	RSCE	RSCE	RNCW	RNCE	DC-30
METHOD	BT	BT	ST	BT	BT	ST	BT	BT	BT	ST
DURATION (MINS)	5	10	10	5	6	10	10	10	10	5
Blueback herring			39	1	1	6	1	1	4	2
White perch	30	34	2				22	6	5	
Spottail shiner	2								1	
Striped bass			1							
Alewife						1				
Alosa sp.										
Atlantic tomcod		1		1	10		9	1	1	
Brown bullhead		1							10	
American shad		1								
Golden shiner										
Hogchoker		32		1	1		88		1	
Goldfish		1						1		
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish		1							1	
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon					4			4		
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker		1								
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

11-28-73

STATIONS	DD-20	RD-30	DD-30	DD-20	DD-30	RD-20	RD-30	DC-10	DC-10	DC-20
METHOD	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST
DURATION (MINS)	5	5	5	5	5	5	5	5	5	5
Blueback herring	1	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*
White perch										
Spottail shiner										
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

11-28-73

STATIONS	DC-30	DC-30	DD-30	RD-20	DD-30	RD-20	DC-20	DD-20	DC-30	RD-30
METHOD	ST	BT	BT	ST	BT	BT	BT	BT	BT	BT
DURATION (MINS)	5	5	5	5	5	5	5	5	5	5
Blueback herring										
White perch					1	4	4	5	6	21
Spottail shiner		1				3	2		6	5
Striped bass										1
Alewife										
Alosa sp.										
Atlantic tomcod			12		17		1	11		
Brown bullhead				1						
American shad										
Golden shiner										
Hogchoker										
Goldfish										1
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish								1		
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	11-28-73						12-11-73			
STATIONS	DC-20	RD-30	DD-20	RD-20	RSCW	RNCW	DC-20	RNCE	RDE	RDW
METHOD	BT	BT	BT	BT	BT	BT	BT	BT	ST	ST
DURATION (MINS)	5	5	5	5	10	10	5	10	10	10
Blueback herring								1	NC*	NC*
White perch	12	21	14	113	1	2	4	2	NC*	NC*
Spottail shiner	70	3	1	19			5			
Striped bass	16		7	6						
Alewife				1						
Alosa sp.										
Atlantic tomcod		3	4		4		10	1		
Brown bullhead								1		
American shad										
Golden shiner								1		
Hogchoker										
Goldfish	10			1						
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter	5			1						
Banded killifish										
White catfish			1			2				
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

12-11-73

STATIONS	DC-10	RNCE	RNCW	DC-20	RDWS	RSCE	RDWS	RSCE	RSCW	RDW
METHOD	ST	ST	ST	ST	BT	ST	BT	ST	ST	ST
DURATION (MINS)	5	10	10	5	5	10	5	10	10	10
Blueback herring	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*	NC*
White perch										
Spottail shiner										
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

12-11-73

STATIONS	DC-20	RDE	RNCW	RSCW	RNCW	RSCW	RDNW	RSCE	RDWN	DC-20
METHOD	ST	ST	ST	BT	BT	BT	BT	BT	BT	BT
DURATION (MINS)	10	10	10	10	10	10	5	10	5	5
Blueback herring	NC*	NC*	NC*	NC*						
White perch					1			28	1	7
Spottail shiner										9
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod									4	4
Brown bullhead										
American shad										
Golden shiner						1				
Hogchoker										
Goldfish										
Pumpkinseed										
Bay anchovy										
Bluegill sunfish										
Tessellated darter							1			2
Banded killifish										
White catfish										
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

12-11-73

STATIONS	RSCE	DC-10	RNCE
METHOD	BT	BT	BT
DURATION (MINS)	10	5	10
Blueback herring			
White perch	13	1	3
Spottail shiner		93	
Striped bass		1	
Alewife			
Alosa sp.			
Atlantic tomcod	1		1
Brown bullhead			
American shad			
Golden shiner		2	
Hogchoker	1		
Goldfish			
Pumpkinseed			
Bay anchovy			
Bluegill sunfish			
Tessellated darter		1	
Banded killifish			
White catfish			
American eel			
Gizzard shad			
Morone sp.			
Notropis sp.			
Carp			
Atlantic sturgeon			
Largemouth bass			
Rainbow smelt			
Silvery minnow			
Redbreasted sunfish			
White sucker			
Cravelle jack			
Black crappie			
White mullet			
Shortnose sturgeon			
Yellow perch		2	
Atlantic menhaden			
Smallmouth bass			
White crappie			
Fourspine stickleback			
Cyprinid			

SEINES

ROSETON/DANSKAMMER POINT FISH SAMPLING

	3-21-73				4-25-73		5-18-73			5-30-73
STATIONS METHOD	DD S	DD S	DCN S	DCN S	DD S	DCS S	DD S	DCN S	WC S	DCS S
Blueback herring							8		NC*	
White perch	1						2	13		8
Spottail shiner	12	9	3		7	34	2	8		18
Striped bass										1
Alewife							6	3		2
Alosa sp.			1							
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner	31	8					8	1		
Hogchoker										
Goldfish	43	20	1							
Pumpkinseed		1								2
Bay anchovy										
Bluegill sunfish		1				1				1
Tessellated darter	1	1			1	1		1		
Banded killifish					2	3		1		
White catfish	1	1					1			
American eel										1
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp	5	10								
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie	1									
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	5-30-73							6-13-73		
STATIONS	WC	DCN	RD	RSCE	DD	RE	DE	DCN	DD	DCS
METHOD	S	S	S	S	S	S	S	S	S	S
Blueback herring				2	193	2	13	1		
White perch	10		21	18	8	6	10			6
Spottail shiner			33	29	4	16	11			1
Striped bass					1					1
Alewife	2	2	1	4	6	36	10	6		
Alosa sp.										
Atlantic tomcod					1					
Brown bullhead					13				2	
American shad										
Golden shiner	53		4	6	13	1				
Hogchoker										
Goldfish								1		
Pumpkinseed	1	1	2	13	9		1			5
Bay anchovy										
Bluegill sunfish				3	2					2
Tessellated darter			3	1						
Banded killifish		1	1	7				1		49
White catfish									1	
American eel			3	6						
Gizzard shad										
Morone sp.										
Notropis sp.	1				1					8
Carp									8	
Atlantic sturgeon										
Largemouth bass				3	1				1	
Rainbow smelt										
Silvery minnow										11
Redbreasted sunfish	1									1
White sucker										
Cravelle jack										
Black crappie				1	3					
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid							1			

ROSETON/DANSKAMMER POINT FISH SAMPLING

	6-18-73						6-26-73			
STATIONS METHOD	DD S	DD S	DCN S	RMXT S	DSCE S	RSCE S	DD S	RSCI S	RMXT S	RD S
Blueback herring	1	1								1
White perch	4	1						2		
Spottail shiner				3	13	18		7		7
Striped bass										1
Alewife		1						1		18
Alosa sp.										
Atlantic tomcod										
Brown bullhead	1	1			1		5	6		
American shad										
Golden shiner	4				5			1	1	1
Hogchoker										
Goldfish			2		5			1		
Pumpkinseed				1	13	7	1	6		
Bay anchovy										
Bluegill sunfish				1	2					
Tessellated darter						1				
Banded killifish						1				
White catfish	4	2								
American eel	1					4		2		
Gizzard shad										
Morone sp.										
Notropis sp.	6						3			
Carp										
Atlantic sturgeon										
Largemouth bass				2					1	
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker								1		
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie		1								
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	6-26-73		7-10-73		7-24-73					
STATIONS METHOD	DD S	RE S	DD S	DCN S	DCS S	DCS S	RSCW S	RSCE S	DD S	DCN S
Blueback herring			NC*	4	18	NC*	8	4		11
White perch	90	1		2	8		4	1	2	
Spottail shiner		3			18		2	2		
Striped bass					1		15	1	1	
Alewife		7			10		24			
Alosa sp.									3	
Atlantic tomcod										
Brown bullhead	3							2		
American shad							48	7		
Golden shiner		1		4	1		1			
Hogchoker					1					
Goldfish				1						
Pumpkinseed				4			1	2	1	1
Bay anchovy										
Bluegill sunfish										
Tessellated darter										
Banded killifish				6	1				1	1
White catfish										
American eel		1		2	3		1			
Gizzard shad										
Morone sp.					4					
Notropis sp.	7									
Carp										
Atlantic sturgeon										
Largemouth bass				4						
Rainbow smelt										
Silvery minnow									3	
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden							1	1		
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

	7-24-73	8-7-73				8-9-73		8-21-73		
STATIONS METHOD	RDN S	DCN S	DCN S	DD S	DD S	DCS S	DCN S	DD S	RD S	RSCW S
Blueback herring	211	3	18			76	8	1		
White perch	25	11				74	9	3	51	14
Spottail shiner	10	10	2		1	11	20		9	34
Striped bass	7		5			23		1	13	5
Alewife		1					1		5	
Alosa sp.										19
Atlantic tomcod										
Brown bullhead										
American shad		12	17			7	9			
Golden shiner	3	1	3	2	1		7	1	3	15
Hogchoker										
Goldfish	1	3				1			1	1
Pumpkinseed	1	8			3	2	3		1	
Bay anchovy										
Bluegill sunfish		2			2					
Tessellated darter						5			5	3
Banded killifish										1
White catfish										
American eel			1		1	1	2			
Gizzard shad										
Morone sp.										
Notropis sp.			1							
Carp										
Atlantic sturgeon										
Largemouth bass					1		2			
Rainbow smelt										
Silvery minnow									1	
Redbreasted sunfish		2							1	
White sucker										2
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass		1								
White crappie										
Fourspine stickleback										1
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	8-21-73				9-5-73					
STATIONS METHOD	RSCE S	DD S	DCN S	RSCW S	RSCE S	RD S	DCS S	DCS S	DCN S	DD S
Blueback herring				5	3474	51	145	367	23	
White perch	12	1	3	1	12	27			1	2
Spottail shiner	16		53			6				
Striped bass					1	7		2		
Alewife	11		1		3				8	
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad			32	58	20	9		5		
Golden shiner	6					10				
Hogchoker						1				
Goldfish										
Pumpkinseed	1	2	2		2	5			5	3
Bay anchovy		1			1					
Bluegill sunfish	2									1
Tessellated darter	4		2		7	4		1	4	
Banded killifish	1		2			1			3	
White catfish										
American eel	1		2							
Gizzard shad										
Morone sp.										
Notropis sp.		2								
Carp										
Atlantic sturgeon										
Largemouth bass	2							1		
Rainbow smelt									3	
Silvery minnow										
Redbreasted sunfish								1	1	
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass									1	
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	9-18-73								10-3-73	
STATIONS METHOD	RSCE S	DCS S	DD S	RE S	DD S	RD S	RSCW S	DCN S	DCN S	DD S
Blueback herring	36	20		8	3	49	204	79	1	5
White perch	3		25		20	12	15	1		
Spottail shiner		9	1	2	1	19	17	8		2
Striped bass	3	1	23	5	13	24	14		1	2
Alewife	12		1		6	2	2	36		
Alosa sp.										
Atlantic tomcod										
Brown bullhead					2					
American shad	3	1		27	1	5	13	6		14
Golden shiner		1		2		2		3		
Hogchoker										
Goldfish										
Pumpkinseed	1			1	2				2	1
Bay anchovy	4		1							
Bluegill sunfish			1		12	1	1	1		
Tessellated darter	1		1	1			1		1	1
Banded killifish		1								1
White catfish			13							
American eel										
Gizzard shad										
Morone sp.										
Notropis sp.		1		1						
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish					1			2		
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	10-3-73					10-9-73				
STATIONS METHOD	DD S	DCN S	DCS S	DCS S	RE S	DD S	DCS S	RSCE S	RSCW S	DD S
Blueback herring	8	16	110	3						
White perch	44		7	2		13	3	5	5	4
Spottail shiner			14	12	17	1	8			
Striped bass	61		3	1	2	9	3	2	5	2
Alewife			4	2	5		2			
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad	13		2	2	10		3			
Golden shiner	1			1						
Hogchoker										
Goldfish										
Pumpkinseed			3	5				5	2	
Bay anchovy										
Bluegill sunfish	90		1	2		2				10
Tessellated darter				6		1				
Banded killifish				4						
White catfish						3				
American eel				1						
Gizzard shad										
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass				1						
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish			1						1	
White sucker										
Cravelle jack										
Black crappie	1									
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-9-73 10-17-73

STATIONS METHOD	DCN S	RD S	DD S	DCS S	RSCW S	RSCE S	DCN S	DD S	RE S	RD S
Blueback herring	180	24	1	23	13	18	3	3		
White perch	3	16	193	6	4	2	3	227		19
Spottail shiner	14	81		74	61	13	48	1	6	35
Striped bass		1	41	8	1	1		140		1
Alewife	23	12			1	1	4			3
Alosa sp.										
Atlantic tomcod										
Brown bullhead			3							
American shad	19	5		2	5	2	1	5	4	
Golden shiner		5	1					2		12
Hogchoker					2	1	1			
Goldfish			1							
Pumpkinseed				1	3		4	2	1	7
Bay anchovy						1				
Bluegill sunfish						1		3		
Tessellated darter	1	1		4	7	4	6	1		1
Banded killifish					33	1				
White catfish			6							
American eel					1	1				
Gizzard shad			1							1
Morone sp.										
Notropis sp.		3			1			1		
Carp			1							
Atlantic sturgeon										
Largemouth bass	1									
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish							1			
White sucker										
Cravelle jack			1					2		
Black crappie								1		
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

10-31-73

STATIONS METHOD	CN S	CN S	DCS S	DCS S	DD S	DD S		DCS S		
Blueback herring								1		
White perch	5	7			47	150		43		
Spottail shiner	4	15	47	12	1	1		18		
Striped bass	1	2	2	5	5	201		23		
Alewife	1							60		
Alosa sp.		300	4	5	2					
Atlantic tomcod										
Brown bullhead					2	4				
American shad										
Golden shiner		4								
Hogchoker										
Goldfish										
Pumpkinseed	1					1		1		
Bay anchovy								1		
Bluegill sunfish	1	4	1		4	3				
Tessellated darter	4				1			1		
Banded killifish								1		
White catfish										
American eel								2		
Gizzard shad		4			1	7				
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass			1							
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack					3					
Black crappie						2				
White mullet					3	1				
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

	11-15-73				11-11-73		11-20-73	11-21-73	
STATIONS	DC	RD	RD	DCS	DD	DCS	RDE	DCN	RSCE
METHOD	S	S	S	S	S	S	S	S	S
Blueback herring				2		1			
White perch			1		66	1	5	6	
Spottail shiner			4		3	15	67	47	15
Striped bass			1	1	15	4	2		
Alewife			1	1					
Alosa sp.									
Atlantic tomcod									
Brown bullhead					5				
American shad					2				
Golden shiner					5				
Hogchoker									
Goldfish					1				
Pumpkinseed								4	1
Bay anchovy									
Bluegill sunfish								1	
Tessellated darter							2	15	
Banded killifish								1	
White catfish									
American eel									
Gizzard shad		4			10				
Morone sp.									
Notropis sp.		1							
Carp									
Atlantic sturgeon									
Largemouth bass									
Rainbow smelt									
Silvery minnow									
Redbreasted sunfish									
White sucker									
Cravelle jack									
Black crappie									
White mullet					1				
Shortnose sturgeon									
Yellow perch									
Atlantic menhaden									
Smallmouth bass									
White crappie									
Fourspine stickleback									
Cyprinid									

ROSETON/DANSKAMMER POINT FISH SAMPLING

	11-21-73	11-28-73			11-24-73					12-11-73
STATIONS METHOD	RSCW S	RD S	DD S	DCN S	RD S	DCS S	DD S	DCN S	DCS S	RD S
Blueback herring	1	1			2					
White perch		2	33		1				1	
Spottail shiner		30		11		2	1	9	2	1
Striped bass		1	7							
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner							3			
Hogchoker										
Goldfish			1							
Pumpkinseed				3				3	1	
Bay anchovy										
Bluegill sunfish										
Tessellated darter		3		1				1		1
Banded killifish										
White catfish										
American eel										
Gizzard shad			23				1			
Morone sp.										
Notropis sp.										
Carp			1							
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet			1							
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

ROSETON/DANSKAMMER POINT FISH SAMPLING

12-11-73

STATIONS METHOD	RDE S	DCS S	RSCW S	DCN S	RSCE S	DCS S	RD S	DCN S	DD S	DD S
Blueback herring	NC*	NC*								
White perch										12
Spottail shiner			3	2	1	5	1	13		
Striped bass										5
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner							2		38	1
Hogchoker										
Goldfish										
Pumpkinseed								1		
Bay anchovy										
Bluegill sunfish										1
Tessellated darter							1	6		
Banded killifish								2		
White catfish										
American eel										
Gizzard shad									1	1
Morone sp.										
Notropis sp.										
Carp										
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

*No Catch

ROSETON/DANSKAMMER POINT FISH SAMPLING

12-26-73

STATIONS METHOD	DD S									
Blueback herring										
White perch										
Spottail shiner	1									
Striped bass										
Alewife										
Alosa sp.										
Atlantic tomcod										
Brown bullhead										
American shad										
Golden shiner										
Hogchoker										
Goldfish										
Pumpkinseed	1									
Bay anchovy										
Bluegill sunfish	1									
Tessellated darter										
Banded killifish										
White catfish										
American eel										
Gizzard shad	1									
Morone sp.										
Notropis sp.										
Carp	1									
Atlantic sturgeon										
Largemouth bass										
Rainbow smelt										
Silvery minnow										
Redbreasted sunfish										
White sucker										
Cravelle jack										
Black crappie										
White mullet										
Shortnose sturgeon										
Yellow perch										
Atlantic menhaden										
Smallmouth bass										
White crappie										
Fourspine stickleback										
Cyprinid										

TRAP NETS

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

	7-23-73			7-24-73	
LOCATION	RSCE	DCN	75 ΔT	RSCE	DCN
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	25hr+45m	23hr+13m	96hr	90hr+40m	25 hrs
SPECIES					
Blueback Herring					
White Perch	51	9	10	12	11
Spottail Shiner	1	3		1	6
Striped Bass	2	2			
Alewife					1
Brown Bullhead		1	2	4	4
American Shad					
Golden Shiner		1	1		
Goldfish	1				
Pumpkinseed	4	6	5	36	5
Bluegill Sunfish					
Banded Killifish					
White Catfish	1		1		
American Eel	4	19	6	1	2
Carp					1
White Sucker					
Black Crappie					
Emerald Shiner					
Yellow Perch					
White Crappie		2			2
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

7-24-73 7-25-73 7-27-73

LOCATION	RSCE	DCN	DD	DD	MΔT
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	25hr+15m	45hrs	95hr+35m	23hrs+25m	92hr+50m
SPECIES					
Blueback Herring	3	38			16
White Perch	34	2			
Spottail Shiner					
Striped Bass	6		1	1	
Alewife	1	1			
Brown Bullhead					
American Shad					
Golden Shiner		7			
Goldfish		6			
Pumpkinseed	5		2	2	2
Bluegill Sunfish					1
Banded Killifish			1	1	
White Catfish			1	1	1
American Eel	3	1	3	3	5
Carp	1	1			
White Sucker					
Black Crappie					
Emerald Shiner					
Yellow Perch					
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

	7-27-73		7-31-73		
LOCATION	DCN	DD	DCN	RSCE	DD
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	96hr+50m	96hrs	25hr+45m	23hr+5m	25hr+5m
SPECIES					
Blueback Herring					
White Perch	3	7		8	2
Spottail Shiner	2				
Striped Bass	1				
Alewife	1				
Brown Bullhead	3	4		7	1
American Shad					
Golden Shiner					
Goldfish					
Pumpkinseed	3	5		14	
Bluegill Sunfish					2
Banded Killifish					
White Catfish		4		1	
American Eel	1	44	1	5	2
Carp		1			
White Sucker				1	
Black Crappie				1	
Emerald Shiner					
Yellow Perch	1				
White Crappie					
Yellow Bullhead		1			

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

	7-31-73		8-1-73		
LOCATION	RMXT	DD	DCN	RSCE	RMXT
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	23hr35m	24hr+35m	23hr	27hr+35m	26hr+35m
SPECIES					
Blueback Herring	7				60
White Perch	4	1	4	6	3
Spottail Shiner			1		
Striped Bass					
Alewife	1		1		1
Brown Bullhead	1	1	4	2	
American Shad					
Golden Shiner					
Goldfish					
Pumpkinseed	2		4	7	1
Bluegill Sunfish					
Banded Killifish					
White Catfish				1	
American Eel		9	1	1	5
Carp					
White Sucker					
Black Crappie			1		
Emerald Shiner					
Yellow Perch	1			1	
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING
TRAP NETS

	8-14-73	8-15-73			8-16-73
LOCATION	WC	WC	RNCE	DCN	RNCE
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	24hrs	23hrs+25m	24hr	23hr+50m	23 hrs+48m
SPECIES					
Blueback Herring		2			2
White Perch	4		4	1	1
Spottail Shiner					
Striped Bass				1	
Alewife		2			2
Brown Bullhead			17	3	16
American Shad					
Golden Shiner				1	
Goldfish				1	
Pumpkinseed	2	3	5	3	5
Bluegill Sunfish			1		3
Banded Killifish					
White Catfish					1
American Eel		3		6	7
Carp					5
White Sucker			4		1
Black Crappie					
Emerald Shiner					
Yellow Perch			1		
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

	8-16-73				9-4-73
LOCATION	WC	DCN	DCS	DD	DCN
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	24 hrs	24 hrs	24 hrs	24 hrs	25 hrs +15m
SPECIES					
Blueback Herring	20	4			1
White Perch			4	1	1
Spottail Shiner		1			9
Striped Bass			5	1	
Alewife	3	10			137
Brown Bullhead		6			
American Shad					
Golden Shiner					1
Goldfish					
Pumpkinseed	1	4	6	4	2
Bluegill Sunfish			2	1	1
Banded Killifish					
White Catfish			2		
American Eel	1	26	17	2	
Carp					1
White Sucker	1				
Black Crappie					
Emerald Shiner					
Yellow Perch	1				
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

9-4-73

LOCATION	DD				
METHOD	TRAP NET				
DURATION (MINS)	25 hrs+45m				
SPECIES					
Blueback Herring	1				
White Perch	4				
Spottail Shiner					
Striped Bass	1				
Alewife					
Brown Bullhead					
American Shad					
Golden Shiner	1				
Goldfish					
Pumpkinseed	8				
Bluegill Sunfish					
Banded Killifish					
White Catfish					
American Eel	5				
Carp					
White Sucker					
Black Crappie					
Emerald Shiner					
Yellow Perch					
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

TRAP NETS

8-2-73 8-14-73

LOCATION	RSCE	DCN	DD	RMΔT	DCN
METHOD	TRAP NET	TRAP NET	TRAP NET	TRAP NET	TRAP NET
DURATION (MINS)	24hr+50m	26hr+25m	26hr+10m	26 hrs	24 hrs
SPECIES					
Blueback Herring		3	1	280	
White Perch	3	4	7	4	2
Spottail Shiner				3	
Striped Bass		5		12	
Alewife					
Brown Bullhead					
American Shad				1	
Golden Shiner			1	1	
Goldfish					
Pumpkinseed	3	2	2	1	
Bluegill Sunfish					
Banded Killifish			1	1	
White Catfish					
American Eel	2			4	
Carp					
White Sucker					
Black Crappie	1	2			
Emerald Shiner					
Yellow Perch					
White Crappie					
Yellow Bullhead					

GILL NETS

ROSETON/DANSKAMMER POINT FISH SAMPLING
GILL NETS

	4-25-73		5-3-73		5-18-73
LOCATION	DC-30	RD	RD	RDW	DC-30
METHOD	SGN	5" SGN	Drftg. SGN	3" SGN	3" SGN
DURATION (MINS)	60	120	10	70	60
SPECIES					
Blueback Herring	66		99		9
White Perch					
Spottail Shiner					
Striped Bass					1
Alewife	180			141	29
Brown Bullhead					
American Shad		1			
Golden Shiner					
Gold Fish					
Pumpkinseed					
Bluegill Sunfish					
Banded Killifish					
White Catfish					
American Eel					
Carp					
White Sucker					
Black Crappie					
Emerald Shiner					
Yellow Perch					
White Crappie					
Yellow Bullhead					

ROSETON/DANSKAMMER POINT FISH SAMPLING

GILL NETS

	5-30-73		6-13-73	7-10-73	7-25-73
LOCATION	RDE	RDE	DANSK 7 INTAKE	DCS	RSCE
METHOD	SGN 5"	SGN 3"	SGN	GN	TN
DURATION (MINS)	60	45	120	125	2790
SPECIES					
Blueback Herring	NC*	33	NC*	NC*	
White Perch	NC*		NC*	NC*	23
Spottail Shiner					
Striped Bass					
Alewife		8			2
Brown Bullhead					4
American Shad					
Golden Shiner					
Gold Fish					
Pumpkinseed					4
Bluegill Sunfish					
Banded Killifish					
White Catfish					1
American Eel					3
Carp					
White Sucker					
Black Crappie					
Emerald Shiner					
Yellow Perch					
White Crappie					
Yellow Bullhead					

*No Catch

APPENDIX VII - A

APPENDIX VII-A

MAJOR WATER QUALITY SAMPLING LOCATIONS ON THE HUDSON RIVER

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Lower Hudson Estuary	City Univ. of N.Y.	0-30	2-4/72	Monthly	Physical, Chemical & Bacteriological
Upper N.Y. Bay to Bear Mt. Bridge	ISC	0-47	8/71	Thrice/Day	Physical, Chemical & Bacteriological, graphs
MP 0-150.7	QLM 169-1:	0-150.7			
	(NYSD of Health)	(0-80)	1929, 36, 59 & 64		Salinity
	"	(30-150)	12/70		DO, BOD
	"	(30-153.7)	9/67		DO, BOD
	"	(150.7)	8/67		long-term BOD
	"	(4-77.4)	1964 & 1967		Salinity
MP 11-63	QLM 169-1	11-63	2-10/66	Daily & Monthly	Salinity Profiles.
MP 11-115	Michigan State Univ.	11-115	1964	Irregular	Biological-Chemical
Harlem to Coxsackie	QLM	14-125	10-12/72	Monthly	W.Q. Raw Data
Yonkers	USEPA	15.9	10-12/72	Monthly	W.Q. Raw Data
	NYSDEC	15.9	10/67-9/70	Monthly	W.Q. Percentile Summa
	NYSDEC	15.9	4/68 -9/72	Monthly	W.Q. Raw Data Listing
	NYSDEC	15.9	10/14/70-9/29/71	Monthly	W.Q. Raw Data Listing

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Mt. St. Vincent	ISC	16	7/20/64	Irregular	Tidal
Mt. St. Vincent	QLM	16	9/25/67	Irregular	Salinity
MP20-100	NYU Med. Center	20-100	1964-1967	Annually	Metals, Radiological Pesticides
Hastings-on-Hudson	QLM	21.8	12/2/72	Every 1 1/2 hours	Current & chloride
Dobbs Ferry	QLM	23	11/23-24/64		Salinity (graphs)
Nyack	NYSDEC	24.6	4/68-9/72		W.Q. Raw Data
	NYSDEC	24.6	10/67-9/70		W.Q.Percentile Summ.
	NYSDEC	24.6	1967-1970		W.Q.Means & Ranges
	NYSDEC	24.6	10/14/70-9/29/71		W.Q.Raw Data Listing
	NYSDEC	24.6	1971-1972		W.Q.Means & Ranges
Piermont	USEPA	25	1/70-12/72	Monthly	W.Q. Statistical Summary
Tappan Zee Bridge	QLM	27	9/23/67		Salinity
MP 27-100	USPHS at Poughkeepsie	27-100	11/66		Trace metals
	McCrone 1967	27-76	7-8/65		Trace Metals
	& USPHS		11/66		Trace Metals
MP 27-67	NYU Med. Center	27-67	1/66-12/68	Monthly	Trace Metals
Croton Pt.	QLM	33	11/23/64	Irregular	Salinity (graph)
NE Lower Hudson (Metropolitan Area)	USEPA	0	1/70-12/72	Monthly	W.Q.Raw Data Listing
		8.6			
		11			
		14.8			

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Bowline	QLM	37.5	1971-1972		Interim Report: Phys-Chem.
			6-10/1970		Pre-op. Ecological Studies
			1971-1972		Progress Report-Ecological Studies
			8-10/69	Monthly	Physical, Chemical
			8-12/71	Monthly	Physical, Chemical
			5-12/72	Monthly	Physical, Chemical
			5-17/72	Hourly	Physical, Chemical
			7/14/72	Hourly	Physical, Chemical
Minisceongo Creek	QLM		1,8-12/72	Monthly	Physical, Chemical
Lovett	QLM	40	6-10/70	Monthly	Physical, Chemical
			1/27 & 2/17/72	Monthly	Physical, Chemical
Peekskill	NYSDEC	40.5	10/1/67-9/30/70	Monthly	W.Q. Percentile Summ.
			4/68-9/72	Monthly	W.Q.Raw Data Listing
			10/14/70-9/29/71	Monthly	W.Q.RawData Listing
			1967-1970		W.Q.Means & Ranges
			1971-1972		W.Q.Means & Ranges
Verplank	USGS		10/71-9/72		W.Q.Raw Data Listing
	USGS		1971-1972		W.Q.Means & Ranges
	USEPA		1/70-12/72		W.Q.Statistical Summary
	USEPA		1970-1972		W.Q. Means & Ranges
	NYSDEC		4/69-9/70		W.Q.Raw Data Listing
Peekskill	QLM	43	2/9 & 17/72	Hourly	Tidal graphs
	QLM	43	2/9-10/72	Hourly	Cr & Zn graphs

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Indian Pt.	Con Ed	43	11/22/64	Every 2 hours	Salinity
	Con Ed		1958-60	Monthly	Chemical
	Con Ed		1961-63	Monthly	Chemical
	Con Ed		1962-72	Monthly	Chemical
	USGS		1960-65	Daily	Long-term temp. (graphs)
	USGS		1966-68	Daily	Long Term temp. (graphs)
	SBI		1967-69	Daily	Long Term temp. (graphs)
	Con Ed		1967-72	Daily	Long Term temp. (graphs
	Raytheon		1970	Daily	Short-term temp. (graphs)
	NYU		1972	Daily	Short-Term temp. (graphs
	Raytheon		1969-70	Monthly	D.O.Temp.Salinity
	Raytheon		1969-70	Monthly	Chemical (report)
	NYU		1968-69	Monthly	Salinity
	NYSDH (KYMA survey)		1968-69	—	Salinity, flow
	NYU Med. Center		4-12/68	Monthly	Metals
	Texas Instruments		5-6/72	Monthly	Physical-chemical
	Texas Instruments		7-8/65	Monthly	Trace metals
	USFWPCA		1962-68	—	Radioactivity, metals
	USDHE & W		1962-68	Monthly	Radioactivity, metals
	(NYU Med. Center)		2/70-12/72	Monthly	Chemical

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Peekskill	NYSDEC	46.2	4/68-9/72	Monthly	W.Q.Raw data Listing
			10/1/67-9/30/70	Monthly	W.Q.Percentile Summ.
Peekskill	NYSDEC	46.2	4/68-9/72	Monthly	W.Q.Percentile Summ.
			10/14/70-9/29/71	Monthly	W.Q.Raw Data Listing
			1971-1972		W.Q.Means & Ranges
			1967-1970		W.Q.Means & Ranges
			10/1/67-9/30/70	Monthly	W.Q.Raw Data Listing
Bear Mt.	QLM	47	11/21/64	Hourly	Salinity graph
Bear Mt. Bridge-below Troy Lock	NYSDH	46.4-150.8	1949, 51 & 52	7-day basis	W.Q.Raw Data; flow
West Pt.	QLM	51	9 & 11/64	Hourly	salinity
Cornwall	QLM	57	11/3 - 12/6/65	Every other day	Chemical
	QLM	57	6-8/72		Temp. & Chloride
Newburgh	QLM	60.6	11/20-21/64	Hourly	Salinity
Beacon (below B-N bridge)	USEPA	61	3/70-12/72		W.Q.Statistical Summ.
Wappingers	USEPA	60	1/62-12/72		W.Q.Statistical Summ.

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Wappingers Falls	NYSDEC	60	4/69-9/71	Monthly	W.Q.Raw Data Listing
			10/1/67-9/30/70		W.Q.Statistical Summ.
			10/1/67-9/30/70		W.Q.Percentile Summ.
			1967-1970		W.Q.Means & Ranges
Roseton	QLM	65	7-8/71	Frequent	Physical, Chemical
	QLM		5-12/71	Monthly	Physical, Chemical
	QLM		5-12/72	Monthly	Physical, Chemical
	QLM		5-12/72	Bimonthly	(maps, graphs)
	Dutchess Coun. Coll		6/29-8/10/71		Biological
Wappingers Falls	NYSDEC	65.3	1/1/64-9/29/72	Daily	W.Q.Raw Data Listing
			10/1/64-9/30/67		W.Q.Statistical Summ.
			10/1/67-9/30/70		W.Q.Statistical Summ.
			10/1/64-9/30/67		W.Q.Percentile Summ.
			10/1/67-9/30/70		W.Q.Percentile Summ.
			1967-1970		W.Q.Means & Ranges
Chelsea	USEPA	65.3	1/70-12/72		W.Q.Statistical Summ.
Danskammer	Marist College	65	Summer 1971	6 month study	Metals Toxicity-temp.
	QLM		Summer 1969	Weekly	Physical-chemical
	QLM		1956-1965	Monthly	Chlorides, flow
	QLM		5-10/71	Bimonthly	Physical,Chem,Bacter.
	QLM		5-12/72	Monthly	Physical,Chem,Bacter.
Marlboro	QLM	68	11/21/64	Hourly	Salinity
Poughkeepsie	USEPA	71.6	1/70-12/72		W.Q.Statistical Summ.
	NYSDEC		1/29/64-6/19/68	Weekly	W.Q.Raw Data Listing

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Poughkeepsie Water Intake	NYSDEC	75.6	10/13/64-9/29/72	Daily	W.Q.Raw Data Listing
			10/1/64-9/30/70		W.Q.Statistical Summ.
			10/1/64-9/30/67		W.Q.Percentile Summ.
			10/1/67-9/30/70		W.Q.Percentile Summ
			1967-1970		W.Q.Means & Ranges
			1971-1972		
Poughkeepsie	NYSDEC	75.6	10/1/67-9/30/70		W.Q.Percentile Summ.
	NYSDEC	75.6	10/1/67-12/10/70	Daily	W.Q.RawData Listing
	NYSDEC	75.6	1967-1970		W.Q.Means & Ranges
	QLM	75.4	11/20/64	Hourly	Salinity
	NYU Med. Center		3-6/67	Monthly	Metals
	USFWPCA		1962-1969		Metals
Roosevelt Pt.	QLM	77.4		Hourly	Salinity
Rondout Creek at Rosendale	USEPA	88	1962-1971		W.Q.Means & Ranges
Rondout Creek near Lowes Corners			1966-1970		W.Q. Means & Ranges
Rondout Creek at Eddyville			1969-1972		W.Q. Means & Ranges
Kingston East	NYSDEC	89.2	6/66-7/66	Irregular	W.Q.Raw Data Listing
			6/68-8/68	Irregular	W.Q.Raw Data Listing
			6-7/66 & 6-8/68		W.Q.Means & Ranges
Kingston	QLM	96	1971-1972	Monthly	Physical-Chemical
Rondout Creek	USEPA	89	10/62-9/72		W.Q.Statistical Summ.
Esopus Creek	USEPA	102	1/62-12/72		W.Q.Statistical Summ.
Esopus Creek at Coldbrook			1962-1970		W.Q. Means & Ranges

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Esopus Creek at Shandaken			1963-1972		W.Q.Means & Ranges
Saugerties	NYSDEC	102.3	10/1/67-9/30/70		W.Q.Percentile Summ.
	NYSDEC	102.4	10/1/67-9/30/70		W.Q.Percentile Summ.
	NYSDEC	103	10/1/67-9/30/70		W.Q.Percentile Summ.
	NYSDEC	102.3	1967-1970		W.Q.Means & Ranges
	NYSDEC	102.4	1967-1970		W.Q.Means & Ranges
		103	1967-1970		W.Q.Means & Ranges
Clementon	NYSDEC	104.3	10/1/67-9/30/70		W.Q.Percentile Summ.
	NYSDEC	104.3	1967-1970		W.Q.Means & Ranges
Catskill	NYSDEC	108	10/1/72-10/73		W.Q.Raw Data Listing
Hudson South	NYSDEC	110.5	10/1/67-9/30/70		W.Q.Percentile Summ.
			10/14/70-9/29/71	Monthly	W.Q.Raw Data Listing
			4/68	Monthly	W.Q.Raw Data Listing
			1967-1970		W.Q.Means & Ranges
			1971-1972		W.Q.Means & Ranges
Ravena	NYSDEC	131.6	10/1/67-9/30/70		W.Q.Percentile Summ
	NYSDEC		1967-1970		W.Q.Means & Ranges
Delmar	NYSDEC	139.7	10/1/67-9/30/70		W.Q.Percentile Summ.
			1967-1970		W.Q.Means & Ranges

(continued)

MAJOR SAMPLING LOCATIONS IN THE HUDSON RIVER

SAMPLING LOCATION	SOURCE	MP	DATE OF RECORD	FREQUENCY OF SAMPLING	TYPE OF DATA
Troy South	NYSDEC	149.7	10/1/67-9/30/70		W.Q.Percentile Summ.
Troy North	NYSDEC	151.6	10/1/67-9/30/70		W.Q.Percentile Summ.
Albany	QLM	140	1970		Ecological Survey
Albany Steam Station	QLM 191-1	118-154	10/70		D.O.
		110-154	9/64		D.O.
		110-154	10/64		D.O.
		I10-154	7-10/		D.O., PO_4, NO_3
	NYSDEC	110-154	10/67-2/71		W.Q.Percentile Summ.
Green Island	USGS	~~145~~ 153.5	1959/1964	Daily	Flow, Salinity
			1/71-12/72	Daily	Flow
Hadley, Newcomb & North Creek		220.3,	1972	Daily	Flow
Green Island & Lower Hudson	USGS		1948-1972	Monthly	Flow; 25-yr average
Green Island	USGS	153.5	1-12/72	Daily	Discharge, flow
			1/73-10/73	Daily	Discharge, flow
Upper Hudson	NYSDH	150-300	1959	Irregular	W.Q.;discharge & stream gauging summ.
	Hydroscience, Inc.	0.2-50.5	8-10/64		Physical-Chemical
	WATERS AROUND	METROPOLITAN NEW YORK			
Sandy Hook Bay	ISC		7/12-22/71	24 hour survey	W.Q.
Raritan Bay	ISC				
Throgs Neck			8/3/64		D.O., Temp.
The Narrows			7/22/64		D.O., temp.

APPENDIX VII-B

APPENDIX VII-B

DISCUSSION OF RELEVANT WATER QUALITY PARAMETERS

RELEVANT WATER QUALITY PARAMETERS

A. OXYGEN DISTRIBUTION AND DEPLETION

Dissolved Oxygen (DO) is derived from contact with the atmosphere or from photosynthetic processes. Relatively low levels of DO in surface waters may contribute to an unfavorable environment for fish and other aquatic life. The absence of DO may lead to the appearance of the odoriferous products of anaerobic decomposition in the water column. The concentration of DO in water, which is at equilibrium with a normal atmosphere, is a function of the water temperature, the salinity, and the atmospheric pressure. The ability of water to hold oxygen decreases with increased temperature or dissolved solids or decreased atmospheric pressure.

Natural waters, however, are seldom at equilibrium. Nonequilibrium conditions are brought about by changes in temperature and other physical, chemical, or biogenic activities which alter the chemistry of the water as shown diagramatically in the previous section. Most perturbations from equilibrium are caused by biogenic processes. Oxygen is consumed by the respiration processes of plants and animals, bacterial decomposition of organic matter and also the chemical oxidation of reduced chemical species produced in the reducing areas. DO may show marked diurnal variation.

In polluted waters, oxygen is required for the natural purification process which takes place in riverine systems. This process involves the bacterial oxidation of added organic matter and the stabilization of the mud-water equilibria. The determination of DO at various points in the river is necessary to assess the extent to which self-purification has proceeded.

The biochemical oxygen demand (BOD) is a bioassay measurement of the quantity of oxygen required for a five-day bacterial oxidation of certain waterborne organic wastes at ambient temperatures. The primary chemical compounds affected fall into three general categories: 1) Carbonaceous organic material usable as a source of food by aerobic microorganisms; 2) Oxidizable nitrogen (nitrites, ammonia, organic nitrogen) which serves as food sources in the nitrification process; and 3) certain chemically oxidizable materials (ferrous iron, sulfide, sulfite).

In a slow, sluggish stream, a 5-day BOD of about 5 mg/l might be sufficient to produce deoxygenation resulting in an anaerobic condition, whereas a swiftly flowing stream can often handle 50 mg/l of 5-day BOD without appreciable depletion of DO. Each stream must therefore be considered in its own right, and until the reaeration characteristics of the stream are known, the limiting values of BOD should not be set.

The BOD is often used as a measurement of the self-purification ability of a stream to handle discharges of biodegradeable substances.

The chemical oxygen demand (COD) also provides a measurement of the readily oxidizable organic compounds in a receiving water or effluent. In this test, the results are expressed in terms of the total quantity of oxygen required for the oxidation of the organic materials by a strong chemical oxidant (potassium dichromate). Most organic substances, with the exception of certain high molecular weight organics and benzene-type structures, are oxidized in this test regardless of the biological assimilability of these substances. Therefore, COD values are often greater than the corresponding BOD values, and may be much greater when significant amounts of biologically resistant organic matter are present.

B. MAJOR WATER CONSTITUENTS

In natural waters the principal dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates and possible nitrates of calcium, magnesium, sodium, and potassium, with traces of iron, manganese, and other substances. These constituents generally originate from the weathering of soils and rocks. This mineral content may be lowered artificially by dilution or raised by the addition of chemical wastes, dissolved salts, acids, alkalis, etc.

Total dissolved solids is a measure of the dissolved solids obtained by the weight of the residue remaining after evaporation of the volatile portion of an aliquot of the filtered water sample. Waters are sometimes classified on the basis of total dissolved solids as follows:

Fresh water	0 - 1000 mg/l
Brackish water	1000 - 10,000 mg/l
Salty water	10,000 - 100,000 mg/l
Brine	>100,000

The quantity and quality of dissolved solids serve as nutrients in productivity, as agents in osmotic stress, and in direct toxicity. Dissolved solids may also influence the toxicity of heavy metals and organic compounds to fish and other aquatic life, primarily because of the antagonistic effect of the heavy metals. Many toxicants are generally more toxic in distilled water than in hard water of high dissolved solids. It is recognized that concentrations of total dissolved solids should not be changed to the extent that the biological communities characteristic of particular habitats are significantly changed.

Specific Conductance is a second method of rapidly estimating the dissolved solids of a sample. This reading is a measure of the capacity of water to convey an electrical current, and is related to the total concentration of the ionized substrates in water (and the temperature at which the measurement is made). Values are expressed in μmhos/cm at 25°C. The nature of the various dissolved substances, their actual and relative concentrations, and the ionic strength of the water sample, all affect the specific conductance. These measurements are often related to each other by an empirical factor. Commonly, the amount of total dissolved solids in mg/l is about 55 to 75 percent of the specific conductance.

Hardness represents a third method of determining the dissolved salts in water. The hardness of water is commonly accepted to represent the total amount of calcium and magnesium present in water, expressed in terms of an equivalent amount of calcium carbonate in mg/l. Other polyvalent cations may also contribute, but commonly to a much smaller degree. Hardness has also been used to classify waters as follows:

Soft	0 - 60 mg/l
Moderately hard	61 - 120 mg/l
Hard	121 - 180 mg/l
Very hard	>180 mg/l

As mentioned in the discussion of total dissolved solids, the hardness modifies the toxicity of many pollutants.

Magnesium is one of the most common elements in the crust of the earth, constituting about 2.1 percent of it. Concentrations of magnesium in fresh waters are extremely variable, depending upon the amount and solubility of the element

bound in the surrounding geological sources. Magnesium occurs as part of the chlorophyll molecule making it necessary for photosynthesis in small quantities. It is often discussed as a component of the water's hardness.

Chloride is the most important and most widely distributed of the chemical halogens in natural water. Chloride salts are very soluble and once in solution, the concentration is only changed through evaporation or dilution, because there are few effective biogeochemical controls or regulation. Besides natural sources, chloride addition also occurs through the discharge of industrial and municipal wastes and in deicing operations. In estuarine systems, chloride concentrations are often used to measure the extent of sea water intrusion at a given location. These waters can be classified according to the following generalized scheme:

Fresh water	0 - 100 mg/l Cl
Brackish water	100 - 1000 mg/l Cl
Salty water	>1000 mg/l Cl
Seawater	∿19,000 mg/l

Rapid fluctuations in chloride concentration can cause osmotic pressure imbalances in freshwater fish and aquatic life.

Sulfate is the most oxidized species in the sulfur group and is often reported as mg/l sufate (SO_4). Natural sources of this anion include the dissolution of sulfate containing rocks, the breakdown and oxidation of organic sulfur compounds (proteins), and the oxidation of biologically produced hydrogen sulfide. It is also discharged in the effluents of both industrial and municipal point sources.

Sulfate can be broken down to the odoriferous hydrogen sulfide gas by sulfate reducing bacteria under reducing conditions. Sulfur species are continually undergoing oxidation and reduction reactions in the aquatic environment. Concentration limits have been set in domestic waters at 250 mg/l to avoid problems associated with taste or a mild laxative effect. At these concentrations, sulfate can cause scaling problems in industrial water applications. There are no toxicological effects noted for aquatic life. On the contrary, sulfur species are required for protein and chlorophyll formation.

C. NUTRIENT CHEMISTRY (MACRONUTRIENTS)

Nutrients, such as carbon, nitrogen and phosphorus, are important properties of water and sediment quality. Nutrient-rich waters create the potential for algal blooms and eutrophication in estuaries and other partially restricted bodies of water. The bio-stimulatory effect of these nonconservative constituents is related to their chemical form; for example orthophosphate, nitrate, ammonia, carbon dioxide, bicarbonate etc. These "available" nutrients can be dissolved in the water, adsorbed on the pelagic particulate system or included in the sediments.

Nutrients can enter the aquatic system through natural decomposition of either allochthonous or autochthonous organic materials. By carefully controlling the addition of all organic wastes from sewage and industrial point sources, it might be possible under certain conditions to limit excess productivity. Besides the macronutrients, these wastes contain vitamins, trace elements and other growth stimulants. Details of the three major macronutrient chemical systems as measured in this report are briefly described below:

1. Carbon System

Alkalinity is an indicator of the ability of a given water sample to neutralize or accept hydrogen (H+) ions and it is often expressed as the equivalent amount of calcium carbonate in mg/l. Alkalinity of natural waters is primarily due to the presence of inorganic carbon species with other salts of weak acids (acetate, phosphates, silicates, borates, cyanide, sulfides, etc.) usually adding only a minor contribution in non-marine aquatic systems. Direct contribution of hydroxide may be present from industrial discharges, however this does not represent the natural chemical character of the water.

The complicated equilibrium involving the inorganic carbon forms is shifted by changes in temperature, pH, cations, and other dissolved solids, thus changing the concentrations of the individual species found. The relative proportions of these different forms vary with the pH. The theoretical amount assuming equilibrium, may be obtained from available species-distribution diagrams. However, because this system is involved in biological activity (respiration adds CO_2 and photosynthesis removes CO_2) equilibrium cannot be attained. The difference between measured values for the alkalinity species and the theoretical amounts that should be present at equilibrium provide the researcher with a measure of the nonequilibrium in the system and the magnitude of the biological processes. Changes in this index are related to changes in the concentration of other chemical species important to biological productivity.

This test is often used by aquatic biologists as a rough index of the fertility of a stream or lake. The alkalinity also serves as a buffering agent to help prevent any sudden change in pH value, which might cause death to fish or other aquatic life.

2. Nitrogen System

Nitrogen occurs abundantly in nature, constituting some 78 percent by volume of the atmosphere. Nitrogen is also an essential constituent of all living organisms and it is present in many mineral deposits as nitrates. From organic matter, nitrogen undergoes bacterial degradation from complex proteins to ammonia, nitrites, and nitrates. These simple nitrogen forms can be synthesized through photosynthesis into complex organic matter once again. Nitrogen is present in aquatic organisms and natural waters in various oxidation states ranging from -3 (ammonia and amino groups) to +5 (nitrate).

Most water analyses have been restricted to ammonia-(NH_3), nitrite-(NO_2), nitrate-(NO_3), and kjeldahl (NH_3-N plus organic-N) nitrogen.

AMMONIA NITROGEN is found in the following chemical species: ammonium ion (NH_4^+), free ammonia, and other unionized ammonium compounds. This distribution of ionized vs. unionized ammonia at a given temperature varies with pH. In most natural waters, the pH range is such that the ammonium ions predominate, however, in alkaline waters high concentrations of unionized ammonia can be found, which increases the toxicity of ammonia solutions. In streams polluted with sewage, up to one-half of the nitrogen may be in the form of free ammonia. Ammonia is the product of the heterotrophic microbiological decay of animal and plant protein. These compounds as well as amines may be discharged in industrial effluents. Especially in oligotrophic fresh waters, ammonia nitrogen can exhibit marked diurnal variations. For many aquatic microorganisms, this nitrogen form is preferred to the nitrate form.

NITRITE AND NITRATE occur in natural waters as the intermediate and end products, respectively, of the bio-oxidation of ammonia nitrogen (nitrification). Nitrite is often used as a corrosion inhibitor in industrial process water. However, this form is not commonly found in surface waters to any great extent because it is rapidly oxidized to nitrate. Nitrate is commonly used as a fertilizer and is also found in industrial discharges. For many types of algae it is the form most readily used in their growth. Many studies have cited this nitrogen form as being "limiting" to the growth of aquatic microorganisms in estuarine systems.

TOTAL KJELDAHL NITROGEN, after subtracting the ammonia nitrogen, provides a measure of the organic nitrogen in the aquatic system. These nitrogen forms are derived largely from biological synthesis with smaller amounts contributed by the discharge of industrial and municipal wastes. Organic nitrogen can be transformed into the above nitrogen species by bacterial activity, thus adding to the nutritionally available nitrogen pool.

3. Phosphorus System

The exact chemical forms of the phosphorus compounds present in aquatic systems are still imperfectly known. Most analyses have been restricted to relatively simple assays for orthophosphate and total-phosphorus. Phosphates seldom exhibit direct toxic effects upon fish or other aquatic life. However, the discharge of excessive amounts of phosphates to freshwater aquatic systems can contribute to excessive growths of algae with the concomitant oxygen depletion leading to fish mortality and degradation of water-based recreational activity. Because of the bio-utilization of phosphates, they are seldom found in large concentrations unless a constant pollutant source is available.

D. TRACE ELEMENTS (METALS)

The group of elements included under this heading are often referred to as heavy metals. Most, if not all, of these metal ions serve as micronutrients in various metabolic processes of aquatic life at extremely low concentrations. This effect is often difficult to analytically determine because of the inability to distinguish the "available" ionic species (valence state) at these low levels. Once these low nutrient levels are exceeded, these heavy metals become toxic to some species in the different trophic levels. The toxic effects of these metals may be persistent and cumulative over the long term. They can also act synergistically with each other substances to increase the toxicity. A brief description of each metal involved in this study is included below:

1. Chromium

Significant concentrations of chromium seldom come from natural sources. Hexavalent chromium in either the chromate ion (CrO_4^{-2}) or the dichromate ion ($Cr_2O_7^{-2}$) is often discharged in cooling waters in which it has been used as a corrosion inhibitor. Fairly high concentrations of hexavalent chromium are possible in waters having normal pH levels. When chromium is present as a cation in its trivalent state, its solubility is quite low with conditions present in most natural waters. Both chemical valence states are toxic to most biological species at relatively low levels. On the basis of available literature, it appears that the following concentrations of chromium (total, as determined by atomic absorption spectrophotometry) will not interfere with the specified beneficial uses of the water:

1. Domestic Water Supply.....0.05 mg/l
2. Wildlife.....5.0 mg/l
3. Fish.....1.0 mg/l
4. Other aquatic life.....0.05 mg/l.

2. Copper

Copper ions commonly occur in natural surface waters only in amounts up to about 0.05 mg/l. Their presence is generally the result of a discharge containing corrosive products of copper or brass tubing or from the use of copper compounds for the control of undesirable plankton organisms. Cupric ions introduced into natural waters at pH 7 or above will precipitate the metal as the hydroxide or as basic copper carbonate, thus keeping the concentrations relatively low. Complexation reactions may enhance the solubility under certain conditions. On the basis of the toxicity literature available, the following threshold concentrations of copper are indicated for specific beneficial water uses:

1. Domestic Supply.....1.0 mg/l
2. Freshwater fish and aqutic life.....0.02 mg/l
3. Marine water fish and aquatic life.....0.05 mg/l.

3. Iron

This element is an abundant and widespread constituent of rocks and soils. It is released to natural water by bacterial reduction in the presence of organic matter. Iron is also present in discharges containing metallic corrosion products. While ferrous iron (Fe^{+2}) is quite soluble in water, much of the total iron is readily oxidized in the presence of dissolved oxygen to the ferric state (Fe^{+3}) and is subsequently precipitated out as the flocculant hydrous oxide. Due to iron's staining characteristics, concentrations of only a few tenths of a milligram per liter can make it unsuitable for many domestic and industrial uses. Iron is a necessary element in the formation of many plant and animal porphyrins. The oxidized iron precipitates have done damage to aquatic organisms by the smothering and coating action which is characteristic of these flocs.

4. Lead

Although this element is often released from galena and limestone, much of the lead in natural waters results from the wide use of lead as a gasoline additive and its subsequent dispersal in engine exhaust. Lead is also widely used in plumbing and is released as a corrosion product.

At a pH greater than 4.5 lead is precipated from solution as the hydroxide or carbonate keeping ambient concentrations moderately low. In view of the Drinking Water Standards setting a mandatory limit of 0.05 mg/l of lead in water delivered to the consumer, and in light of the fact that lead concentrations as low as 0.1 mg/l have been deleterions to fishlife, especially in soft waters, it is evident that the dissolved lead content of surface waters should be restricted to less than 0.05 mg/l where these two beneficial water uses are involved.

5. Manganese

Although present in small quantities, manganese is ubiquitous in occurrence. It is commonly found in its divalent form which is either in solution or adsorbed to the suspended particulate matter. Manganese can also be present in the quadrivalent hydrous oxide form which is also part of the suspended phase in natural waters. Industries may use manganese compounds in a higher valence state, such as potassium permanganate (Mn^{+7}). However, this species is very unstable and reverts to the di- and quadrivalent species in the aquatic environment. Natural sources of manganese include mineral weathering and decomposition of vegative matter. Although manganese is a key micronutrient (necessary for photosynthesis in plants and as an important enzyme activator in animals) and biostimulatory at certain low levels, it

also inhibits the growth of aquatic organisms at slightly higher levels. Concentration limits around 0.05 mg/l for many water uses have been set because of the staining and the deposition of manganese compounds on plumbing fixtures.

6. Vanadium

This element is also essential for the growth of green plants and is concentrated by aquatic life. Large concentrations of vanadium in oil-bearing strata are further concentrated in the fly-ash from burning coal and oil and same is released to the atmosphere. In this manner, the element finds its way into the environment.

Its concentration in natural waters is often quite low because of the solubility of its compounds. Whether any concentrations of vanadium are actually harmful to aquatic life has not been adequately demonstrated. The EPA found no reports in the literature on the toxicity of vanadium to marine organisms.

7. Zinc

Zinc is abundant in rocks and ores but is only a minor constituent in natural waters because of the solubility of its compounds. Because it is a micronutrient for algal growth, zinc is released to the aquatic environment by decomposition processes. Zinc is also found in most industrial wastes, resulting from corrosion of galvanized iron and brass in condensing, cooling, and distribution systems, and from its use as a corrosion inhibitor. This metal is quite toxic at low levels for freshwater aquatic life and fish. The major concern with zinc compounds in marine waters is not one of acute toxicity, but rather of the long-term sub-lethal effects of the metallic compounds and complexes.

E. SOLIDS AND OTHER WATER PARAMETERS

1. Total Suspended Solids

This test represents the isolation of the materials causing turbidity in water. These materials include sand, clay, finely divided organic matter, bacteria, and plankton. Agricultural runoff, construction activities, industrial operations, storm sewers, and municipal wastes all contribute suspended solids to the water. The composition and concentrations of suspended particles in surface waters are important because of their effect on light penetration, temperature, solubility products, and aquatic life. The interference with light penetration limits the biological production of oxygen and organic matter.

2. Turbidity

Turbidity refers to the measurement of opacity or light-scattering in water. It expresses the extent to which suspended matter in the water inhibits the penetration of light because of scattering and absorption. Turbidity results are generally expressed in Jackson Turbidity Units (JTU). Secchi disc measurements also give a measure of turbidity or water clarity by determining the depth in meters at which a circular white disk disappears from view when lowered into the water. Turbidity may have an impact upon fisheries in a body of water by inhabiting growth or egg and larvae development, interfering with natural movements, reducing the availability of food, and reducing the fish's ability to capture food organisms.

3. Total Solids

Total solids is a measure of the dissolved and suspended solids obtained by the weight of the residue remaining after evaporation of the volatile portion of an aliquot of the whole water sample (see the sections on total dissolved solids and total suspended solids).

4. Total Volatile Solids

Total volatile solids is a measure of organic material or other volatile matter in the solids fraction driven off by ignition in a muffle furnace at 550°C. While the method is supposed to measure organic carbon it also included a water of crystallization measurement under certain circumstances.

5. Phenols

The term phenol generally refers to phenol and phenolic type compounds which react with 4-aminoantipyrene to yield a measureable color intensity. Phenols and chlorinated or phenylated derivatives represent a major class of cooling tower biocides. These compounds are also found in domestic and animal wastes, in other industrial discharges, and in the decomposition of organic matter, especially deciduous leaves. In domestic waters, phenols, particularly halogenated phenols, impart a medicinal taste at relatively low concentrations. Phenolic compounds may also affect fish in two ways, by their direct toxic action and by imparting a taste or otherwise tainting their flesh. Reported concentrations of phenolic compounds which are toxic to aquatic life vary widely because of the applicable antagonistic and synergistic effects of other dissolved substances present. Phenols are used in larger concentrations as a disinfectant for bacteria and other microorganisms.

6. pH

pH is a measurement which is defined as the negative logarithm (base 10) of the hydrogen ion concentration. The pH scale ranges from 0 to 14 with a pH of 7 representing neutral conditions, i.e., equal concentrations of hydrogen (acid) and hydroxyl (base) ions. Values of pH less than 7 indicate progressively increasing acidity, while pH values greater than 7 denote increasing alkalinity. The pH value is an effective parameter for predicting chemical and biological properties of aqueous solutions. Extremes of pH can exert stress conditions or kill aquatic life outright. Even moderate changes from acceptable criteria limits of pH are deleterious to some aquatic species. Since pH controls the degree of dissociation of many substances (i.e., ammonia, sulfide, cyanides, etc.); and since the undissociated compounds are frequently more toxic than the ionic forms, pH may be a highly significant factor in determining limiting or threshold concentrations. The pH also determines the distribution of species in the nutrient cycles described earlier in this section.

While the pH of natural fresh waters generally lies between 6.0 and 8.5, photosynthesis or caustic additions can increase this value to 9.0 or higher. Natural waters with high concentrations of carbon dioxide or that are influenced by other acidity releasing reactions, such as sulfur oxidation, can reach pH values lower than 4.5. A solution is said to be buffered if its pH is not greatly changed by addition of moderate quantities of acid or base. The ocean represents a buffered aquatic system where pH rarely fluctuates outside the range between 8.0 and 8.3.

7. Temperature

Changes in water bodies or streams may result from natural climatic phenomena or from the introduction of industrial wastes such as condenser cooling waters. Temperature is an important factor in properly determining the quality of waters. It affects the palatability of water, treatment processes, the value of water for many industrial uses (including cooling processes), and its suitability as a habitat for aquatic life. Temperature is a major factor in determining the effect of pollution on aquatic organisms. The resistance of fish to certain toxin substances has been shown to vary widely with temperature. Dissolved oxygen concentration are temperature dependent as previously discussed. Because oxygen is more soluble in cold water, the reduction of DO by pollution is especially serious during periods of high temperature when oxygen levels are already low. Increased temperature also accelerate biological activity including that of the oxygen utilizing bacteria which decompose organic wastes. These pollutional effects may be especially serious when low flow conditions coincide with high temperatures.

APPENDIX VII-C

APPENDIX VII-C

RESULTS OF
MONTHLY WATER QUALITY SAMPLING

ALPHABETICAL LISTING OF PARAMETERS WITH ABBREVIATION

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Alkalinity	ALK	mg/l $CaCO_3$
Biochemical Oxygen Demand (Total)	TBOD	mg/l
Biochemical Oxygen Demand (Filtered)	FBOD	mg/l
Carbon Dioxide	CO_2	mg/l
Chemical Oxygen Demand (Total)	TCOD	mg/l
Chemical Oxygen Demand (Filtered)	FCOD	mg/l
Chloride	Cl	mg/l
Chlorophyll-A	Chla	µg/l
Coliforms:		
Total Coliform	TCol	# Colonies/100ml
Fecal Coliform	FCol	# Colonies/100ml
Color	Col	CU
Cyanide	CN	mg/l
Dissolved Oxygen (Lab Measurement)	DO	mg/l
Dissolved Oxygen (Field Measurement)	FDO	mg/l
Fluoride	F	mg/l
Nitrogen:		
Ammonia Nitrogen	NH_3N	mg/l N
Organic Nitrogen (Total)	ORGN	mg/l N
Organic Nitrogen (Dissolved/Filtered)	ORND	mg/l N
Total Kjeldahl Nitrogen	TKN	mg/l N
Nitrate Nitrogen	NO_3N	mg/l N
Nitrite Nitrogen (Total)	NO_2N	mg/l N
Nitrite Nitrogen (Filtered)	NO_2F	mg/l N
Oil & Grease	OG	mg/l
pH (Lab Measurement)	pH	

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
(Field Measurement)	FpH	
Phenols	Phl	mg/l
Phosphorus:		
Ortho-Phosphate	OP	mg/l P
Total Phosphorus	TP	mg/l P
Salinity (Field)	FSAL	ppt
Settleable Residue	SetR	ml/l/hr
Solids:		
Total Solids	TS	mg/l
Total Dissolved Solids	TDS	mg/l
Total Volatile Solids	TVS	mg/l
Total Suspended Solids	TSS	mg/l
Volatile Suspended Solids	VSS	mg/l
Specific Conductance:		
(Lab Measurements)	SpC	µmhos/cm at 25° C
(Field Measurements)	FCon	µmhos/cm at 25° C
Sulfate	SO_4	mg/l
Surfactant	Sur	µm/l LAS
Temperature	T	^{o}F
Total Hardness	TH	mg/l $CaCO_3$
Total Inorganic Carbon (Total)	TTIC	mg/l
Total Inorganic Carbon (Filtered)	FTIC	mg/l
Total Organic Carbon (Total)	TTOC	mg/l
Total Organic Carbon (Filtered)	FTOC	mg/l
Turbidity	Tur	FTU

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals		
Aluminum	Al	mg/l
Antimony	Sb	mg/l
Arsenic	As	mg/l
Barium	Ba	mg/l
Beryllium	Be	mg/l
Cadmium	Cd	mg/l
Calcium	Ca	mg/l
Chromium	Cr	mg/l
Cobalt	Co	mg/l
Copper	Cu	mg/l
Iron	Fe	mg/l
Lead	Pb	mg/l
Magnesium	Mg	mg/l
Manganese	Mn	mg/l
Mercury	Hg	mg/l
Molybdenum	Mo	mg/l
Nickel	Ni	mg/l
Potassium	K	mg/l
Selenium	Se	mg/l
Silicon	Si	mg/l
Silver	Ag	mg/l
Sodium	Na	mg/l
Thallium	Tl	mg/l
Tin	Sn	mg/l
Titanium	Ti	mg/l

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals Cont'd.		
Vanadium	V	mg/l
Zinc	Zn	mg/l

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14989	17632	CH-1	73/05/29	14:10	1.0		68.2	60.0	GRAB	MO	9	9	0.55	6	0.000	0.025	0.025
17199	17632	CH-1	73/06/19	16:05	1.0		68.2	60.0	GRAB	MO	10	3	0.55	6	0.000	0.018	0.056
21199	17632	CH-1	73/07/30	11:25	1.0		68.2	55.0	GRAB	MO	3	7	0.00	6	0.015	0.000	0.040
23499	17632	CH-1	73/08/22	9:40	1.0		68.2	60.0	GRAB	MO	17	7	0.49	11	0.020	0.000	0.036
27697	17632	CH-1	73/10/03	13:20	1.0		68.2	60.0	GRAB	MO	10	1	0.35	16	0.000	0.000	0.006
29899	17632	CH-1	73/10/24	13:17	1.0		68.2	60.0	GRAB	MO	5	26	0.45	50	0.035	0.000	0.050
33295	17632	CH-1	73/11/27	11:15	1.0		68.2	55.0	GRAB	MO	11	12	0.30	18	0.003	0.024	0.102
301	17632	CH-1	74/01/03	11:30	1.0		68.2	60.0	GRAB	MO	5	85	0.63	11	0.000	0.035	0.040

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14989	17632	CH-1	73/05/29	14:10	1.0		68.2	60.0	GRAB	MO	43.0	0.2	0.03
17199	17632	CH-1	73/06/19	16:05	1.0		68.2	60.0	GRAB	MO	46.0	0.0	0.08
21199	17632	CH-1	73/07/30	11:25	1.0		68.2	55.0	GRAB	MO	55.0	0.0	0.09
23499	17632	CH-1	73/08/22	9:40	1.0		68.2	60.0	GRAB	MO	61.0	0.0	0.08
27697	17632	CH-1	73/10/03	13:20	1.0		68.2	60.0	GRAB	MO	60.0	0.0	0.08
29899	17632	CH-1	73/10/24	13:17	1.0		68.2	60.0	GRAB	MO	59.0	0.0	0.05
33295	17632	CH-1	73/11/27	11:15	1.0		68.2	55.0	GRAB	MO	56.0	0.0	0.02
301	17632	CH-1	74/01/03	11:30	1.0		68.2	60.0	GRAB	MO	44.0	0.1	0.07

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14989	17632	CH-1	73/05/29	14:10	1.0		68.2	60.0	GRAB	MO	125	6	12	1	0.38	9	54.00
17199	17632	CH-1	73/06/19	16:05	1.0		68.2	60.0	GRAB	MO	100	6	15	2	0.76	10	71.20
21199	17632	CH-1	73/07/30	11:25	1.0		68.2	55.0	GRAB	MO	160	6	17	1	0.27	3	
23499	17632	CH-1	73/08/22	9:40	1.0		68.2	60.0	GRAB	MO	140	11	13	1	0.47	17	
27697	17632	CH-1	73/10/03	13:20	1.0		68.2	60.0	GRAB	MO	160	16	21	1	0.37	10	71.60
29899	17632	CH-1	73/10/24	13:17	1.0		68.2	60.0	GRAB	MO	210	50	27	1	0.37	5	71.60
33295	17632	CH-1	73/11/27	11:15	1.0		68.2	55.0	GRAB	MO	155	18	28	0	0.73	11	46.40
301	17632	CH-1	74/01/03	11:30	1.0		68.2	60.0	GRAB	MO	75	11	16	2	0.70	5	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14989	17632	CH-1	73/05/29	14:10	1.0		68.2	60.0	GRAB	MO	7.7	25	135
17199	17632	CH-1	73/06/19	16:05	1.0		68.2	60.0	GRAB	MO	7.6	16	105
21199	17632	CH-1	73/07/30	11:25	1.0		68.2	55.0	GRAB	MO	7.8	80	170
23499	17632	CH-1	73/08/22	9:40	1.0		68.2	60.0	GRAB	MO	7.8	75	150
27697	17632	CH-1	73/10/03	13:20	1.0		68.2	60.0	GRAB	MO	7.6	51	160
29899	17632	CH-1	73/10/24	13:17	1.0		68.2	60.0	GRAB	MO	7.4	59	235
33295	17632	CH-1	73/11/27	11:15	1.0		68.2	55.0	GRAB	MO	6.9	25	165
301	17632	CH-1	74/01/03	11:30	1.0		68.2	60.0	GRAB	MO	7.4	38	160

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INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-1 V=50,60
ENTER JOB NUMBER(S)
□:
      17632
TOTAL NO. OF SAMPLES = 8
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14988	17632	CH-1	73/05/29	14:10	58.0		68.2	60.0	GRAB	MO	23	86	0.80	7	0.000	0.060	0.069
17198	17632	CH-1	73/06/19	16:25	58.0		68.2	60.0	GRAB	MO	12	11	0.60	6	0.004	0.011	0.456
21198	17632	CH-1	73/07/30	11:25	53.0		68.2	55.0	GRAB	MO	20	145	0.00	11	0.035	0.032	0.050
23498	17632	CH-1	73/08/22	9:40	58.0		68.2	60.0	GRAB	MO	14	27	0.33	10	0.000	0.000	0.025
27696	17632	CH-1	73/10/03	13:20	58.0		68.2	60.0	GRAB	MO	9	15	0.15	15	0.000	0.000	0.040
29898	17632	CH-1	73/10/24	13:17	58.0		68.2	60.0	GRAB	MO	15	25	0.62	69	0.030	0.000	0.100
33294	17632	CH-1	73/11/27	11:15	53.0		68.2	55.0	GRAB	MO	19	40	0.40	17	0.050	0.000	0.117
302	17632	CH-1	74/01/03	11:30	58.0		68.2	60.0	GRAB	MO	18	130	0.95	10	0.050	0.035	0.066

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14988	17632	CH-1	73/05/29	14:10	58.0		68.2	60.0	GRAB	MO	43.0	0.0	0.14
17198	17632	CH-1	73/06/19	16:25	58.0		68.2	60.0	GRAB	MO	47.0	0.0	0.11
21198	17632	CH-1	73/07/30	11:25	53.0		68.2	55.0	GRAB	MO	52.0	0.0	0.22
23498	17632	CH-1	73/08/22	9:40	58.0		68.2	60.0	GRAB	MO	58.0	0.0	0.17
27696	17632	CH-1	73/10/03	13:20	58.0		68.2	60.0	GRAB	MO	58.0	0.0	0.08
29898	17632	CH-1	73/10/24	13:17	58.0		68.2	60.0	GRAB	MO	61.0	0.0	0.09
33294	17632	CH-1	73/11/27	11:15	53.0		68.2	55.0	GRAB	MO	58.0	0.0	0.05
302	17632	CH-1	74/01/03	11:30	58.0		68.2	60.0	GRAB	MO	40.0	0.0	0.18

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TROD	NO3N	TCOD	T
14988	17632	CH-1	73/05/29	14:10	58.0		68.2	60.0	GRAB	MO	130	7	13	4	0.50	23	54.00
17198	17632	CH-1	73/06/19	16:25	58.0		68.2	60.0	GRAB	MO	110	6	15	2	0.79	12	70.70
21198	17632	CH-1	73/07/30	11:25	53.0		68.2	55.0	GRAB	MO	175	11	13	1	0.31	20	
23498	17632	CH-1	73/08/22	9:40	58.0		68.2	60.0	GRAB	MO	145	10	14	2	0.56	14	
27696	17632	CH-1	73/10/03	13:20	58.0		68.2	60.0	GRAB	MO	165	15	19	2	0.38	9	70.70
29898	17632	CH-1	73/10/24	13:17	58.0		68.2	60.0	GRAB	MO	250	69	29	3	0.38	15	72.50
33294	17632	CH-1	73/11/27	11:15	53.0		68.2	55.0	GRAB	MO	275	17	30	0	0.82	19	46.40
302	17632	CH-1	74/01/03	11:30	58.0		68.2	60.0	GRAB	MO	75	10	21	2	0.83	18	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14988	17632	CH-1	73/05/29	14:10	58.0		68.2	60.0	GRAB	MO	7.6	45	220
17198	17632	CH-1	73/06/19	16:25	58.0		68.2	60.0	GRAB	MO	7.5	28	130
21198	17632	CH-1	73/07/30	11:25	53.0		68.2	55.0	GRAB	MO	7.8	85	320
23498	17632	CH-1	73/08/22	9:40	58.0		68.2	60.0	GRAB	MO	7.8	85	175
27696	17632	CH-1	73/10/03	13:20	58.0		68.2	60.0	GRAB	MO	7.5	82	180
29898	17632	CH-1	73/10/24	13:17	58.0		68.2	60.0	GRAB	MO	7.0	72	276
33294	17632	CH-1	73/11/27	11:15	53.0		68.2	55.0	GRAB	MO	6.9	120	315
302	17632	CH-1	74/01/03	11:30	58.0		68.2	60.0	GRAB	MO	7.5	37	205

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INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-2 ▽=0,2
ENTER JOB NUMBER(S)
□:
      17632
TOTAL NO. OF SAMPLES = 8
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14987	17632	CH-2	73/05/29	15:10	1.0		66.7	25.0	GRAB	MO	13	23	0.70	4	0.000	0.010	0.025
17197	17632	CH-2	73/06/19	16:35	1.0		66.7	25.0	GRAB	MO	16	16	0.89	6	0.004	0.000	0.144
21197	17632	CH-2	73/07/30	11:55	1.0		66.7	25.0	GRAB	MO	7	35	0.15	8	0.020	0.000	0.011
23497	17632	CH-2	73/08/22	10:00	1.0		66.7	25.0	GRAB	MO	5	11	0.34	10	0.011	0.000	0.022
27699	17632	CH-2	73/10/03	13:40	1.0		66.7	25.0	GRAB	MO	9	3	0.25	16	0.000	0.000	0.000
29890	17632	CH-2	73/10/24	12:50	1.0		66.7	25.0	GRAB	MO	25	15	0.78	47	0.015	0.000	0.080
33297	17632	CH-2	73/11/27	10:30	1.0		66.7	25.0	GRAB	MO	12	24	0.80	18	0.000	0.024	0.097
303	17632	CH-2	74/01/03	11:46	1.0		66.7	25.0	GRAB	MO	3	70	0.35	11	0.050	0.014	0.031

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14987	17632	CH-2	73/05/29	15:10	1.0		66.7	25.0	GRAB	MO	43.0	0.0	0.06
17197	17632	CH-2	73/06/19	16:35	1.0		66.7	25.0	GRAB	MO	46.0	0.0	0.11
21197	17632	CH-2	73/07/30	11:55	1.0		66.7	25.0	GRAB	MO	53.0	0.0	0.12
23497	17632	CH-2	73/08/22	10:00	1.0		66.7	25.0	GRAB	MO	58.0	0.0	0.12
27699	17632	CH-2	73/10/03	13:40	1.0		66.7	25.0	GRAB	MO	54.0	0.0	0.08
29890	17632	CH-2	73/10/24	12:50	1.0		66.7	25.0	GRAB	MO	57.0	0.0	0.08
33297	17632	CH-2	73/11/27	10:30	1.0		66.7	25.0	GRAB	MO	56.0	0.1	0.03
303	17632	CH-2	74/01/03	11:46	1.0		66.7	25.0	GRAB	MO	40.0	0.1	0.10

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14987	17632	CH-2	73/05/29	15:10	1.0		66.7	25.0	GRAB	MO	110	4	10	1	0.43	13	54.00
17197	17632	CH-2	73/06/19	16:35	1.0		66.7	25.0	GRAB	MO	95	6	13	4	0.76	16	71.40
21197	17632	CH-2	73/07/30	11:55	1.0		66.7	25.0	GRAB	MO	185	8	16	1	0.34	7	
23497	17632	CH-2	73/08/22	10:00	1.0		66.7	25.0	GRAB	MO	170	10	14	1	0.48	5	
27699	17632	CH-2	73/10/03	13:40	1.0		66.7	25.0	GRAB	MO	150	16	22	2	0.48	9	72.00
29890	17632	CH-2	73/10/24	12:50	1.0		66.7	25.0	GRAB	MO	210	47	27	2	0.41	25	71.60
33297	17632	CH-2	73/11/27	10:30	1.0		66.7	25.0	GRAB	MO	210	18	27	0	0.77	12	48.20
303	17632	CH-2	74/01/03	11:46	1.0		66.7	25.0	GRAB	MO	135	11	17	1	0.75	3	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14987	17632	CH-2	73/05/29	15:10	1.0		66.7	25.0	GRAB	MO	7.8	35	135
17197	17632	CH-2	73/06/19	16:35	1.0		66.7	25.0	GRAB	MO	7.4	25	110
21197	17632	CH-2	73/07/30	11:55	1.0		66.7	25.0	GRAB	MO	7.8	75	220
23497	17632	CH-2	73/08/22	10:00	1.0		66.7	25.0	GRAB	MO	7.8	90	180
27699	17632	CH-2	73/10/03	13:40	1.0		66.7	25.0	GRAB	MO	7.5	62	155
29890	17632	CH-2	73/10/24	12:50	1.0		66.7	25.0	GRAB	MO	7.6	88	225
33297	17632	CH-2	73/11/27	10:30	1.0		66.7	25.0	GRAB	MO	6.9	60	235
303	17632	CH-2	74/01/03	11:46	1.0		66.7	25.0	GRAB	MO	7.5	95	205

```
INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-2 ∇=22,25
ENTER JOB NUMBER(S)
□:
      17632
TOTAL NO. OF SAMPLES = 8
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14986	17632	CH-2	73/05/29	15:10	23.0		66.7	25.0	GRAB	MO	14	40	0.65	7	0.000	0.020	0.047
17196	17632	CH-2	73/06/19	16:40	23.0		66.7	25.0	GRAB	MO	155	560	3.64	8	0.000	0.080	0.180
21196	17632	CH-2	73/07/30	12:00	23.0		66.7	25.0	GRAB	MO	10	70	0.20	7	0.015	0.012	0.000
23496	17632	CH-2	73/08/22	10:00	23.0		66.7	25.0	GRAB	MO	15	25	0.38	10	0.029	0.084	0.031
27698	17632	CH-2	73/10/03	13:40	23.0		66.7	25.0	GRAB	MO	8	9	0.20	16	0.000	0.000	0.098
29889	17632	CH-2	73/10/24	12:50	23.0		66.7	25.0	GRAB	MO	12	21	0.56	73	0.015	0.000	0.140
33296	17632	CH-2	73/11/27	10:30	23.0		66.7	25.0	GRAB	MO	34	210	0.50	19	0.003	0.000	0.158
304	17632	CH-2	74/01/03	11:46	23.0		66.7	25.0	GRAB	MO	12	100	0.15	12	0.050	0.018	0.029

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14986	17632	CH-2	73/05/29	15:10	23.0		66.7	25.0	GRAB	MO	45.0	0.0	0.08
17196	17632	CH-2	73/06/19	16:40	23.0		66.7	25.0	GRAB	MO	54.0	0.2	1.43
21196	17632	CH-2	73/07/30	12:00	23.0		66.7	25.0	GRAB	MO	54.0	0.0	0.15
23496	17632	CH-2	73/08/22	10:00	23.0		66.7	25.0	GRAB	MO	58.0	0.0	0.15
27698	17632	CH-2	73/10/03	13:40	23.0		66.7	25.0	GRAB	MO	56.0	0.0	0.08
29889	17632	CH-2	73/10/24	12:50	23.0		66.7	25.0	GRAB	MO	60.0	0.0	0.08
33296	17632	CH-2	73/11/27	10:30	23.0		66.7	25.0	GRAB	MO	58.0	0.0	0.27
304	17632	CH-2	74/01/03	11:46	23.0		66.7	25.0	GRAB	MO	43.0	0.0	0.13

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14986	17632	CH-2	73/05/29	15:10	23.0		66.7	25.0	GRAB	MO	120	7	12	2	0.48	14	54.00
17196	17632	CH-2	73/06/19	16:40	23.0		66.7	25.0	GRAB	MO	310	8	19	9	1.58	155	71.40
21196	17632	CH-2	73/07/30	12:00	23.0		66.7	25.0	GRAB	MO	185	7	16	0	0.27	10	
23496	17632	CH-2	73/08/22	10:00	23.0		66.7	25.0	GRAB	MO	230	10	15	1	0.52	15	
27698	17632	CH-2	73/10/03	13:40	23.0		66.7	25.0	GRAB	MO	150	16	20	1	0.47	8	70.90
29889	17632	CH-2	73/10/24	12:50	23.0		66.7	25.0	GRAB	MO	270	73	27	2	0.38	12	71.60
33296	17632	CH-2	73/11/27	10:30	23.0		66.7	25.0	GRAB	MO	125	18	25	1	0.50	34	47.30
304	17632	CH-2	74/01/03	11:46	23.0		66.7	25.0	GRAB	MO	170	12	18	1	0.73	12	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14986	17632	CH-2	73/05/29	15:10	23.0		66.7	25.0	GRAB	MO	7.8	45	160
17196	17632	CH-2	73/06/19	16:40	23.0		66.7	25.0	GRAB	MO	7.4	110	870
21196	17632	CH-2	73/07/30	12:00	23.0		66.7	25.0	GRAB	MO	7.7	85	255
23496	17632	CH-2	73/08/22	10:00	23.0		66.7	25.0	GRAB	MO	7.8	140	255
27698	17632	CH-2	73/10/03	13:40	23.0		66.7	25.0	GRAB	MO	7.6	57	160
29889	17632	CH-2	73/10/24	12:50	23.0		66.7	25.0	GRAB	MO	7.1	94	290
33296	17632	CH-2	73/11/27	10:30	23.0		66.7	25.0	GRAB	MO	6.9	35	335
304	17632	CH-2	74/01/03	11:46	23.0		66.7	25.0	GRAB	MO	7.3	80	270

```
INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
 TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
 ENTER RESTRICTION KEY   D=730501,740110 S=CH-3 ∇=0,2
 ENTER JOB NUMBER(S)
 □:
      17631
 TOTAL NO. OF SAMPLES = 8
 ENTER A 1 FOR OUTPUT TO TSP LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
 □:
      2
 POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14985	17631	CH-3	73/05/29	15:30	1.0		66.2	25.0	GRAB	MO	14	28	0.50	7	0.000	0.000	0.056
17195	17631	CH-3	73/06/19	16:55	1.0		66.2	25.0	GRAB	MO	20	13	1.31	7	0.000	0.018	0.090
21195	17631	CH-3	73/07/30	12:25	1.0		66.2	25.0	GRAB	MO	4	16	0.25	9	0.000	0.018	0.190
23493	17631	CH-3	73/08/22	10:10	1.0		66.2	25.0	GRAB	MO	11	22	0.23	5	0.111	0.000	0.008
27693	17631	CH-3	73/10/03	14:00	1.0		66.2	25.0	GRAB	MO	13	9	0.40	14	0.015	0.000	0.000
29888	17631	CH-3	73/10/24	14:35	1.0		66.2	25.0	GRAB	MO	10	20	0.84	93	0.040	0.000	0.070
33299	17631	CH-3	73/11/27	10:02	1.0		66.2	25.0	GRAB	MO	13	17	0.90	19	0.000	0.000	0.112
305	17631	CH-3	74/01/03	12:00	1.0		66.2	25.0	GRAB	MO	7	70	0.65	12	0.050	0.017	0.037

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14985	17631	CH-3	73/05/29	15:30	1.0		66.2	25.0	GRAB	MO	46.0	0.0	0.06
17195	17631	CH-3	73/06/19	16:55	1.0		66.2	25.0	GRAB	MO	46.0	0.1	0.11
21195	17631	CH-3	73/07/30	12:25	1.0		66.2	25.0	GRAB	MO	54.0	0.0	0.09
23493	17631	CH-3	73/08/22	10:10	1.0		66.2	25.0	GRAB	MO	61.0	0.0	0.09
27693	17631	CH-3	73/10/03	14:00	1.0		66.2	25.0	GRAB	MO	59.0	0.0	0.06
29888	17631	CH-3	73/10/24	14:35	1.0		66.2	25.0	GRAB	MO	59.0	0.0	0.07
33299	17631	CH-3	73/11/27	10:02	1.0		66.2	25.0	GRAB	MO	56.0	0.0	0.05
305	17631	CH-3	74/01/03	12:00	1.0		66.2	25.0	GRAB	MO	43.0	0.1	0.08

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14985	17631	CH-3	73/05/29	15:30	1.0		66.2	25.0	GRAB	MO	110	7	12	2	0.41	14	55.00
17195	17631	CH-3	73/06/19	16:55	1.0		66.2	25.0	GRAB	MO	115	7	15	4	0.79	20	69.60
21195	17631	CH-3	73/07/30	12:25	1.0		66.2	25.0	GRAB	MO	195	9	16	1	0.29	4	
23493	17631	CH-3	73/08/22	10:10	1.0		66.2	25.0	GPAB	MO	200	5	15	1	0.56	11	
27693	17631	CH-3	73/10/03	14:00	1.0		66.2	25.0	GRAB	MO	260	14	18	1	0.41	13	71.60
29888	17631	CH-3	73/10/24	14:35	1.0		66.2	25.0	GRAB	MO	285	93	31	2	0.37	10	71.60
33299	17631	CH-3	73/11/27	10:02	1.0		66.2	25.0	GRAB	MO	190	19	28	0	0.73	13	48.20
305	17631	CH-3	74/01/03	12:00	1.0		66.2	25.0	GRAB	MO	80	12	18	2	0.54	7	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14985	17631	CH-3	73/05/29	15:30	1.0		66.2	25.0	GRAB	MO	7.4	75	140
17195	17631	CH-3	73/06/19	16:55	1.0		66.2	25.0	GRAB	MO	7.4	33	130
21195	17631	CH-3	73/07/30	12:25	1.0		66.2	25.0	GRAB	MO	7.7	75	210
23493	17631	CH-3	73/08/22	10:10	1.0		66.2	25.0	GRAB	MO	7.8	125	220
27693	17631	CH-3	73/10/03	14:00	1.0		66.2	25.0	GRAB	MO	7.7	185	270
29888	17631	CH-3	73/10/24	14:35	1.0		66.2	25.0	GRAB	MO	7.6	56	305
33299	17631	CH-3	73/11/27	10:02	1.0		66.2	25.0	GRAB	MO	6.9	69	205
305	17631	CH-3	74/01/03	12:00	1.0		66.2	25.0	GRAB	MO	7.5	16	150

```
INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-3 ▽=22,25
ENTER JOB NUMBER(S)
□:
      17631
TOTAL NO. OF SAMPLES = 8
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14984	17631	CH-3	73/05/29	15:30	23.0		66.2	25.0	GRAB	MO	19	67	0.80	6	0.000	0.033	0.081
17194	17631	CH-3	73/06/19	17:00	23.0		66.2	60.0	GRAB	MO	62	180	2.47	7	0.017	0.000	0.200
21194	17631	CH-3	73/07/30	12:35	23.0		66.2	25.0	GRAB	MO	13	81	0.53	9	0.000	0.000	0.000
23492	17631	CH-3	73/08/22	10:10	23.0		66.2	25.0	GRAB	MO	10	26	0.33	16	0.177	0.000	0.028
27692	17631	CH-3	73/10/03	14:00	23.0		66.2	25.0	GRAB	MO	7	16	0.40	13	0.000	0.000	0.010
29887	17631	CH-3	73/10/24	14:35	23.0		66.2	25.0	GRAB	MO	48	240	0.67	150	0.010	0.000	0.140
33298	17631	CH-3	73/11/27	10:02	23.0		66.2	25.0	GRAB	MO	13	27	0.50	19	0.000	0.000	0.107
306	17631	CH-3	74/01/03	12:00	23.0		66.2	25.0	GRAB	MO	22	180	0.56	11	0.100	0.025	0.077

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14984	17631	CH-3	73/05/29	15:30	23.0		66.2	25.0	GRAB	MO	43.0	0.0	0.14
17194	17631	CH-3	73/06/19	17:00	23.0		66.2	60.0	GRAB	MO	48.0	0.1	0.60
21194	17631	CH-3	73/07/30	12:35	23.0		66.2	25.0	GRAB	MO	55.0	0.1	0.18
23492	17631	CH-3	73/08/22	10:10	23.0		66.2	25.0	GRAB	MO	59.0	0.0	0.15
27692	17631	CH-3	73/10/03	14:00	23.0		66.2	25.0	GRAB	MO	58.0	0.0	0.09
29887	17631	CH-3	73/10/24	14:35	23.0		66.2	25.0	GRAB	MO	59.0	0.0	0.47
33298	17631	CH-3	73/11/27	10:02	23.0		66.2	25.0	GRAB	MO	57.0	0.0	0.06
306	17631	CH-3	74/01/03	12:00	23.0		66.2	25.0	GRAB	MO	43.0	0.1	0.26

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TROD	NO3N	TCOD	T
14984	17631	CH-3	73/05/29	15:30	23.0		66.2	25.0	GRAB	MO	130	6	12	1	0.50	19	55.00
17194	17631	CH-3	73/06/19	17:00	23.0		66.2	60.0	GRAB	MO	110	7	11	5	1.50	62	69.40
21194	17631	CH-3	73/07/30	12:35	23.0		66.2	25.0	GRAB	MO	165	9	15	1	0.37	13	
23492	17631	CH-3	73/08/22	10:10	23.0		66.2	25.0	GRAB	MO	200	16	15	1	0.56	10	
27692	17631	CH-3	73/10/03	14:00	23.0		66.2	25.0	GRAB	MO	425	13	20	1	0.49	7	71.40
29887	17631	CH-3	73/10/24	14:35	23.0		66.2	25.0	GRAB	MO	415	150	32	3	0.39	48	71.60
33298	17631	CH-3	73/11/27	10:02	23.0		66.2	25.0	GRAB	MO	240	19	27	0	0.77	13	48.20
306	17631	CH-3	74/01/03	12:00	23.0		66.2	25.0	GRAB	MO	30	11	19	2	0.77	22	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14984	17631	CH-3	73/05/29	15:30	23.0		66.2	25.0	GRAB	MO	7.7	40	200
17194	17631	CH-3	73/06/19	17:00	23.0		66.2	60.0	GRAB	MO	7.5	42	290
21194	17631	CH-3	73/07/30	12:35	23.0		66.2	25.0	GRAB	MO	7.8	105	245
23492	17631	CH-3	73/08/22	10:10	23.0		66.2	25.0	GRAB	MO	7.9	100	225
27692	17631	CH-3	73/10/03	14:00	23.0		66.2	25.0	GRAB	MO	7.6	390	460
29887	17631	CH-3	73/10/24	14:35	23.0		66.2	25.0	GRAB	MO	7.1	110	655
33298	17631	CH-3	73/11/27	10:02	23.0		66.2	25.0	GRAB	MO	6.9	110	270
306	17631	CH-3	74/01/03	12:00	23.0		66.2	25.0	GRAB	MO	7.5	21	210

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INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
R
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-4 ▽=0,2
ENTER JOB NUMBER(S)
□:
      17631
TOTAL NO. OF SAMPLES = 8
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14983	17631	CH-4	73/05/29	15:55	2.0		66.5	80.0	GRAB	MO	12	9	0.70	4	0.000	0.000	0.036
17193	17631	CH-4	73/06/19	17:15	1.0		66.5	80.0	GRAB	MO	16	2	0.82	7	0.010	0.012	0.030
21193	17632	CH-4	73/07/30	12:45	1.0		66.5	80.0	GRAB	MO	3	8	0.39	9	0.000	0.000	0.000
23491	17631	CH-4	73/08/22	10:30	1.0		66.5	80.0	GRAP	MO	10	8	0.14	10	0.283	0.085	0.020
27691	17632	CH-4	73/10/03	14:20	1.0		66.5	80.0	GRAB	MO	8	8	0.20	15	0.000	0.000	0.016
29895	17631	CH-4	73/10/24	14:10	1.0		66.5	80.0	GRAB	MO	14	1	0.34	114	0.030	0.000	0.070
33289	17631	CH-4	73/11/27	9:40	1.0		66.5	80.0	GRAB	MO	12	7	0.30	17	0.000	0.000	0.071
307	17631	CH-4	74/01/03	12:20	1.0		66.5	80.0	GRAB	MO	3	55	0.28	10	0.150	0.027	0.026

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14983	17631	CH-4	73/05/29	15:55	2.0		66.5	80.0	GRAB	MO	43.0	0.0	0.09
17193	17631	CH-4	73/06/19	17:15	1.0		66.5	80.0	GRAB	MO	47.0	0.1	0.08
21193	17632	CH-4	73/07/30	12:45	1.0		66.5	80.0	GRAB	MO	56.0	0.0	0.08
23491	17631	CH-4	73/08/22	10:30	1.0		66.5	80.0	GRAB	MO	61.0	0.0	0.13
27691	17632	CH-4	73/10/03	14:20	1.0		66.5	80.0	GRAB	MO	58.0	0.0	0.07
29895	17631	CH-4	73/10/24	14:10	1.0		66.5	80.0	GRAB	MO	58.0	0.0	0.05
33289	17631	CH-4	73/11/27	9:40	1.0		66.5	80.0	GRAB	MO	57.0	0.0	0.81
307	17631	CH-4	74/01/03	12:20	1.0		66.5	80.0	GRAB	MO	44.0	0.1	0.09

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14983	17631	CH-4	73/05/29	15:55	2.0		66.5	80.0	GRAB	MO	110	4	11	1	0.41	12	55.00
17193	17631	CH-4	73/06/19	17:15	1.0		66.5	80.0	GRAB	MO	98	7	15	4		16	72.30
21193	17632	CH-4	73/07/30	12:45	1.0		66.5	80.0	GRAB	MO	195	9	15	1	0.27	3	
23491	17631	CH-4	73/08/22	10:30	1.0		66.5	80.0	GRAB	MO	150	10	15	1	0.45	10	
27691	17632	CH-4	73/10/03	14:20	1.0		66.5	80.0	GRAB	MO	285	15	16	1	0.40	8	71.60
29895	17631	CH-4	73/10/24	14:10	1.0		66.5	80.0	GRAB	MO	350	114	33	2	0.40	14	72.00
33289	17631	CH-4	73/11/27	9:40	1.0		66.5	80.0	GRAB	MO	245	17	28	0	0.69	12	47.30
307	17631	CH-4	74/01/03	12:20	1.0		66.5	80.0	GRAB	MO	90	10	24	1	0.69	3	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14983	17631	CH-4	73/05/29	15:55	2.0		66.5	80.0	GRAB	MO	7.8	40	120
17193	17631	CH-4	73/06/19	17:15	1.0		66.5	80.0	GRAB	MO	7.5	2	100
21193	17632	CH-4	73/07/30	12:45	1.0		66.5	80.0	GRAB	MO	7.9	90	205
23491	17631	CH-4	73/08/22	10:30	1.0		66.5	80.0	GRAB	MO	7.9	50	160
27691	17632	CH-4	73/10/03	14:20	1.0		66.5	80.0	GRAB	MO	7.6	210	295
29895	17631	CH-4	73/10/24	14:10	1.0		66.5	80.0	GRAB	MO	7.5	85	350
33289	17631	CH-4	73/11/27	9:40	1.0		66.5	80.0	GRAB	MO	6.9	114	255
307	17631	CH-4	74/01/03	12:20	1.0		66.5	80.0	GRAB	MO	7.5	49	145

```
ENTER VARIABLES TO BE DISPLAYED
TCOD,TSS,TKN,CL,PHL,CR,ZN,ALK,NH3N,TP
ENTER RESTRICTION KEY   D=730501,740110 S=CH-4 V=30,40
ENTER JOB NUMBER(S)
□:
      17631,17632
TOTAL NO. OF SAMPLES = 7
ENTER A 1 FOR OUTPUT TO TSR LINE PRINTER, A 2 FOR OUTPUT TO THE TERMINAL
□:
      2
POSITION PAPER AND PRESS RETURN
```

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
17192	17631	CH-4	73/06/19	17:15	40.0		66.5	80.0	GRAB	MO	17	4	1.73	6	0.007	0.033	0.030
21192	17632	CH-4	73/07/30	12:42	40.0		66.5	80.0	GRAB	MO	12	30	0.35	7	0.000	0.024	0.000
23490	17631	CH-4	73/08/22	10:30	40.0		66.5	80.0	GRAB	MO	9	8	0.66	10	0.224	0.000	0.006
27690	17632	CH-4	73/10/03	14:20	40.0		66.5	80.0	GRAB	MO	10	5	0.30	14	0.000	0.000	0.010
29894	17631	CH-4	73/10/24	14:10	40.0		66.5	80.0	GRAB	MO	14	29	0.56	119	0.025	0.000	0.090
33288	17631	CH-4	73/11/27	9:40	40.0		66.5	80.0	GRAB	MO	15	20	0.50	18	0.000	0.024	0.056
308	17631	CH-4	74/01/03	12:20	38.0		66.5	80.0	GRAB	MO	11	70	0.37	12	0.050	0.019	0.040

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
17192	17631	CH-4	73/06/19	17:15	40.0		66.5	80.0	GRAB	MO	47.0	0.0	0.10
21192	17632	CH-4	73/07/30	12:42	40.0		66.5	80.0	GRAB	MO	56.0	0.0	0.12
23490	17631	CH-4	73/08/22	10:30	40.0		66.5	80.0	GRAB	MO	58.0	0.0	0.10
27690	17632	CH-4	73/10/03	14:20	40.0		66.5	80.0	GRAB	MO	60.0	0.0	0.09
29894	17631	CH-4	73/10/24	14:10	40.0		66.5	80.0	GRAB	MO	57.0	0.0	0.06
33288	17631	CH-4	73/11/27	9:40	40.0		66.5	80.0	GRAB	MO	56.0	0.0	0.04
308	17631	CH-4	74/01/03	12:20	38.0		66.5	80.0	GRAB	MO	44.0	0.2	0.25

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
17192	17631	CH-4	73/06/19	17:15	40.0		66.5	80.0	GRAB	MO	125	6	16	5	0.76	17	70.50
21192	17632	CH-4	73/07/30	12:42	40.0		66.5	80.0	GRAB	MO	180	7	15	1	0.29	12	
23490	17631	CH-4	73/08/22	10:30	40.0		66.5	80.0	GRAB	MO	175	10	14	1	0.51	9	
27690	17632	CH-4	73/10/03	14:20	40.0		66.5	80.0	GRAB	MO	250	14	19	1	0.45	10	71.40
29894	17631	CH-4	73/10/24	14:10	40.0		66.5	80.0	GRAB	MO	350	119	31	3	0.38	14	72.50
33288	17631	CH-4	73/11/27	9:40	40.0		66.5	80.0	GRAB	MO	245	18	28	1	0.74	15	47.30
308	17631	CH-4	74/01/03	12:20	38.0		66.5	80.0	GRAB	MO	60	12	20	1	0.84	11	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
17192	17631	CH-4	73/06/19	17:15	40.0		66.5	80.0	GRAB	MO	7.5	25	130
21192	17632	CH-4	73/07/30	12:42	40.0		66.5	80.0	GRAB	MO	7.8	95	211
23490	17631	CH-4	73/08/22	10:30	40.0		66.5	80.0	GRAB	MO	7.9	90	185
27690	17632	CH-4	73/10/03	14:20	40.0		66.5	80.0	GRAB	MO	7.7	190	255
29894	17631	CH-4	73/10/24	14:10	40.0		66.5	80.0	GRAB	MO	7.2	110	380
33288	17631	CH-4	73/11/27	9:40	40.0		66.5	80.0	GRAB	MO	6.9	141	270
308	17631	CH-4	74/01/03	12:20	38.0		66.5	80.0	GRAB	MO	7.4	8	130

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INPUT, MAINTENANCE, ANALYSIS, RETRIEVE, STAT RETRIEVAL OR END?
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CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14982	17631	CH-4	73/05/29	15:55	78.0		66.5	80.0	GRAB	MO	19	84	0.85	6	0.000	0.000	0.068
17191	17631	CH-4	73/06/19	17:25	78.0		66.5	80.0	GRAB	MO	18	0	1.12	7	0.000	0.000	0.020
21191	17632	CH-4	73/07/30	12:40	78.0		66.5	80.0	GRAB	MO	17	110	0.35	0	0.000	0.034	0.695
23489	17631	CH-4	73/08/22	10:30	78.0		66.5	80.0	GRAB	MO	10	16	0.52	9	0.171	0.048	0.006
27689	17632	CH-4	73/10/03	14:20	78.0		66.5	80.0	GRAB	MO	28	325	0.40	17	0.000	0.000	0.005
29893	17631	CH-4	73/10/24	14:10	78.0		66.5	80.0	GRAB	MO	22	67	0.67	130	0.025	0.000	0.070
33287	17631	CH-4	73/11/27	9:40	78.0		66.5	80.0	GRAB	MO	15	14	0.50	18	0.000	0.000	0.092
309	17631	CH-4	74/01/03	12:20	78.0		66.5	80.0	GRAB	MO	11	120	0.45	10	0.050	0.013	0.062

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14982	17631	CH-4	73/05/29	15:55	78.0		66.5	80.0	GRAB	MO	43.0	0.0	0.12
17191	17631	CH-4	73/06/19	17:25	78.0		66.5	80.0	GRAB	MO	48.0	0.0	0.10
21191	17632	CH-4	73/07/30	12:40	78.0		66.5	80.0	GRAB	MO	57.0	0.0	0.19
23489	17631	CH-4	73/08/22	10:30	78.0		66.5	80.0	GRAB	MO	62.0	0.0	0.15
27689	17632	CH-4	73/10/03	14:20	78.0		66.5	80.0	GRAB	MO	58.0	0.0	0.08
29893	17631	CH-4	73/10/24	14:10	78.0		66.5	80.0	GRAB	MO	59.0	0.0	0.15
33287	17631	CH-4	73/11/27	9:40	78.0		66.5	80.0	GRAB	MO	55.0	0.1	0.03
309	17631	CH-4	74/01/03	12:20	78.0		66.5	80.0	GRAB	MO	44.0	0.0	0.14

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14982	17631	CH-4	73/05/29	15:55	78.0		66.5	80.0	GRAB	MO	105	6	12	1	0.45	19	55.00
17191	17631	CH-4	73/06/19	17:25	78.0		66.5	80.0	GRAB	MO	105	7	16	4	0.79	18	70.20
21191	17632	CH-4	73/07/30	12:40	78.0		66.5	80.0	GRAB	MO	185	0	11	1	0.21	17	
23489	17631	CH-4	73/08/22	10:30	78.0		66.5	80.0	GRAB	MO	175	9	14	1	0.55	10	
27689	17632	CH-4	73/10/03	14:20	78.0		66.5	80.0	GRAB	MO	340	17	20	2	0.53	28	71.40
29893	17631	CH-4	73/10/24	14:10	78.0		66.5	80.0	GRAB	MO	430	130	38	2	0.40	22	73.00
33287	17631	CH-4	73/11/27	9:40	78.0		66.5	80.0	GRAB	MO	155	18	28	1	0.75	15	47.30
309	17631	CH-4	74/01/03	12:20	78.0		66.5	80.0	GRAB	MO	185	10	33	1	0.84	11	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	IS
14982	17631	CH-4	73/05/29	15:55	78.0		66.5	80.0	GRAB	MO	7.6	35	190
17191	17631	CH-4	73/06/19	17:25	78.0		66.5	80.0	GRAB	MO	7.1	15	105
21191	17632	CH-4	73/07/30	12:40	78.0		66.5	80.0	GRAB	MO	7.7	75	295
23489	17631	CH-4	73/08/22	10:30	78.0		66.5	80.0	GRAB	MO	7.8	65	190
27689	17632	CH-4	73/10/03	14:20	78.0		66.5	80.0	GRAB	MO	7.7	570	665
29893	17631	CH-4	73/10/24	14:10	78.0		66.5	80.0	GRAB	MO	7.0	130	500
33287	17631	CH-4	73/11/27	9:40	78.0		66.5	80.0	GRAB	MO	6.9	18	170
309	17631	CH-4	74/01/03	12:20	78.0		66.5	80.0	GRAB	MO	7.6	70	305

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14981	17631	CH-5	73/05/29	16:05	1.0		66.5	25.0	GRAB	MO	6	21	0.60	5	0.000	0.000	0.020
17190	17631	CH-5	73/06/19	17:30	1.0		66.5	25.0	GRAB	MO	21	9	1.19	6	0.000	0.000	0.080
21190	17631	CH-5	73/07/30	13:05	1.0		66.5	25.0	GRAB	MO	7	14	0.40	10	0.005	0.087	0.305
23488	17631	CH-5	73/08/22	10:50	1.0		66.5	25.0	GRAB	MO	14	7	0.34	10	0.177	0.000	0.000
27688	17631	CH-5	73/10/03	15:10	1.0		66.5	25.0	MO		9	17	0.30	22	0.000	0.000	0.000
29892	17631	CH-5	73/10/24	13:45	1.0		66.5	25.0	GRAB	MO	26	19	0.45	114	0.005	0.000	0.060
33291	17631	CH-5	73/11/27	9:15	1.0		66.5	30.0	GRAB	MO	9	8	0.60	22	0.005	0.000	0.082
310	17631	CH-5	74/01/03	12:40	1.0		66.5	25.0	GRAB	MO	16	60	0.16	12	0.200	0.011	0.026

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14981	17631	CH-5	73/05/29	16:05	1.0		66.5	25.0	GRAB	MO	43.0	0.0	0.04
17190	17631	CH-5	73/06/19	17:30	1.0		66.5	25.0	GRAB	MO	46.0	0.1	0.09
21190	17631	CH-5	73/07/30	13:05	1.0		66.5	25.0	GRAB	MO	56.0	0.0	0.11
23488	17631	CH-5	73/08/22	10:50	1.0		66.5	25.0	GRAB	MO	59.0	0.0	0.09
27688	17631	CH-5	73/10/03	15:10	1.0		66.5	25.0	MO		49.0	0.0	0.08
29892	17631	CH-5	73/10/24	13:45	1.0		66.5	25.0	GRAB	MO	58.0	0.0	0.07
33291	17631	CH-5	73/11/27	9:15	1.0		66.5	30.0	GRAB	MO	57.0	0.0	0.24
310	17631	CH-5	74/01/03	12:40	1.0		66.5	25.0	GRAB	MO	45.0	0.0	0.08

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14981	17631	CH-5	73/05/29	16:05	1.0		66.5	25.0	GRAB	MO	105	5	12	1	0.30	6	55.00
17190	17631	CH-5	73/06/19	17:30	1.0		66.5	25.0	GRAB	MO	125	6	17	4	0.74	21	71.80
21190	17631	CH-5	73/07/30	13:05	1.0		66.5	25.0	GRAB	MO	190	10	17	1	0.19	7	
23488	17631	CH-5	73/08/22	10:50	1.0		66.5	25.0	GRAB	MO	200	10	16	1	0.52	14	
27688	17631	CH-5	73/10/03	15:10	1.0		66.5	25.0	MO		610	22	19	1	0.43	9	72.00
29892	17631	CH-5	73/10/24	13:45	1.0		66.5	25.0	GRAB	MO	315	114	32	3	0.39	26	72.50
33291	17631	CH-5	73/11/27	9:15	1.0		66.5	30.0	GRAB	MO	170	22	25	1	0.76	9	47.30
310	17631	CH-5	74/01/03	12:40	1.0		66.5	25.0	GRAB	MO	70	12	20	2	0.55	16	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14981	17631	CH-5	73/05/29	16:05	1.0		66.5	25.0	GRAB	MO	7.8	70	125
17190	17631	CH-5	73/06/19	17:30	1.0		66.5	25.0	GRAB	MO	7.4	34	125
21190	17631	CH-5	73/07/30	13:05	1.0		66.5	25.0	GRAB	MO	7.8	125	205
23488	17631	CH-5	73/08/22	10:50	1.0		66.5	25.0	GRAB	MO	7.8	70	210
27688	17631	CH-5	73/10/03	15:10	1.0		66.5	25.0	MO		7.8	540	630
29892	17631	CH-5	73/10/24	13:45	1.0		66.5	25.0	GRAB	MO	7.6	69	335
33291	17631	CH-5	73/11/27	9:15	1.0		66.5	30.0	GRAB	MO	6.9	15	180
310	17631	CH-5	74/01/03	12:40	1.0		66.5	25.0	GRAB	MO	7.8	36	130

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TVH	CL	PHL	CR	ZN
14980	17631	CH-5	73/05/29	16:05	23.0		66.5	25.0	GRAB	MO	12	21	0.55	5	0.000	0.000	0.027
17189	17631	CH-5	73/06/19	17:35	23.0		66.5	25.0	GRAB	MO	13	1	1.27	6	0.000	0.000	0.090
21189	17631	CH-5	73/07/30	13:00	23.0		66.5	25.0	GRAB	MO	9	29	0.35	19	0.000	0.010	0.076
23487	17631	CH-5	73/08/22	10:50	23.0		66.5	25.0	GRAB	MO	5	9	0.17	10	0.165	0.169	0.036
27687	17631	CH-5	73/10/03	15:10	23.0		66.5	25.0	MO		11	56	0.35	16	0.000	0.000	0.013
29891	17631	CH-5	73/10/24	13:45	23.0		66.5	25.0	GRAB	MO	10	21	0.78	161	0.015	0.000	0.110
33290	17631	CH-5	73/11/27	9:15	28.0		66.5	30.0	GRAB	MO	13	22	0.40	19	0.003	0.016	0.082
311	17631	CH-5	74/01/03	12:40	23.0		66.5	25.0	GRAB	MO	13	70	0.00	12	0.100	0.000	0.042

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14980	17631	CH-5	73/05/29	16:05	23.0		66.5	25.0	GRAB	MO	46.0	0.0	0.10
17189	17631	CH-5	73/06/19	17:35	23.0		66.5	25.0	GRAB	MO	47.0	0.1	0.09
21189	17631	CH-5	73/07/30	13:00	23.0		66.5	25.0	GRAB	MO	55.0	0.0	0.12
23487	17631	CH-5	73/08/22	10:50	23.0		66.5	25.0	GRAB	MO	59.0	0.0	0.09
27687	17631	CH-5	73/10/03	15:10	23.0		66.5	25.0	MO		58.0	0.0	0.11
29891	17631	CH-5	73/10/24	13:45	23.0		66.5	25.0	GRAB	MO	62.0	0.0	0.07
33290	17631	CH-5	73/11/27	9:15	28.0		66.5	30.0	GRAB	MO	58.0	0.0	0.07
311	17631	CH-5	74/01/03	12:40	23.0		66.5	25.0	GRAB	MO	44.0	0.0	0.12

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14980	17631	CH-5	73/05/29	16:05	23.0		66.5	25.0	GRAB	MO	110	5	12	1	0.45	12	55.00
17189	17631	CH-5	73/06/19	17:35	23.0		66.5	25.0	GRAB	MO	120	6	16	4	0.76	13	70.90
21189	17631	CH-5	73/07/30	13:00	23.0		66.5	25.0	GRAB	MO	200	19	15	1	0.33	9	
23487	17631	CH-5	73/08/22	10:50	23.0		66.5	25.0	GRAB	MO	170	10	16	1	0.51	5	
27687	17631	CH-5	73/10/03	15:10	23.0		66.5	25.0	MO		245	16	18	1	0.48	11	71.40
29891	17631	CH-5	73/10/24	13:45	23.0		66.5	25.0	GRAB	MO	395	161	35	3	0.40	10	73.00
33290	17631	CH-5	73/11/27	9:15	28.0		66.5	30.0	GRAB	MO	235	19	27	1	0.71	13	48.20
311	17631	CH-5	74/01/03	12:40	23.0		66.5	25.0	GRAB	MO	80	12	23	2	0.77	13	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14980	17631	CH-5	73/05/29	16:05	23.0		66.5	25.0	GRAB	MO	7.8	95	130
17189	17631	CH-5	73/06/19	17:35	23.0		66.5	25.0	GRAB	MO	7.4	39	120
21189	17631	CH-5	73/07/30	13:00	23.0		66.5	25.0	GRAB	MO	7.9	75	230
23487	17631	CH-5	73/08/22	10:50	23.0		66.5	25.0	GRAB	MO	7.8	65	180
27687	17631	CH-5	73/10/03	15:10	23.0		66.5	25.0	MO		7.9	190	305
29891	17631	CH-5	73/10/24	13:45	23.0		66.5	25.0	GRAB	MO	7.1	120	415
33290	17631	CH-5	73/11/27	9:15	28.0		66.5	30.0	GRAB	MO	6.9	91	255
311	17631	CH-5	74/01/03	12:40	23.0		66.5	25.0	GRAB	MO	7.8	31	150

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14979	17631	CH-6	73/05/29	16:35	1.0		62.7	45.0	GRAB	MO	12	3	0.60	4	0.000	0.020	0.012
17188	17631	CH-6	73/06/19	17:45	1.0		62.7	45.0	GRAB	MO	22	3	1.15	6	0.000	0.000	0.070
21188	17631	CH-6	73/07/30	13:30	1.0		62.7	45.0	GRAB	MO	4	9	0.40	8	0.000	0.014	0.000
23495	17631	CH-6	73/08/22	10:10	1.0		62.7	45.0	GRAB	MO	4	9	0.63	11	0.011	0.000	0.014
27695	17631	CH-6	73/10/03	14:50	1.0		72.7	45.0	GRAB	MO	11	6	0.35	28	0.000	0.000	0.032
29897	17631	CH-6	73/10/24	12:00	1.0		62.7	45.0	GRAB	MO	5	70	0.45	166	0.025	0.000	0.050
33293	17631	CH-6	73/11/27	8:35	1.0		62.7	45.0	GRAB	MO	17	17	0.40	20	0.000	0.056	0.092
312	17631	CH-6	74/01/03	13:00	1.0		62.7	45.0	GRAB	MO	6	90	0.06	10	0.050	0.000	0.033

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3N	TP
14979	17631	CH-6	73/05/29	16:35	1.0		62.7	45.0	GRAB	MO	39.0	0.2	0.02
17188	17631	CH-6	73/06/19	17:45	1.0		62.7	45.0	GRAB	MO	45.0	0.1	0.10
21188	17631	CH-6	73/07/30	13:30	1.0		62.7	45.0	GRAB	MO	55.0	0.0	0.10
23495	17631	CH-6	73/08/22	10:10	1.0		62.7	45.0	GRAB	MO	59.0	0.0	0.11
27695	17631	CH-6	73/10/03	14:50	1.0		72.7	45.0	GRAB	MO	60.0	0.0	0.09
29897	17631	CH-6	73/10/24	12:00	1.0		62.7	45.0	GRAB	MO	62.0	0.0	0.06
33293	17631	CH-6	73/11/27	8:35	1.0		62.7	45.0	GRAB	MO	58.0	0.0	0.07
312	17631	CH-6	74/01/03	13:00	1.0		62.7	45.0	GRAB	MO	43.0	0.0	0.09

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCOD	T
14979	17631	CH-6	73/05/29	16:35	1.0		62.7	45.0	GRAB	MO	115	4	10	1	0.41	12	55.00
17188	17631	CH-6	73/06/19	17:45	1.0		62.7	45.0	GRAB	MO	120	6	14	4	0.84	22	70.50
21188	17631	CH-6	73/07/30	13:30	1.0		62.7	45.0	GRAB	MO	185	8	17	1	0.47	4	
23495	17631	CH-6	73/08/22	10:10	1.0		62.7	45.0	GRAB	MO	150	11	15	1	0.48	4	
27695	17631	CH-6	73/10/03	14:50	1.0		72.7	45.0	GRAB	MO	150	28	21	1	0.42	11	73.40
29897	17631	CH-6	73/10/24	12:00	1.0		62.7	45.0	GRAB	MO	410	166	41	2	0.40	5	71.60
33293	17631	CH-6	73/11/27	8:35	1.0		62.7	45.0	GRAB	MO	170	20	28	1	0.75	17	48.20
312	17631	CH-6	74/01/03	13:00	1.0		62.7	45.0	GRAB	MO	150	10	14	1	0.73	6	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14979	17631	CH-6	73/05/29	16:35	1.0		62.7	45.0	GRAB	MO	7.2	55	120
17188	17631	CH-6	73/06/19	17:45	1.0		62.7	45.0	GRAB	MO	7.4	36	125
21188	17631	CH-6	73/07/30	13:30	1.0		62.7	45.0	GRAB	MO	7.8	64	195
23495	17631	CH-6	73/08/22	10:10	1.0		62.7	45.0	GRAB	MO	7.9	16	160
27695	17631	CH-6	73/10/03	14:50	1.0		72.7	45.0	GRAB	MO	7.6	12	160
29897	17631	CH-6	73/10/24	12:00	1.0		62.7	45.0	GRAB	MO	7.3	94	480
33293	17631	CH-6	73/11/27	8:35	1.0		62.7	45.0	GRAB	MO	6.9	92	185
312	17631	CH-6	74/01/03	13:00	1.0		62.7	45.0	GRAB	MO	7.4	40	240

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TCOD	TSS	TKN	CL	PHL	CR	ZN
14978	17631	CH-6	73/05/29	16:35	43.0		62.7	45.0	GRAB	MO	18	67	0.80	7	0.000	0.140	0.086
17187	17631	CH-6	73/06/19	17:50	43.0		62.7	45.0	GRAB	MO	23	10	1.64	5	0.000	0.020	0.080
21187	17631	CH-6	73/07/30	13:40	43.0		62.7	45.0	GRAB	MO	13	60	0.20	10	0.045	0.000	0.000
23494	17631	CH-6	73/08/22	10:10	43.0		62.7	45.0	GRAB	MO	9	14	0.33	10	0.248	0.034	0.875
27694	17631	CH-6	73/10/03	14:50	43.0		72.7	45.0	GRAB	MO	36	20	0.30	37	0.000	0.000	0.004
29896	17631	CH-6	73/10/24	12:00	43.0		62.7	45.0	GRAB	MO	130	63	0.73	275	0.015	0.000	0.060
33292	17631	CH-6	73/11/27	8:35	43.0		62.7	45.0	GRAB	MO	15	32	0.50	18	0.003	0.000	0.087
313	17631	CH-6	74/01/03	13:00	43.0		62.7	45.0	GRAB	MO	16	70	0.06	13	0.050	0.000	0.040

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	ALK	NH3F	TP
14978	17631	CH-6	73/05/29	16:35	43.0		62.7	45.0	GRAB	MO	43.0	0.1	0.08
17187	17631	CH-6	73/06/19	17:50	43.0		62.7	45.0	GRAB	MO	46.0	0.1	0.11
21187	17631	CH-6	73/07/30	13:40	43.0		62.7	45.0	GRAB	MO	55.0	0.0	0.15
23494	17631	CH-6	73/08/22	10:10	43.0		62.7	45.0	GRAB	MO	61.0	0.0	0.07
27694	17631	CH-6	73/10/03	14:50	43.0		72.7	45.0	GRAB	MO	57.0	0.0	0.37
29896	17631	CH-6	73/10/24	12:00	43.0		62.7	45.0	GRAB	MO	59.0	0.0	0.14
33292	17631	CH-6	73/11/27	8:35	43.0		62.7	45.0	GRAB	MO	58.0	0.0	0.07
313	17631	CH-6	74/01/03	13:00	43.0		62.7	45.0	GRAB	MO	44.0	0.0	0.05

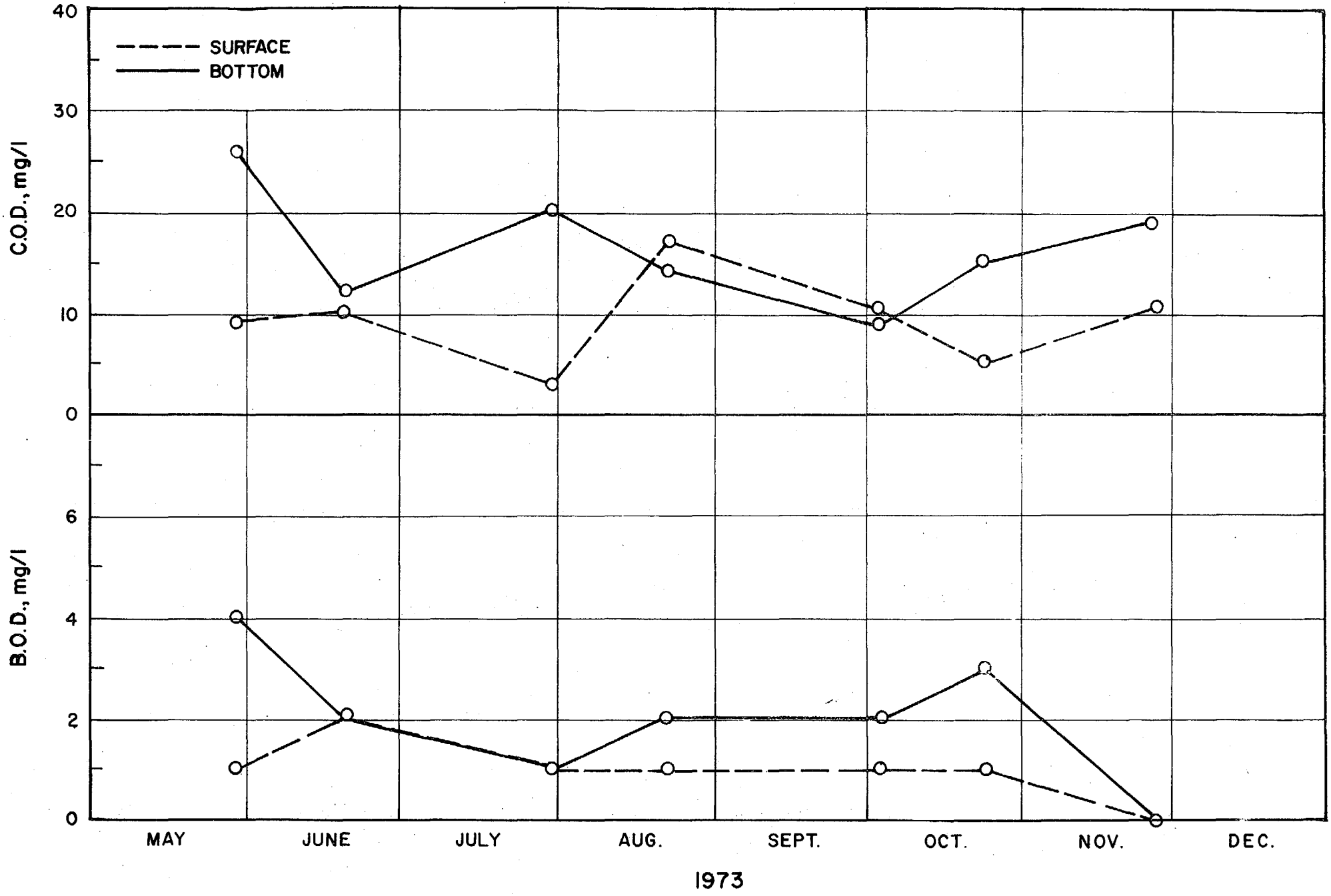
CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	TDS	CL	SO4	TBOD	NO3N	TCCD	T
14978	17631	CH-6	73/05/29	16:35	43.0		62.7	45.0	GRAB	MO	130	7	12	1	0.45	18	54.00
17187	17631	CH-6	73/06/19	17:50	43.0		62.7	45.0	GRAB	MO	105	5	16	6	0.76	23	69.80
21187	17631	CH-6	73/07/30	13:40	43.0		62.7	45.0	GRAB	MO	160	10	15	1	0.48	13	
23494	17631	CH-6	73/08/22	10:10	43.0		62.7	45.0	GRAB	MO	180	10	15	1	0.56	9	
27694	17631	CH-6	73/10/03	14:50	43.0		72.7	45.0	GRAB	MO	130	37	28	1	0.56	36	71.40
29896	17631	CH-6	73/10/24	12:00	43.0		62.7	45.0	GRAB	MO	670	275	50	3	0.41	130	73.40
33292	17631	CH-6	73/11/27	8:35	43.0		62.7	45.0	GRAB	MO	180	18	27	0	0.78	15	48.20
313	17631	CH-6	74/01/03	13:00	43.0		62.7	45.0	GRAB	MO	95	13	20	1	0.70	16	

CODE	JOB	STATION	DATE	TIME	DEPTH	TC	MP	MSD	TYPE	FREQ	PH	TVS	TS
14978	17631	CH-6	73/05/29	16:35	43.0		62.7	45.0	GRAB	MO	6.9	100	190
17187	17631	CH-6	73/06/19	17:50	43.0		62.7	45.0	GRAB	MO	7.5	23	115
21187	17631	CH-6	73/07/30	13:40	43.0		62.7	45.0	GRAB	MO	7.8	100	220
23494	17631	CH-6	73/08/22	10:10	43.0		62.7	45.0	GRAB	MO	7.9	90	195
27694	17631	CH-6	73/10/03	14:50	43.0		72.7	45.0	GRAB	MO	7.7	44	150
29896	17631	CH-6	73/10/24	12:00	43.0		62.7	45.0	GRAB	MO	7.0	134	735
33292	17631	CH-6	73/11/27	8:35	43.0		62.7	45.0	GRAB	MO	6.9	55	210
313	17631	CH-6	74/01/03	13:00	43.0		62.7	45.0	GRAB	MO	7.7	43	165

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

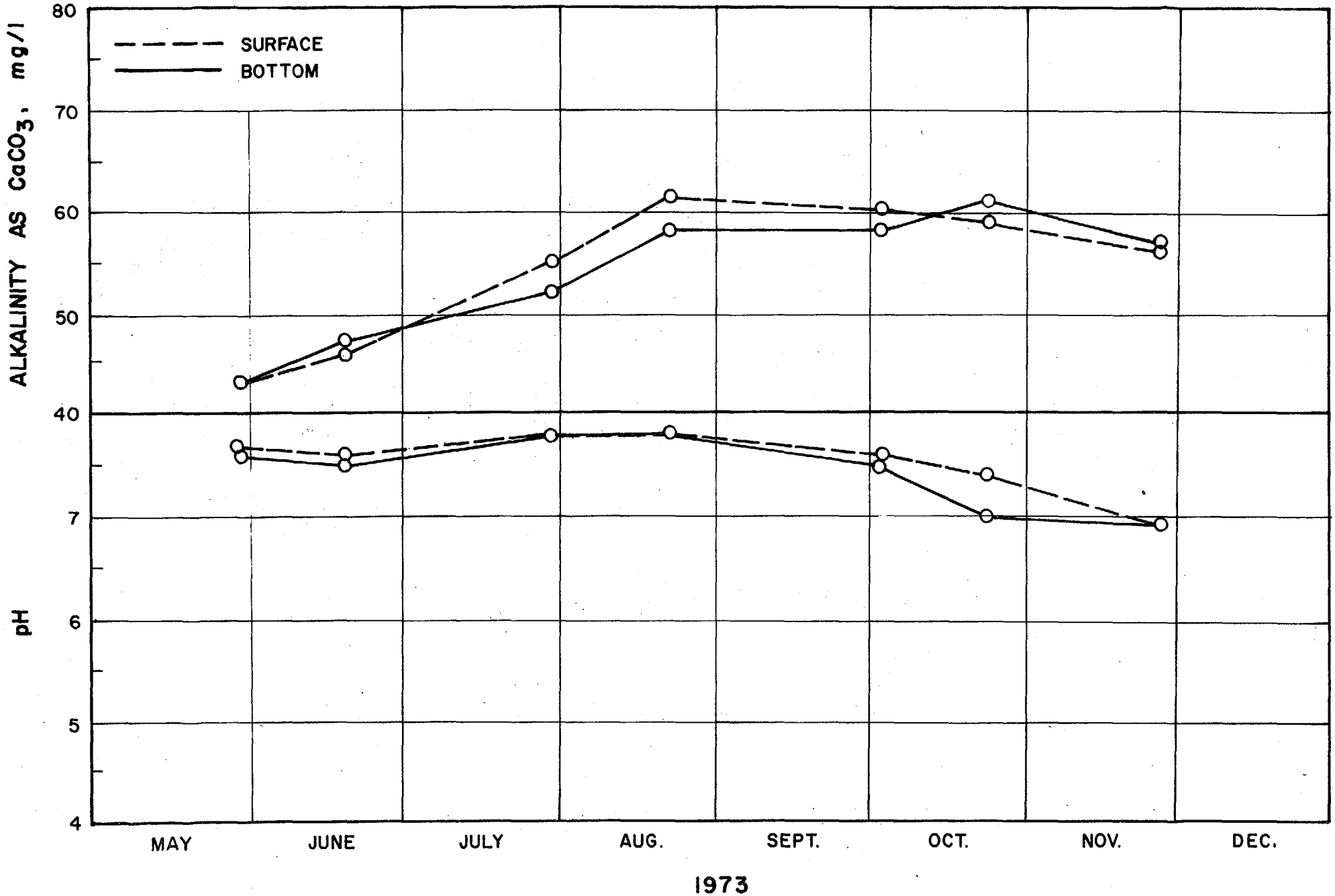
STATION CH-1 NORTH CONTROL



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

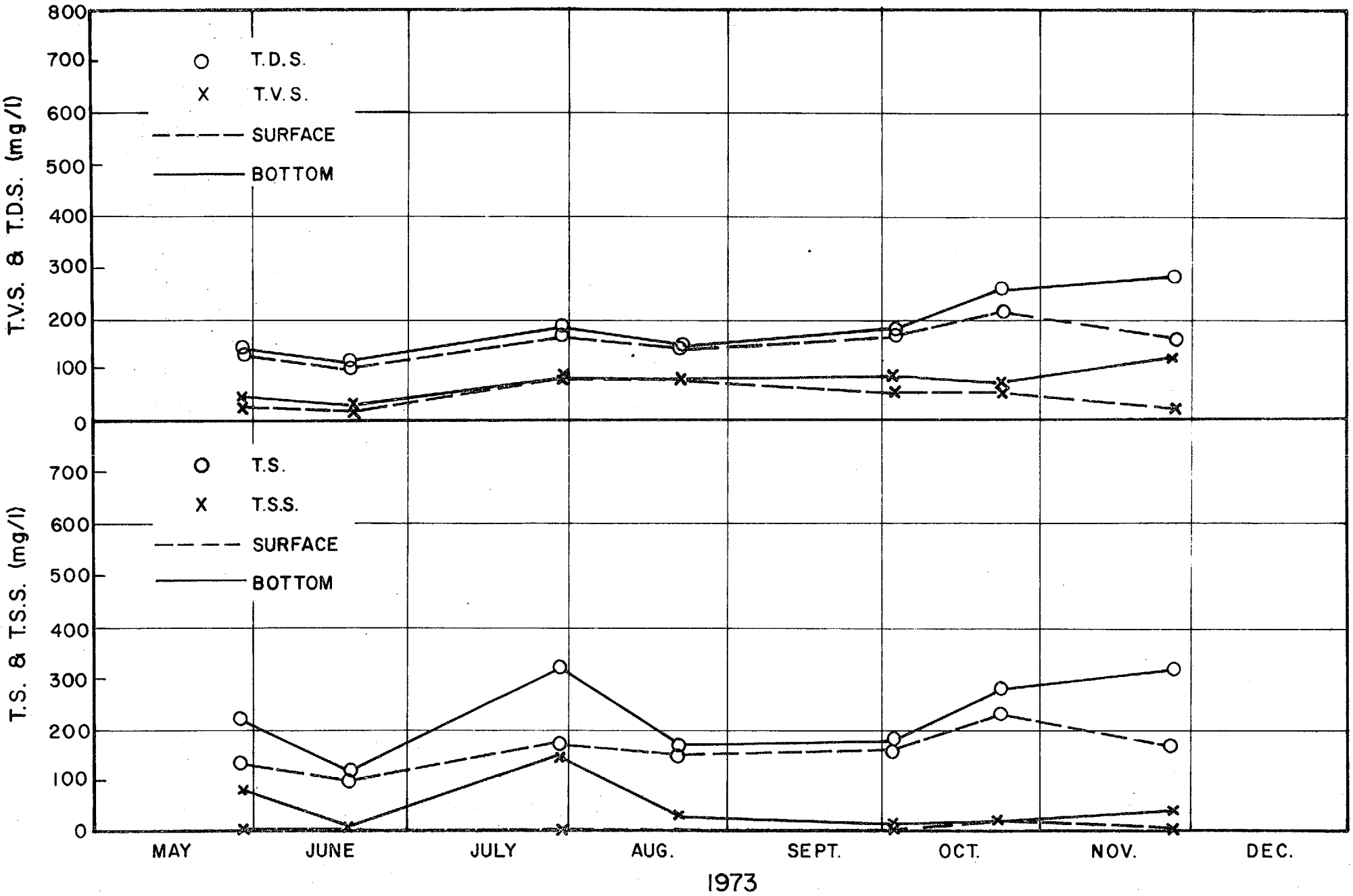
STATION CH-1 NORTH CONTROL



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

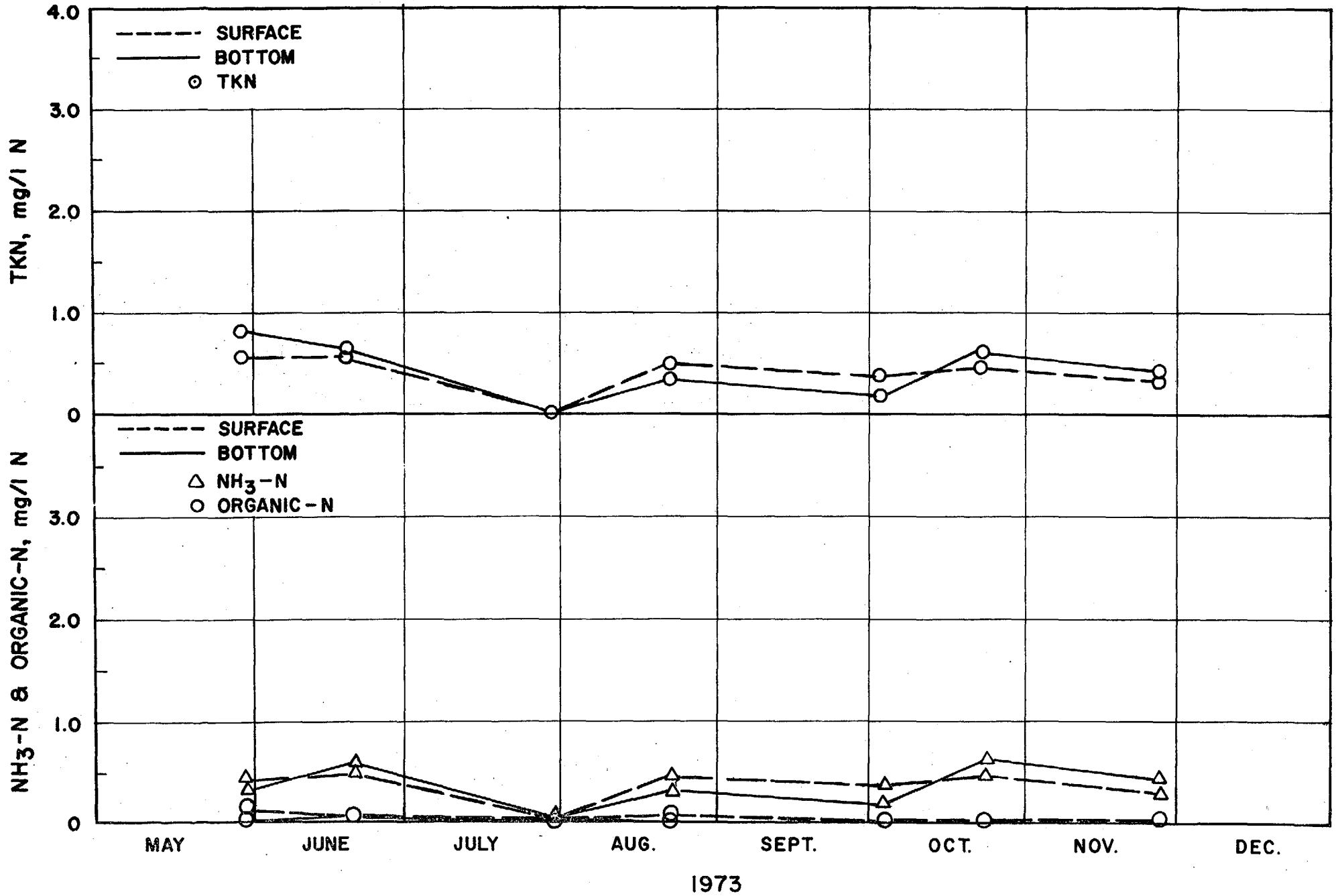
STATION CH-1 NORTH CONTROL



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

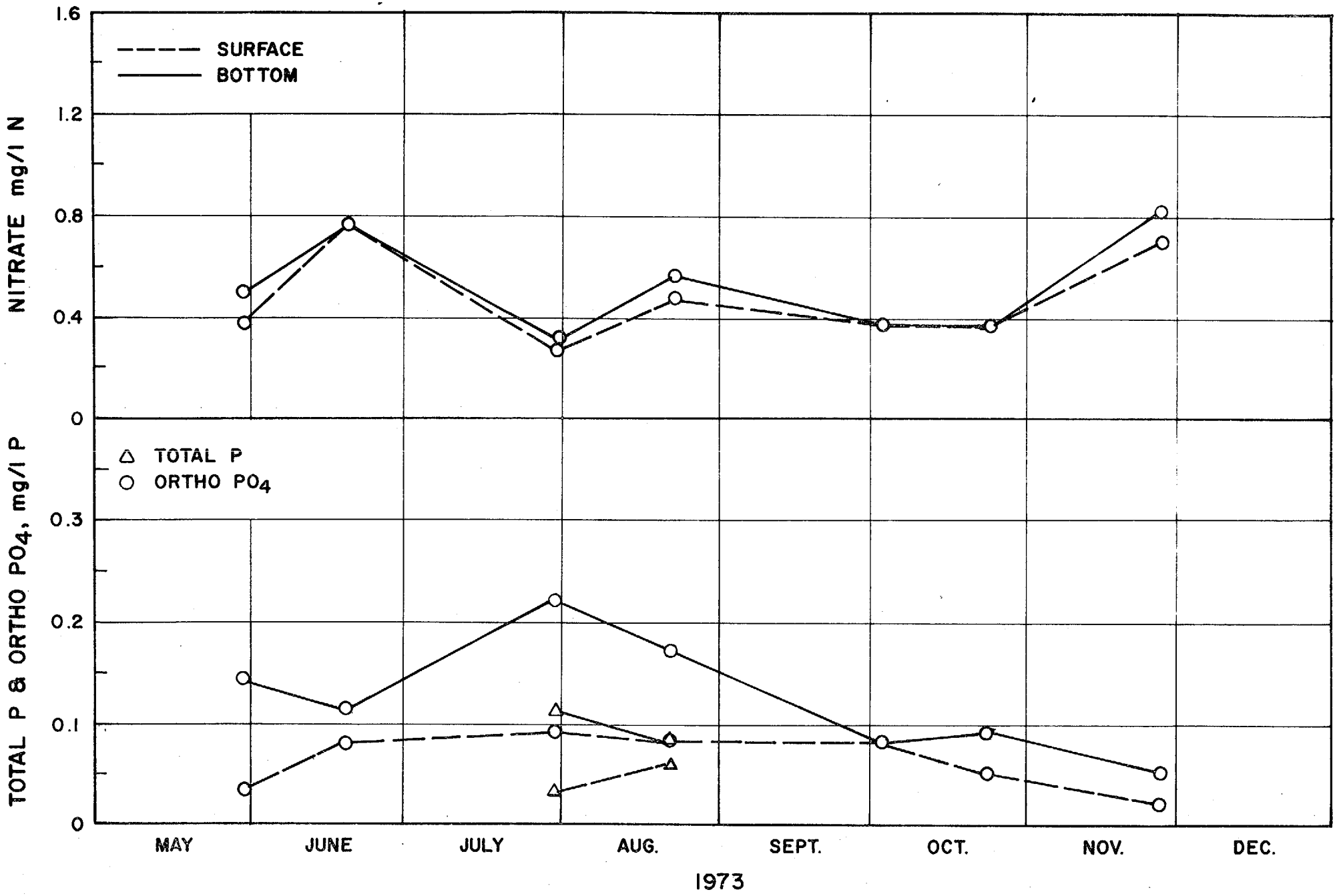
ROSETON & DANSKAMMER

STATION CH-1 NORTH CONTROL



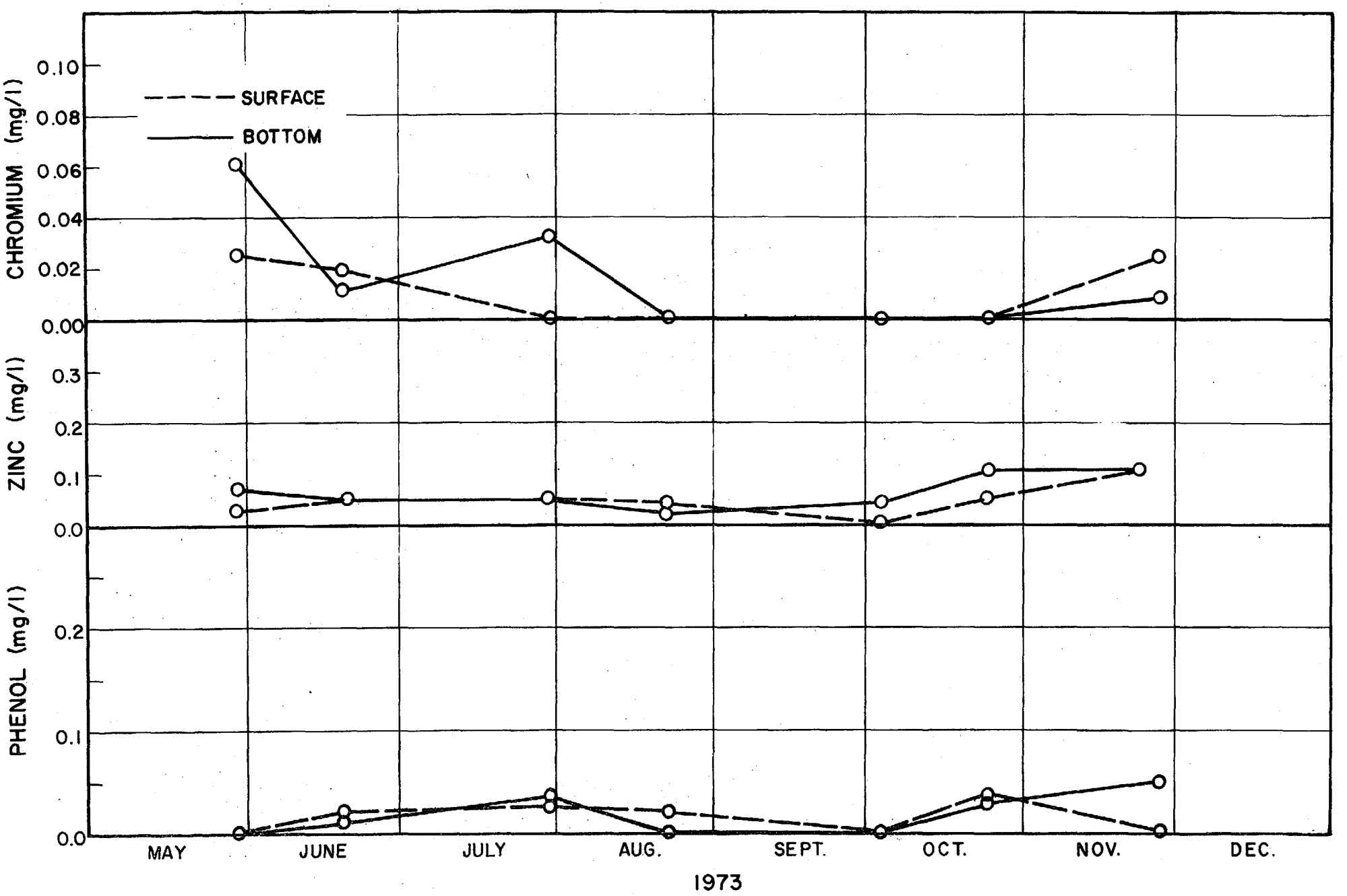
CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-1 NORTH CONTROL



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-1 NORTH CONTROL



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-1 NORTH CONTROL

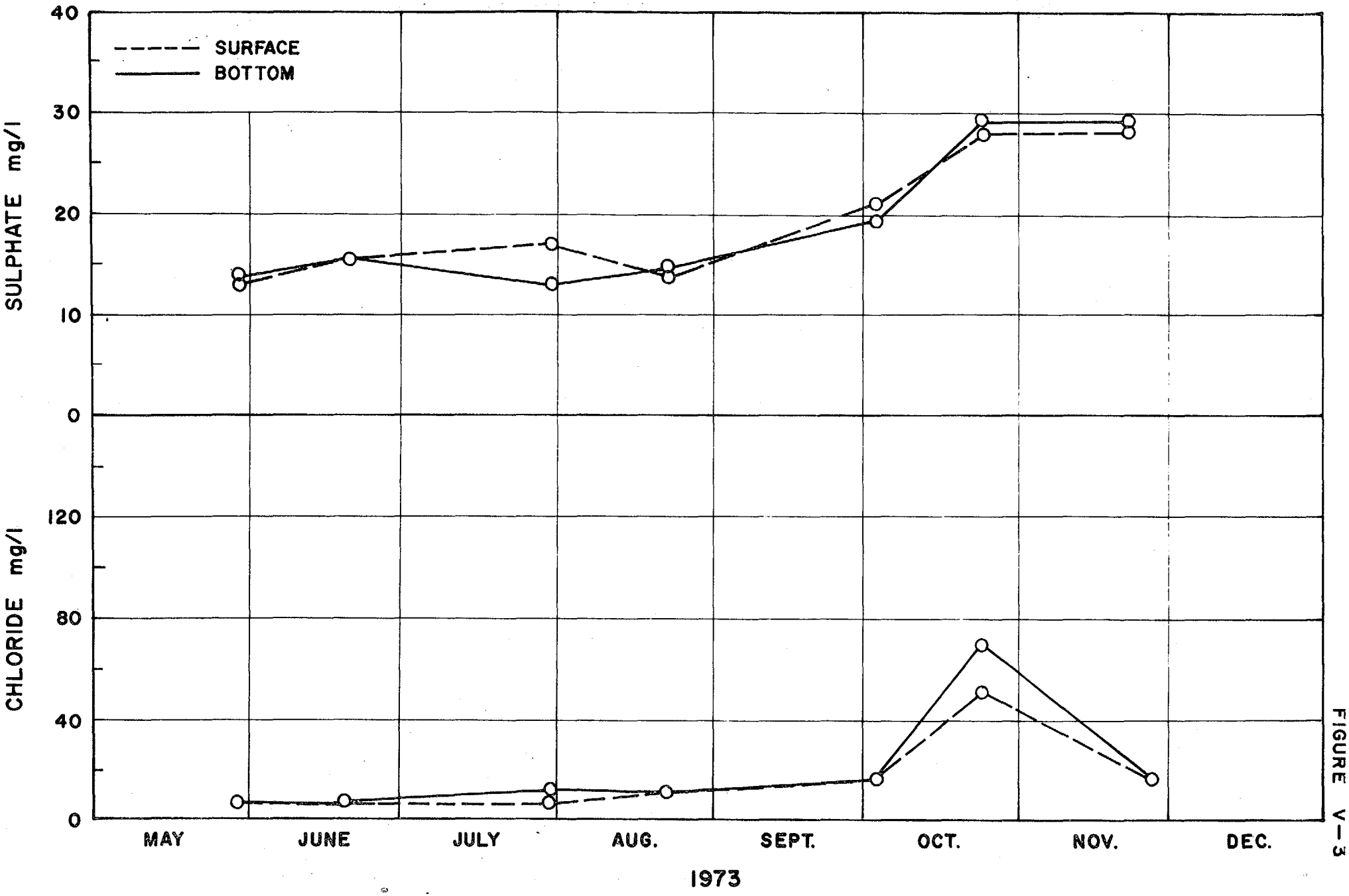
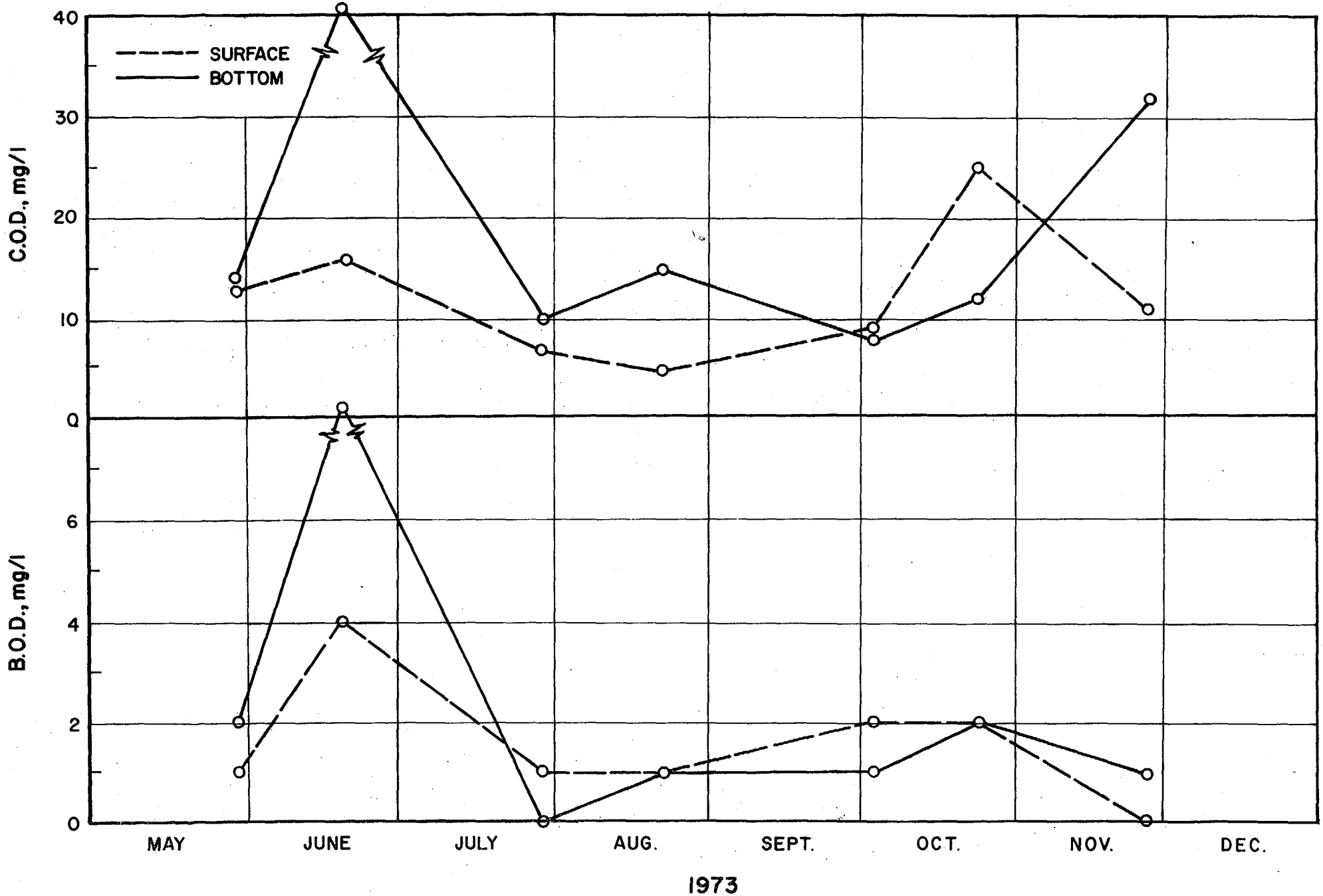


FIGURE V-3

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

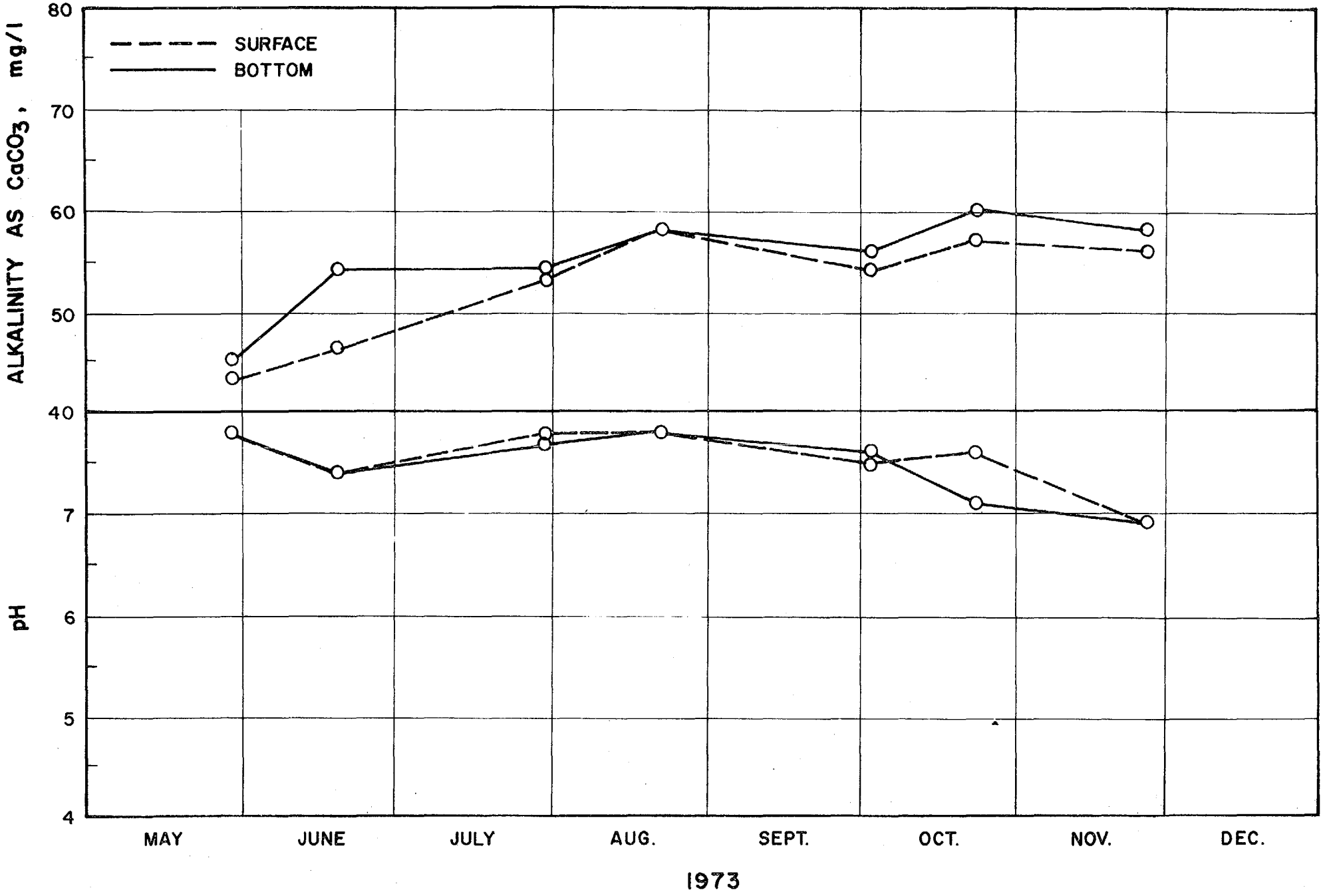
STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

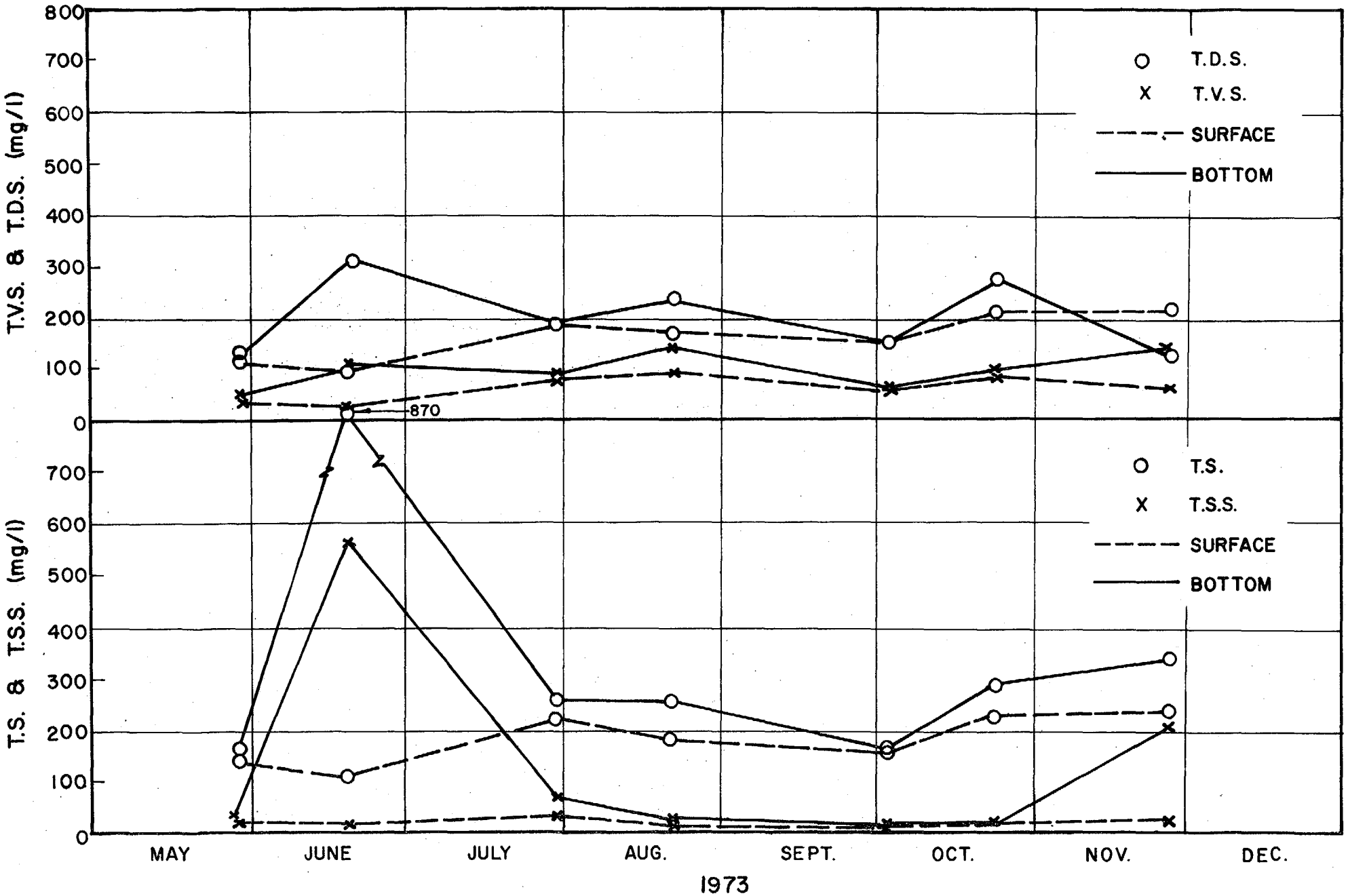
STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

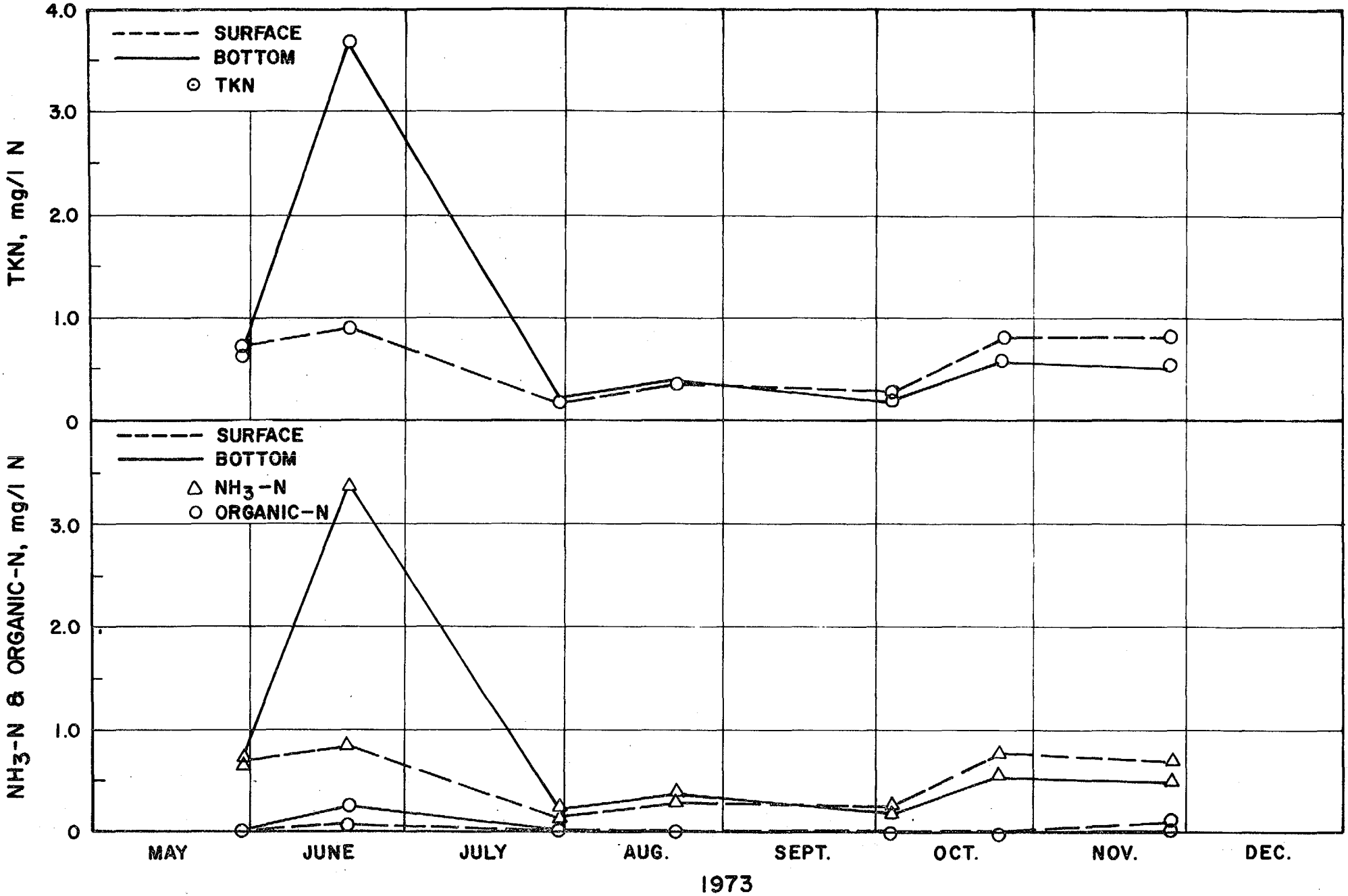
STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

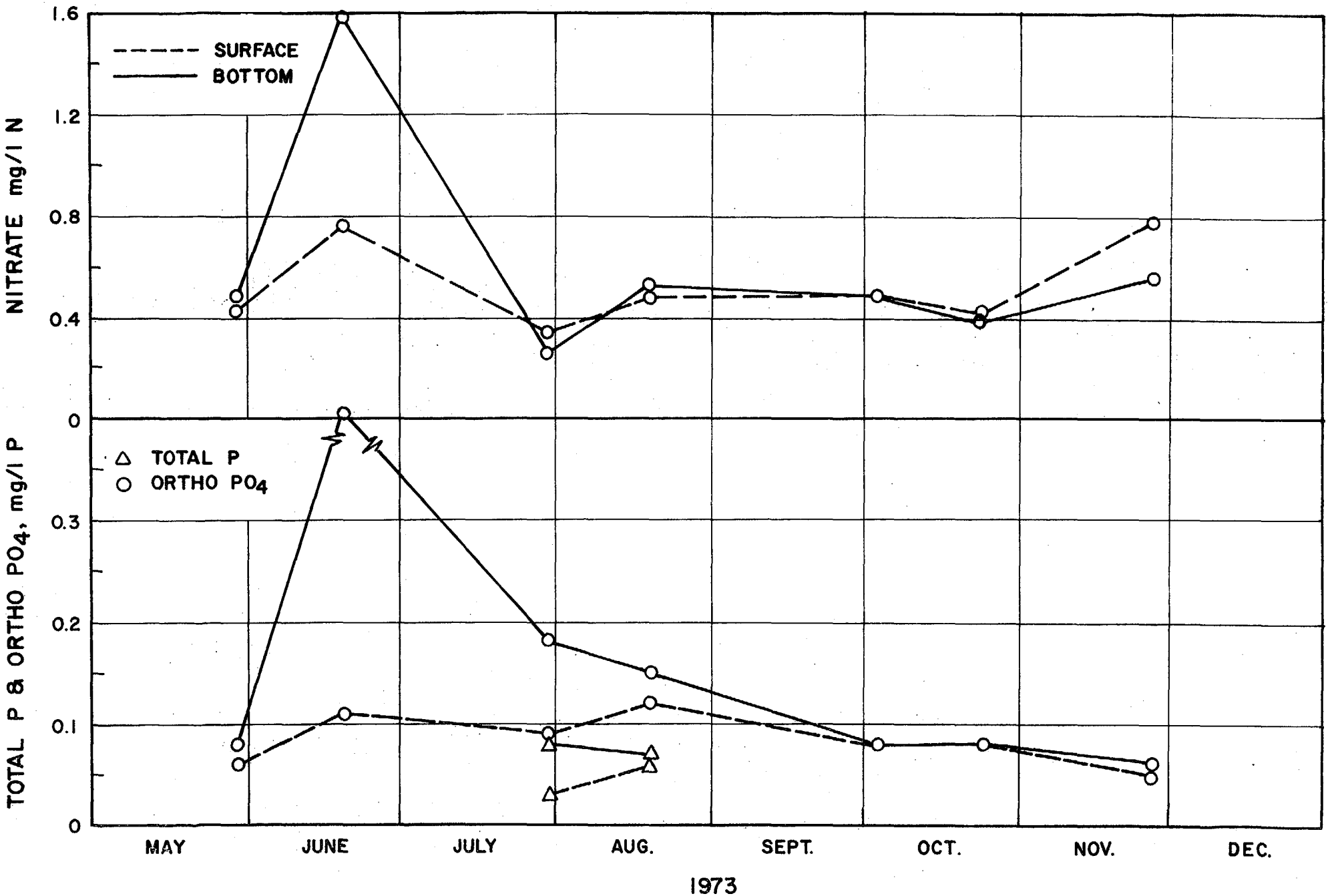
STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

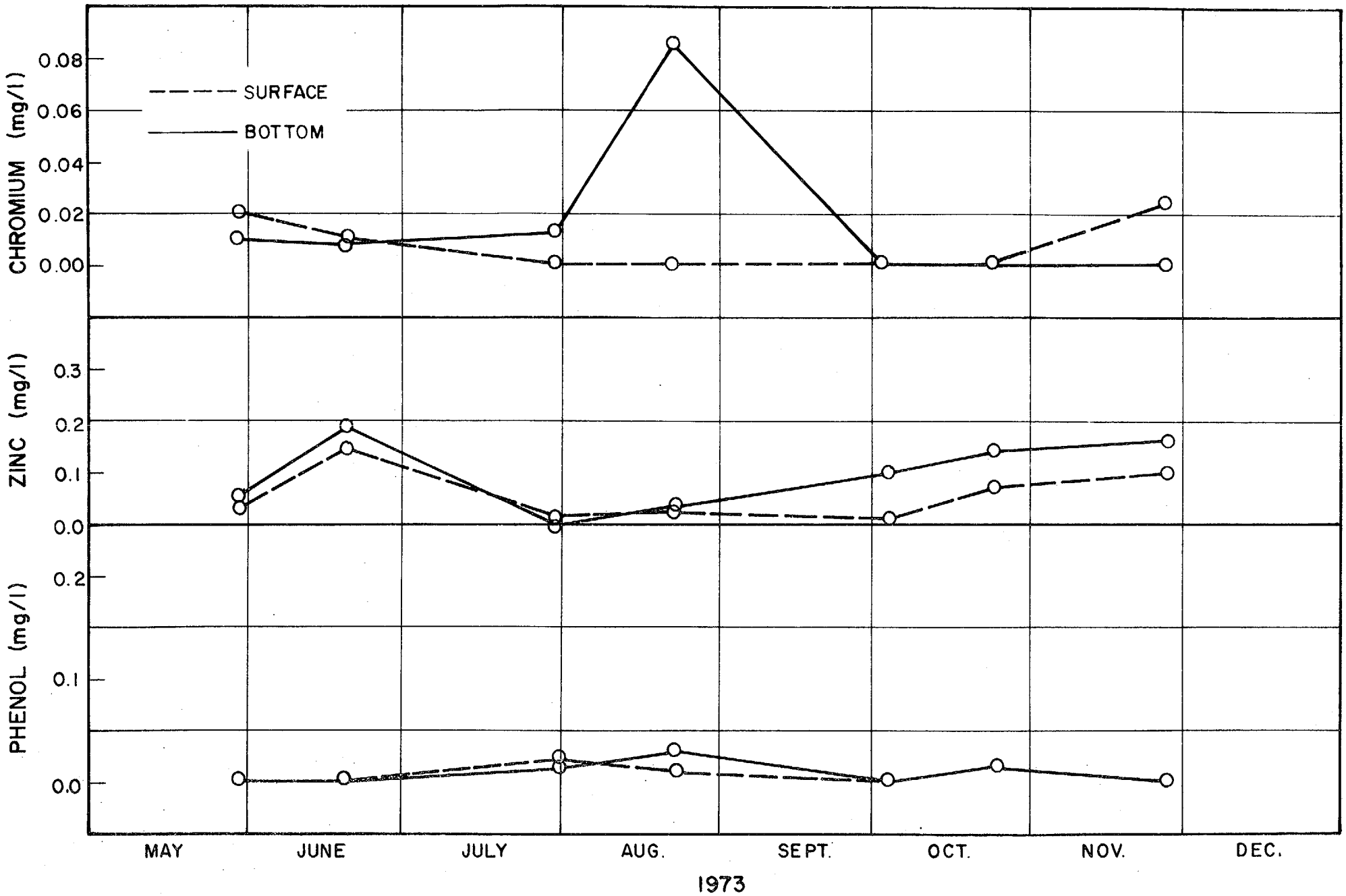
STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-2 DANSKAMMER INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-2 DANSKAMMER INTAKE

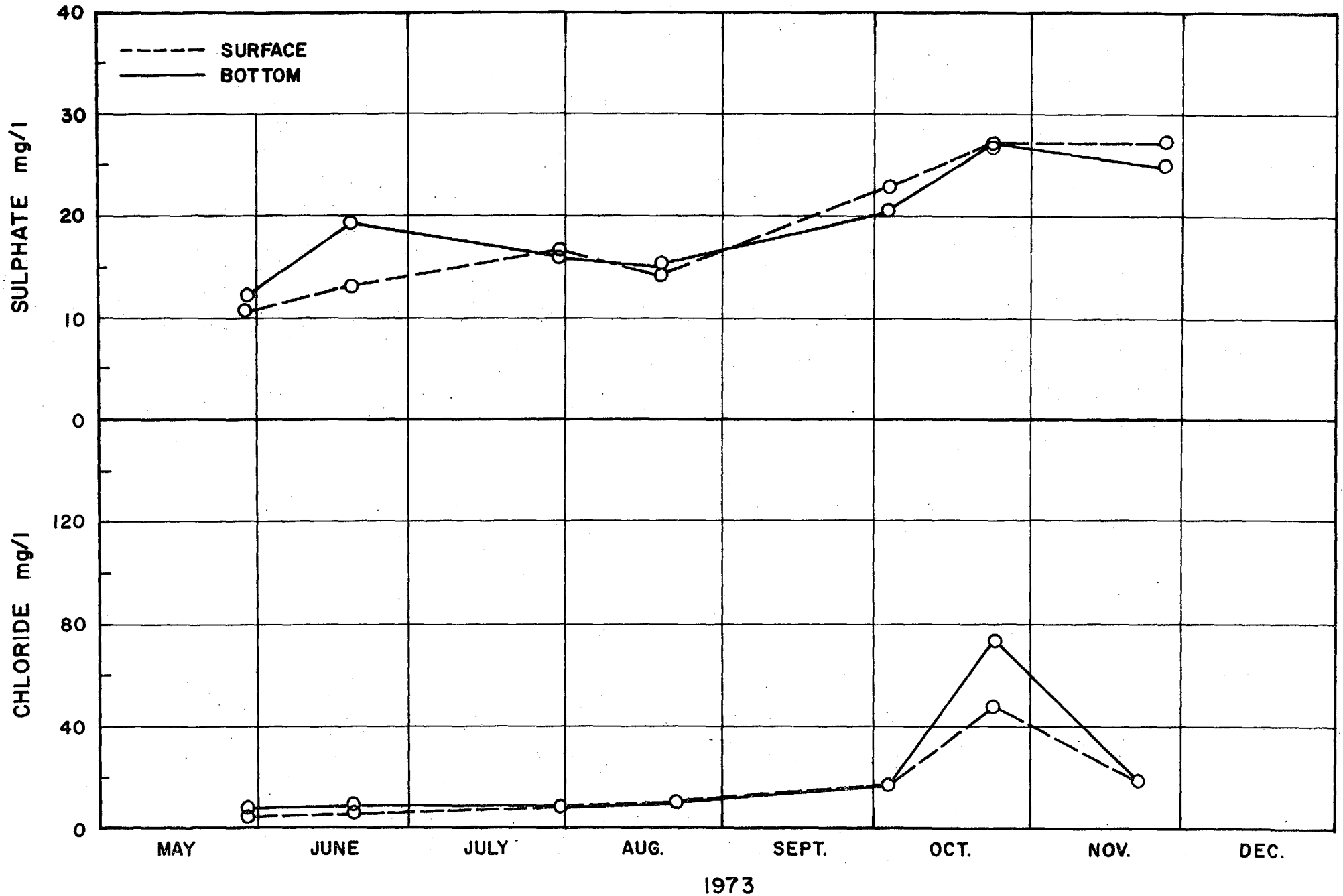
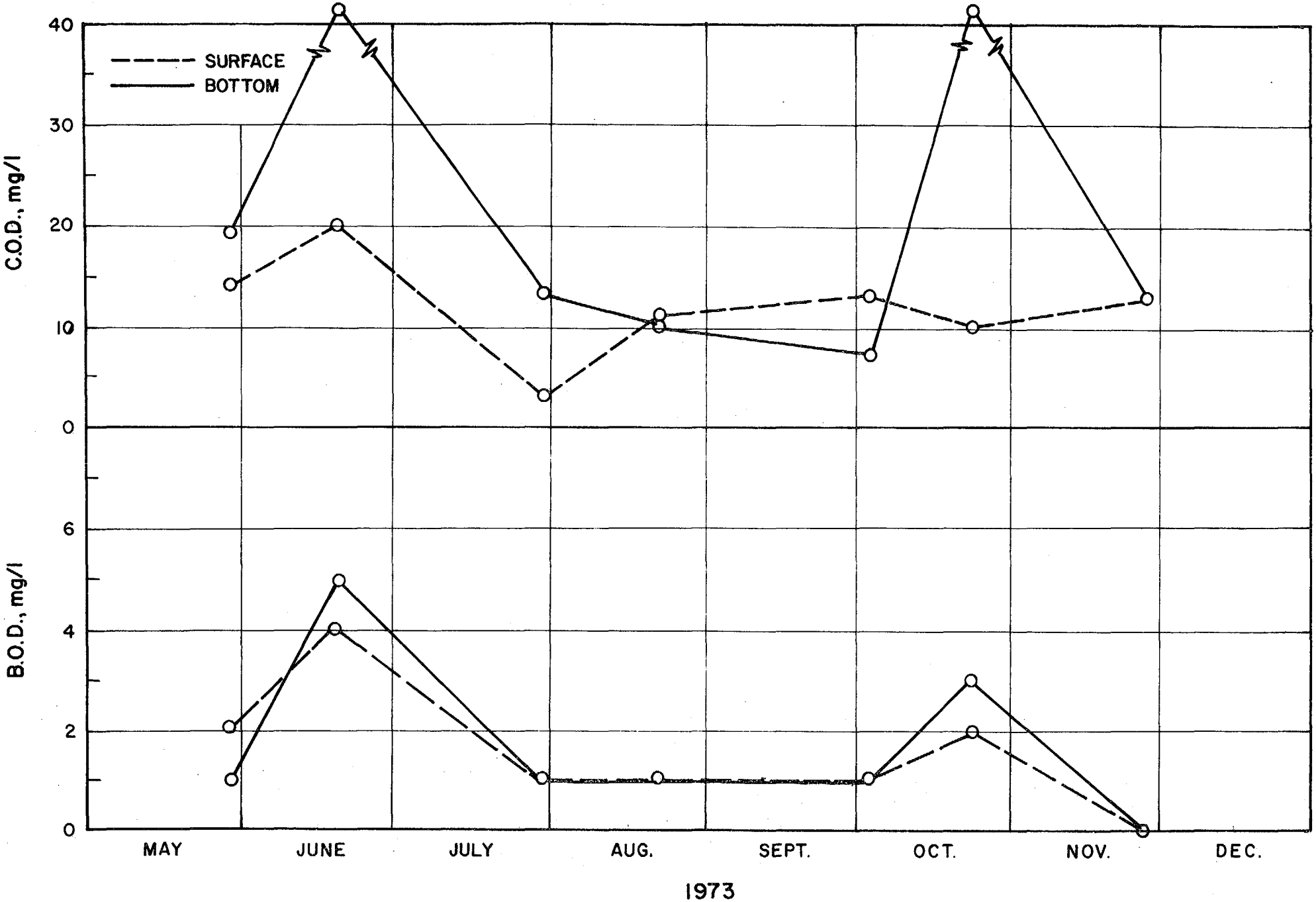


FIGURE V-4

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

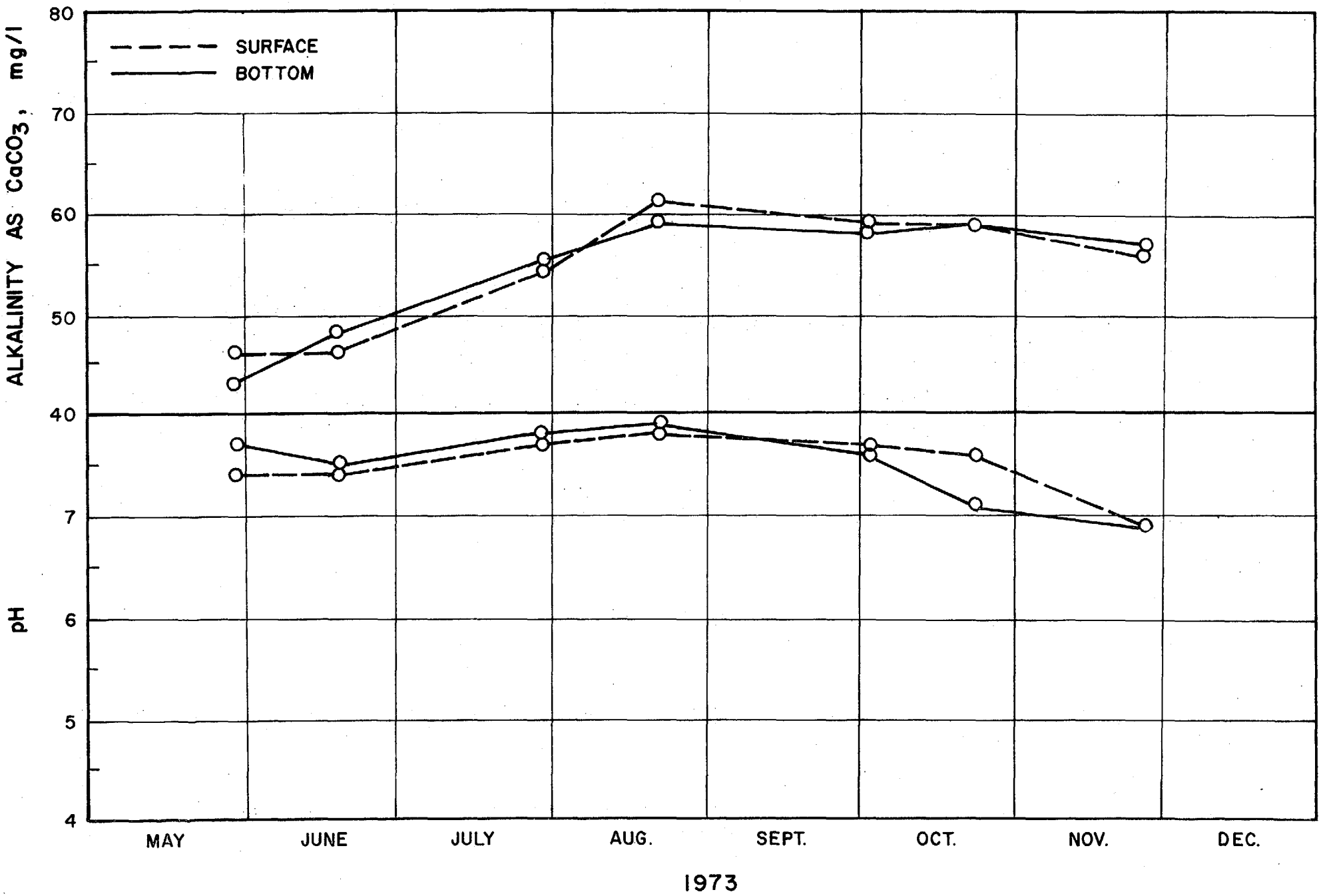
STATION CH-3 ROSETON INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

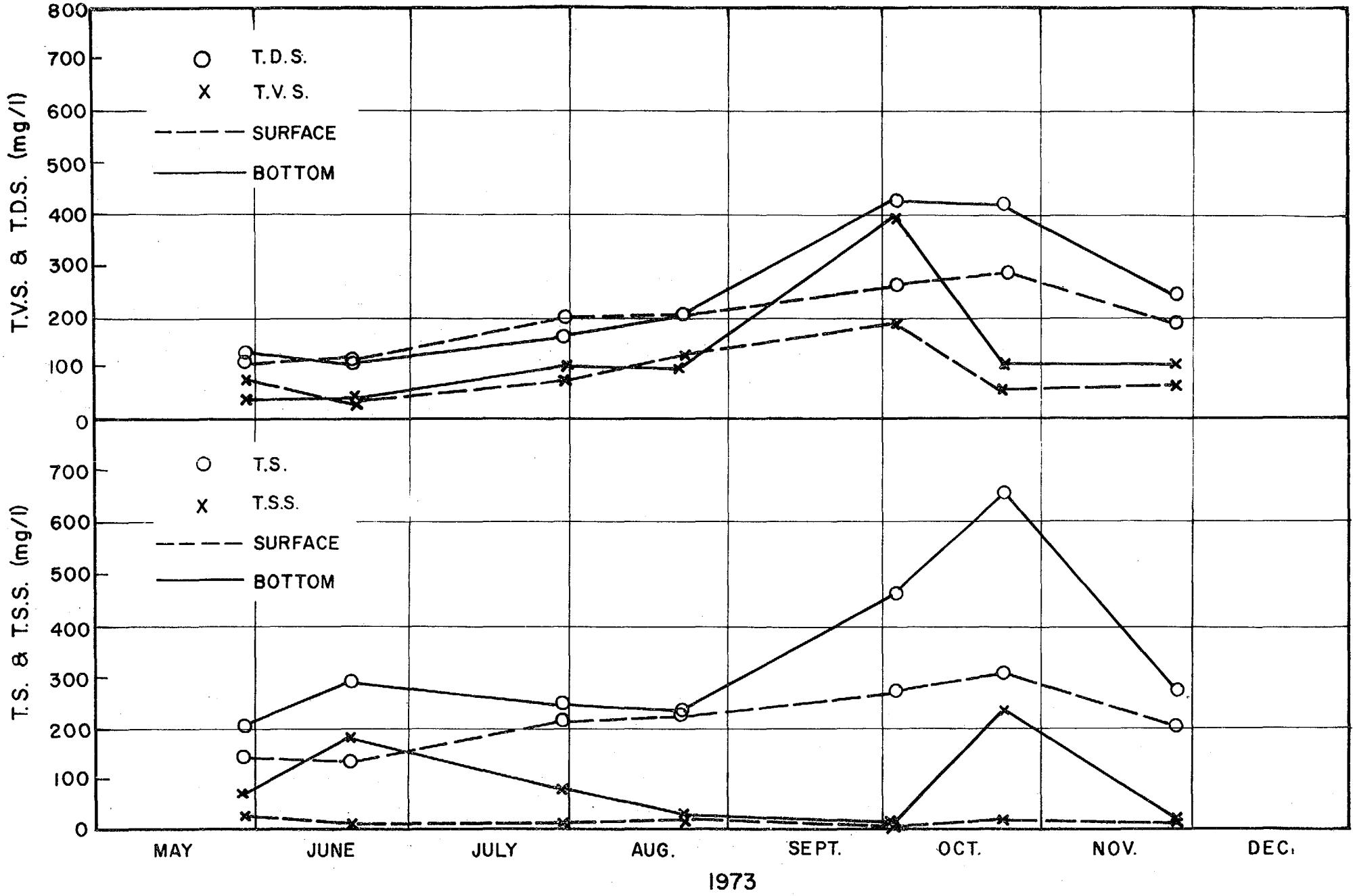
STATION CH-3 ROSETON INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

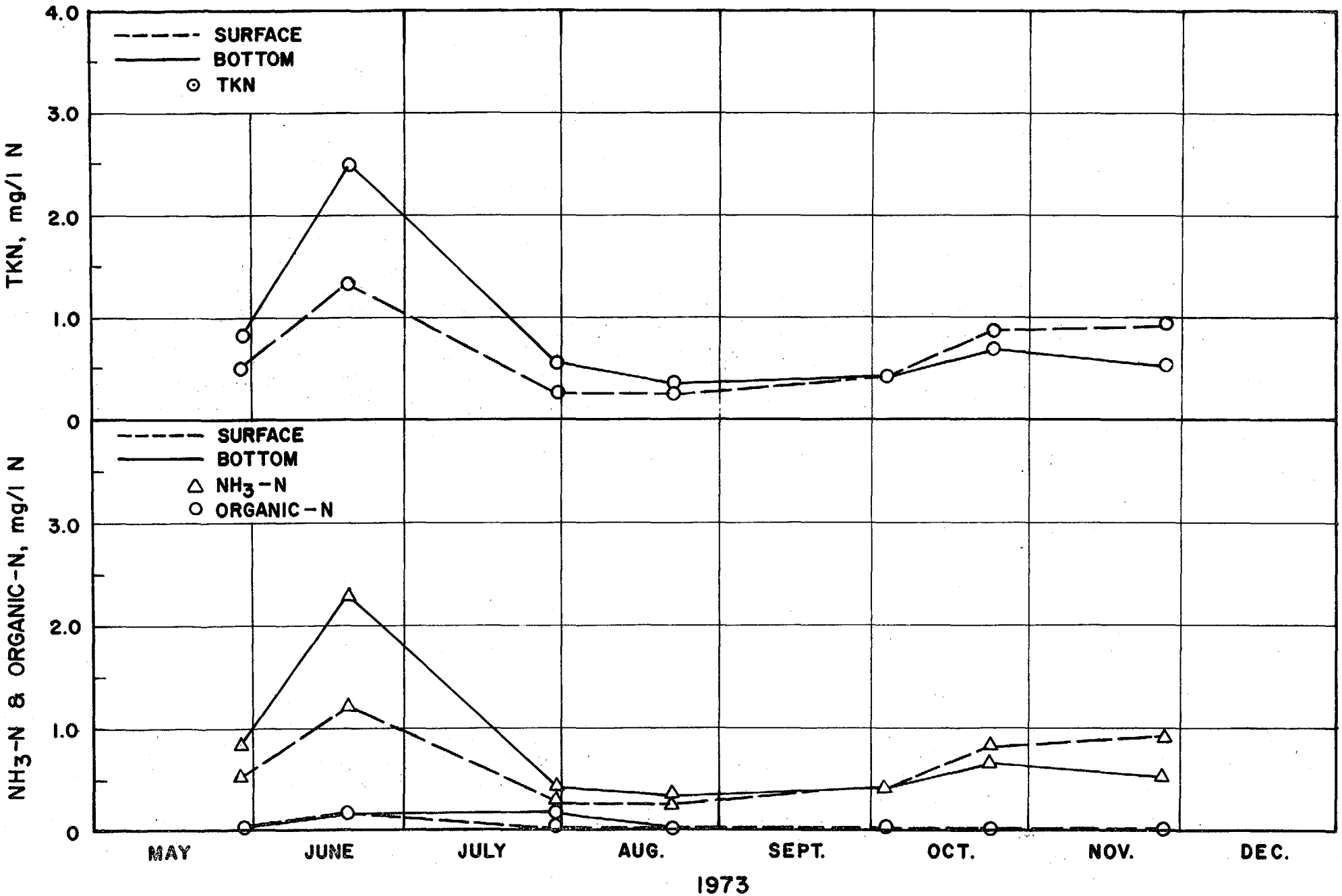
STATION CH-3 ROSETON INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

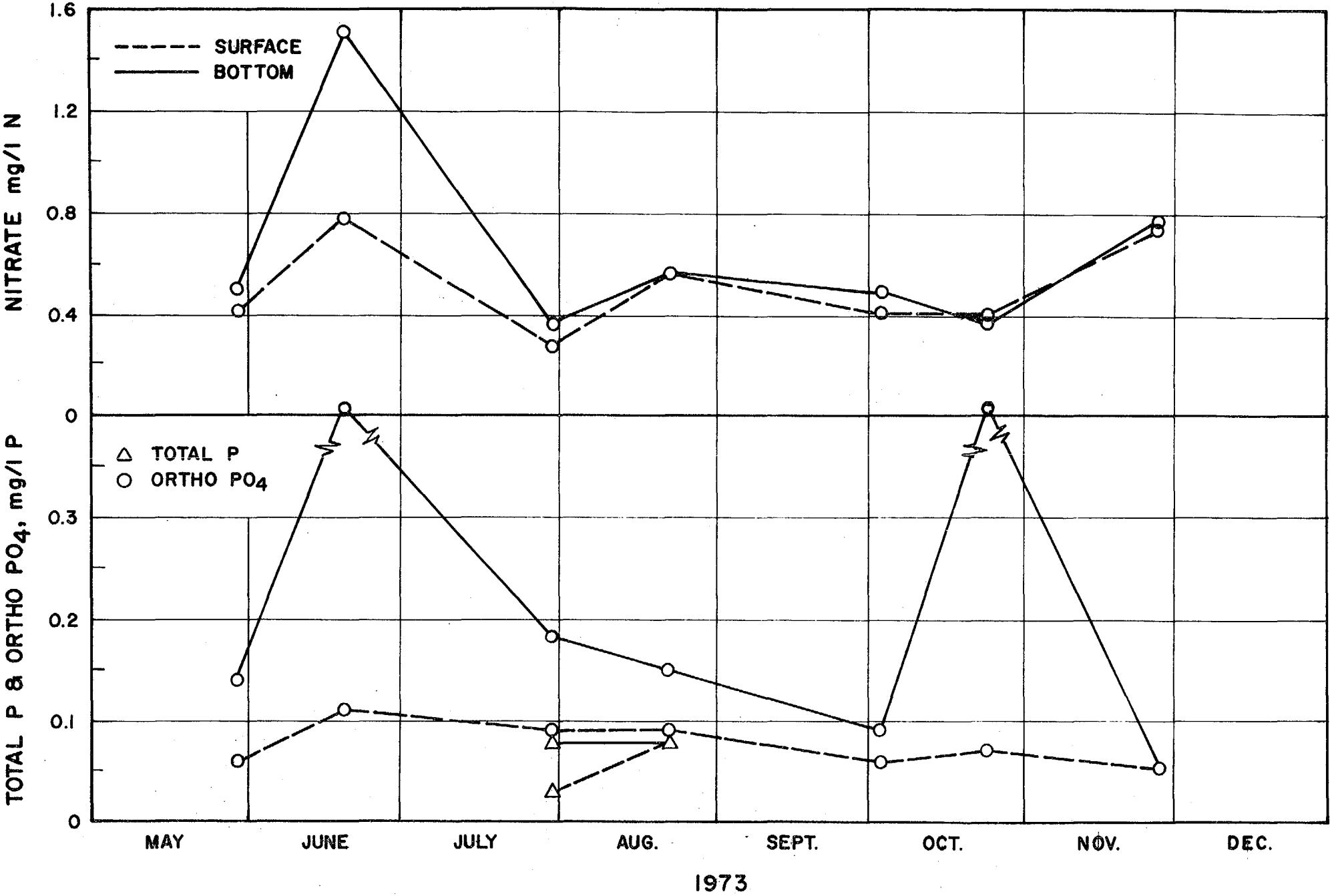
ROSETON & DANSKAMMER

STATION CH-3 ROSETON INTAKE



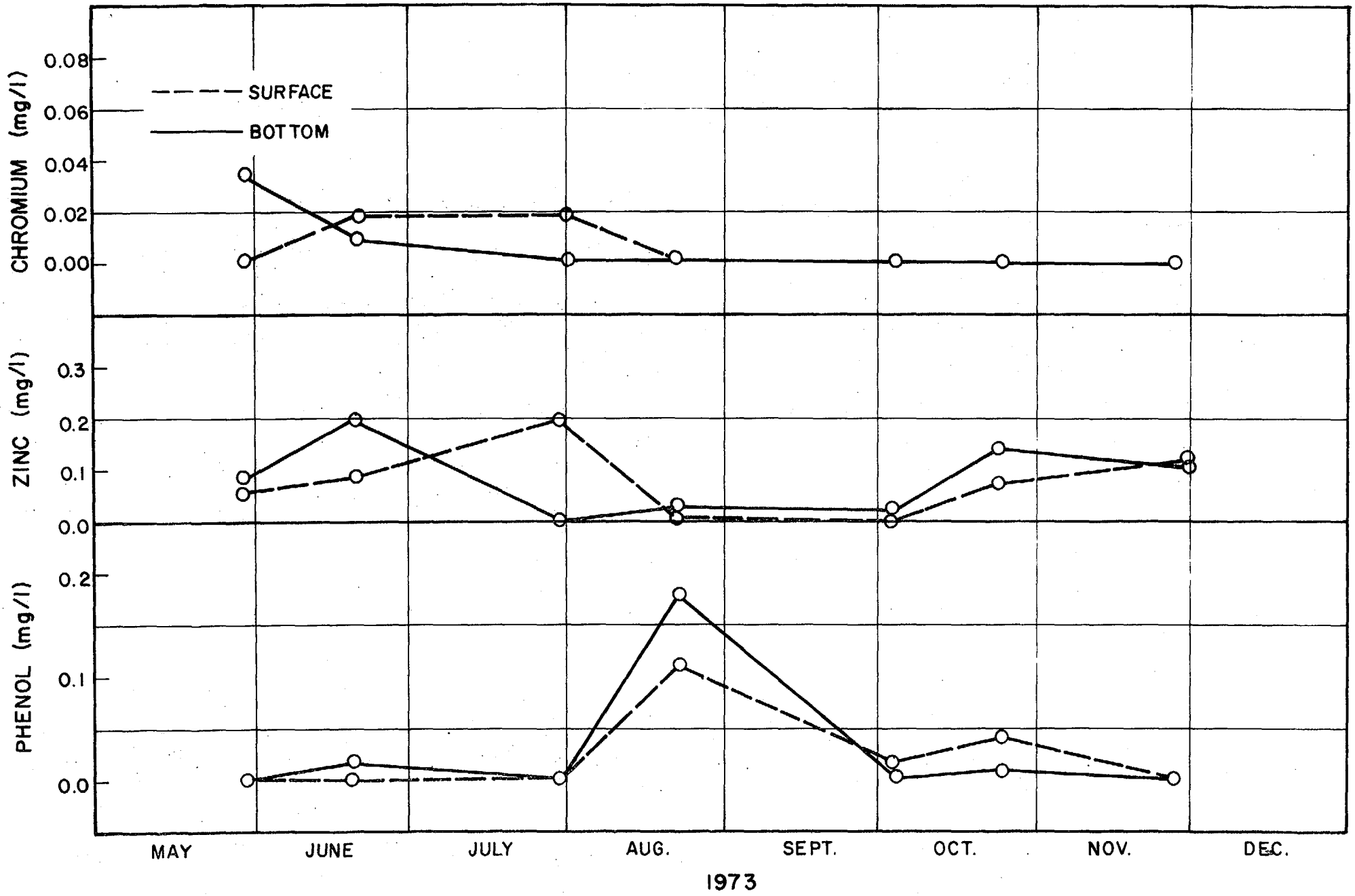
CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-3 ROSETON INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-3 ROSETON INTAKE



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-3 ROSETON INTAKE

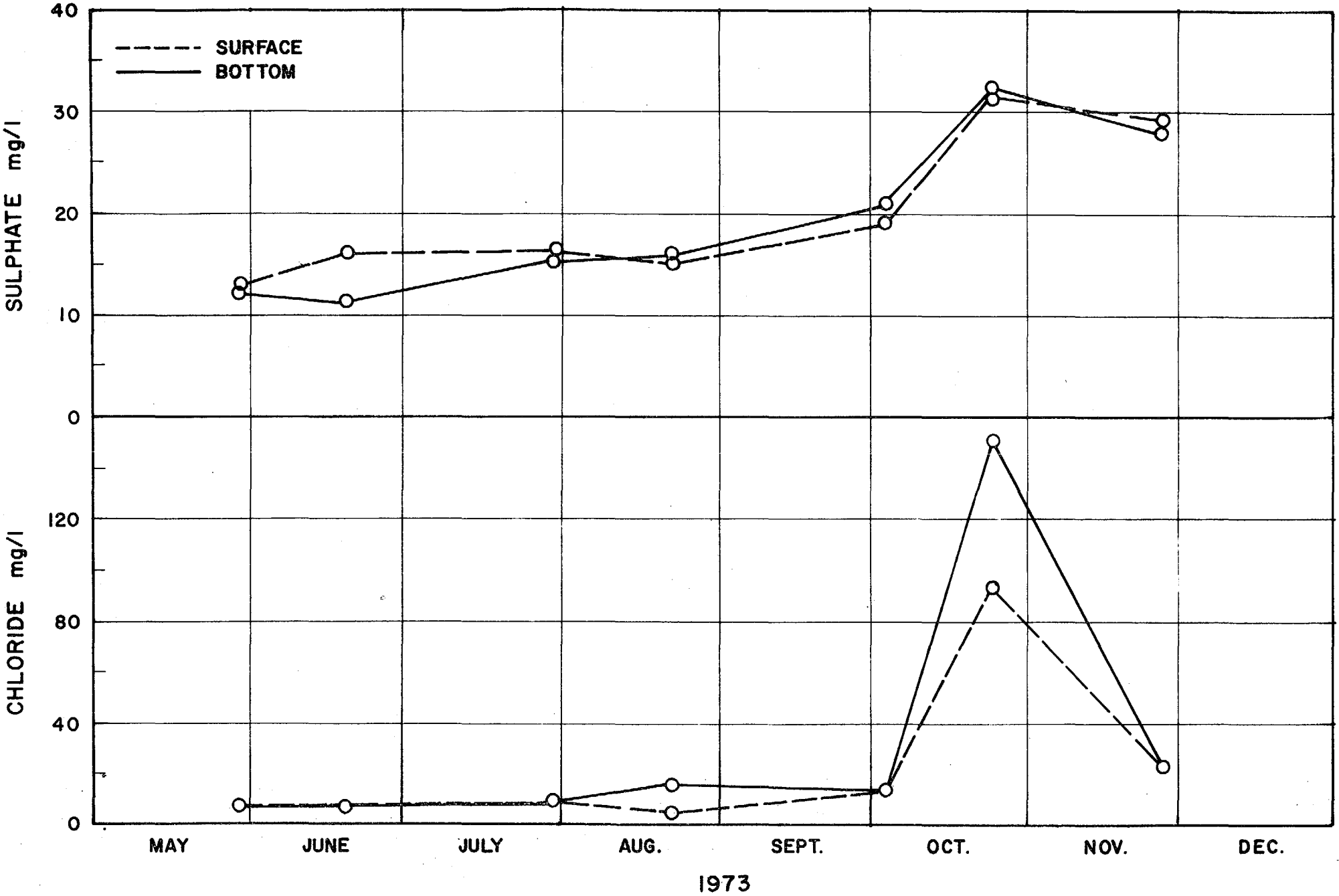
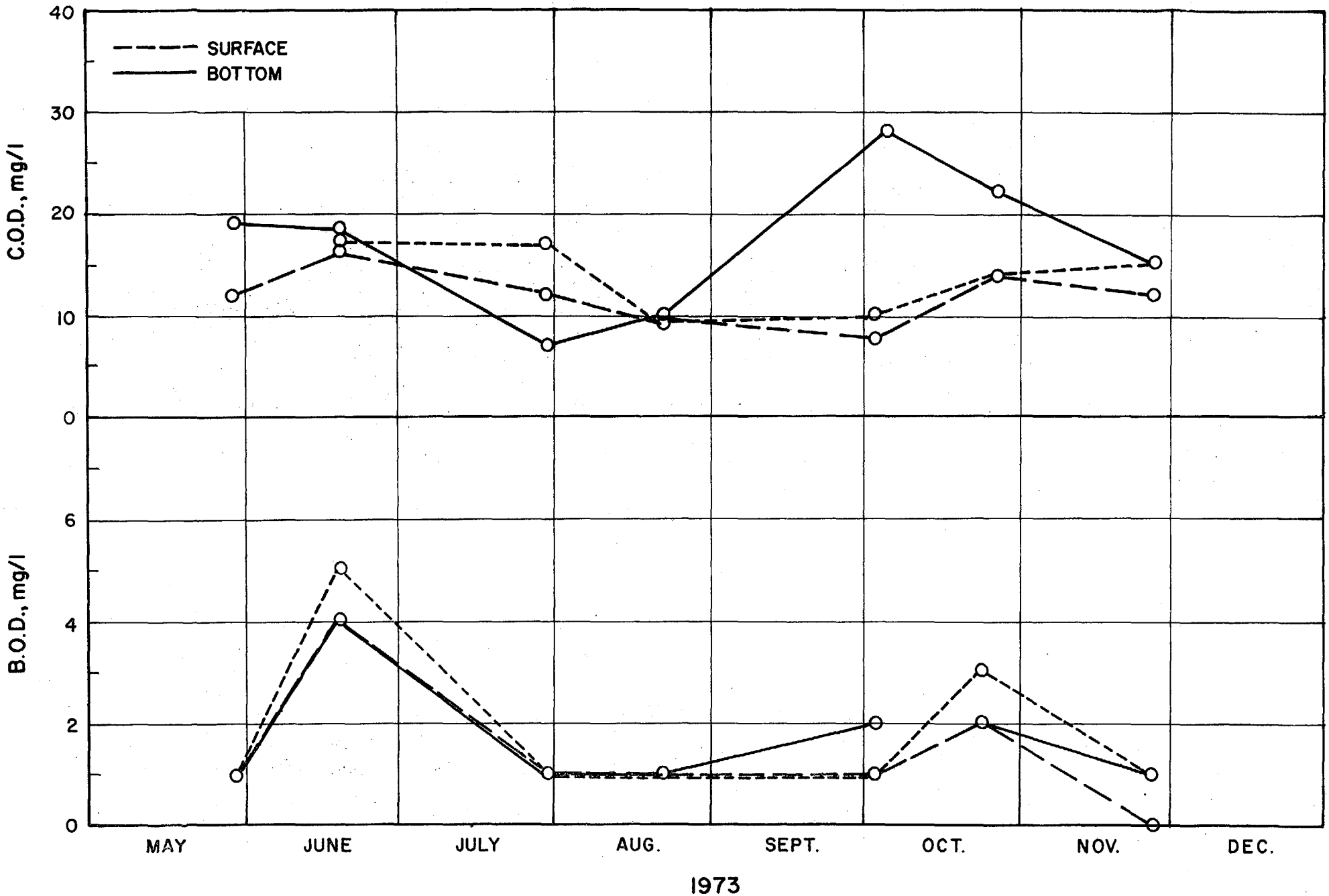


FIGURE V-5

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

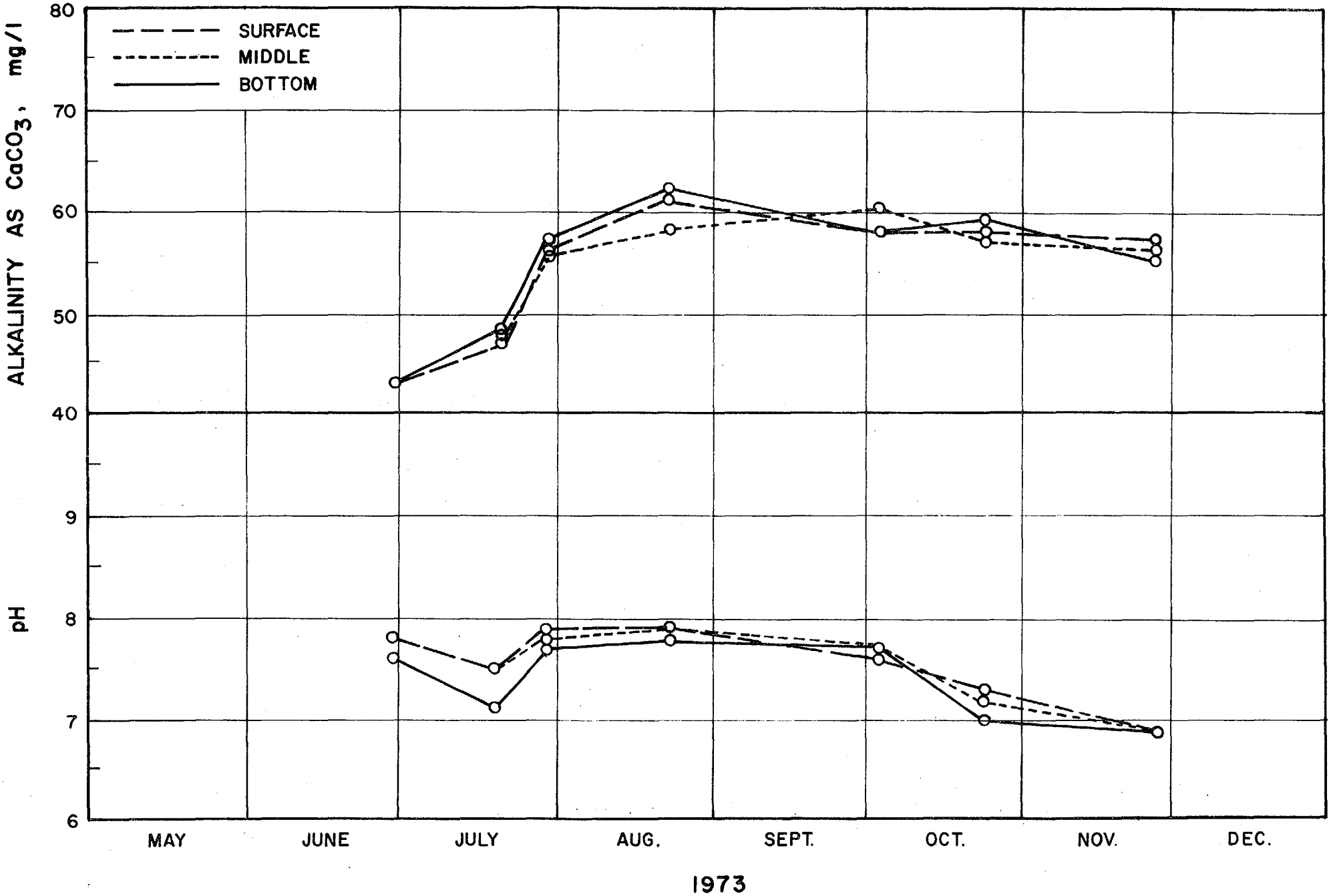
STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

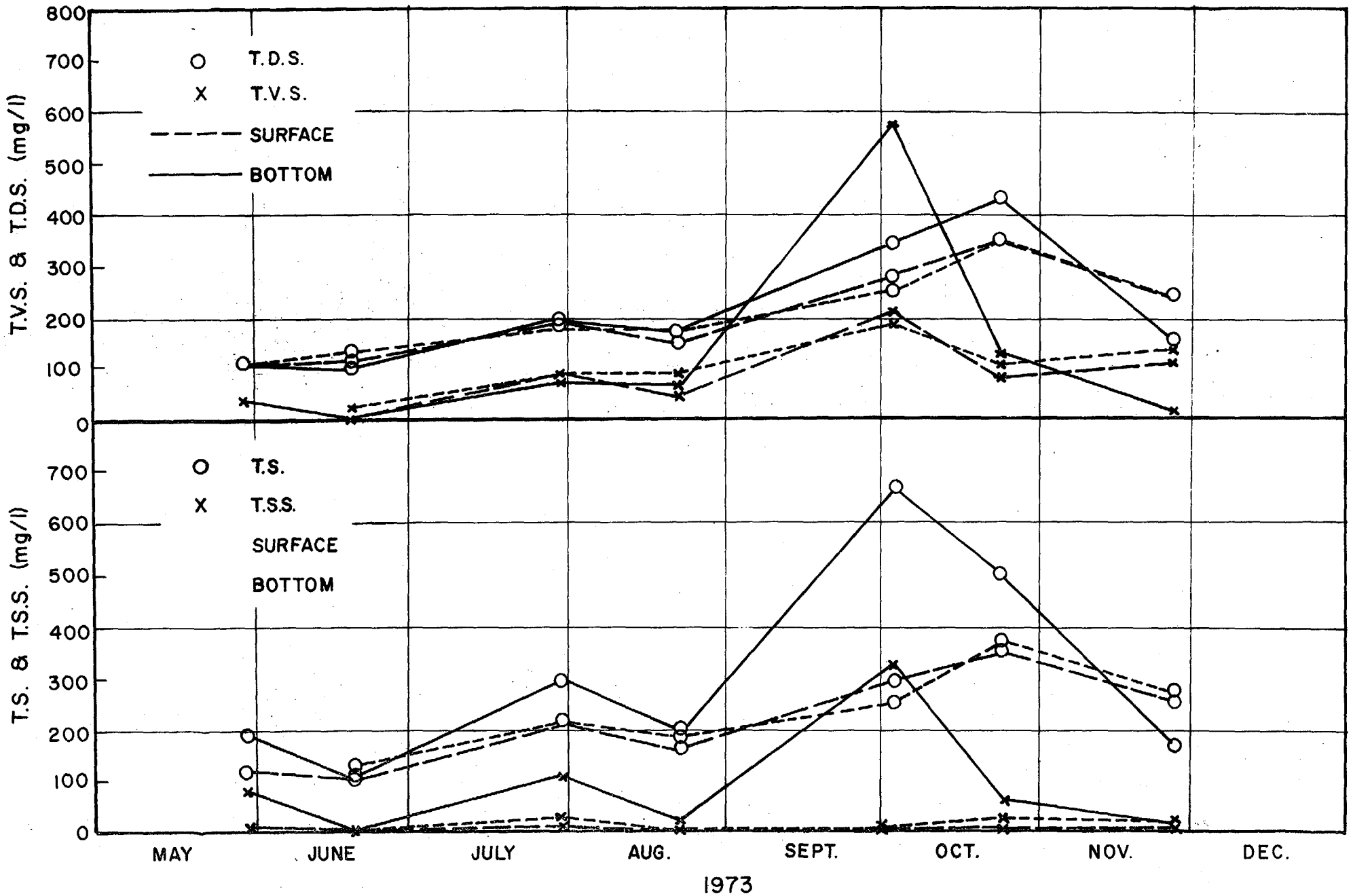
STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

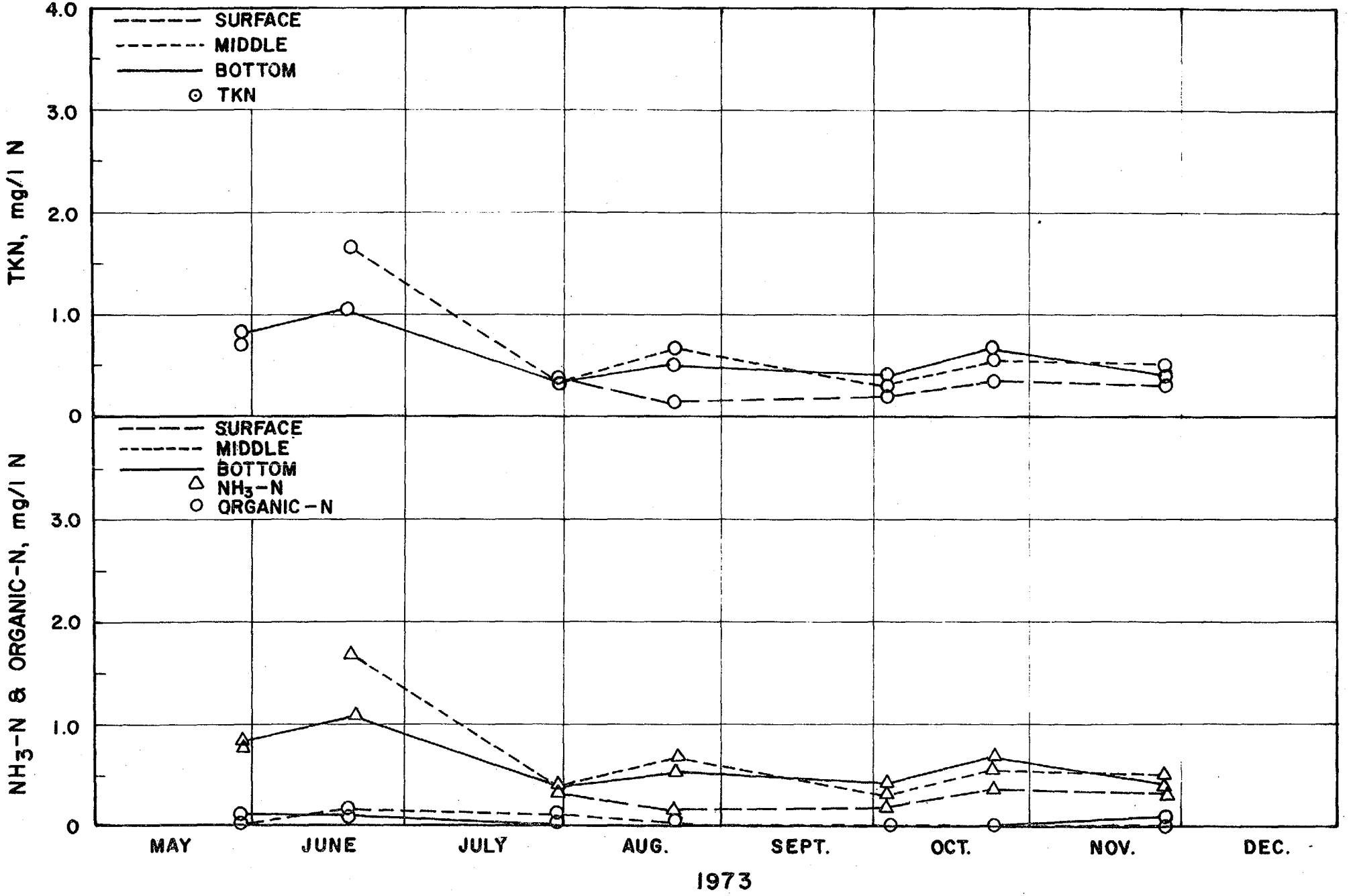
STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

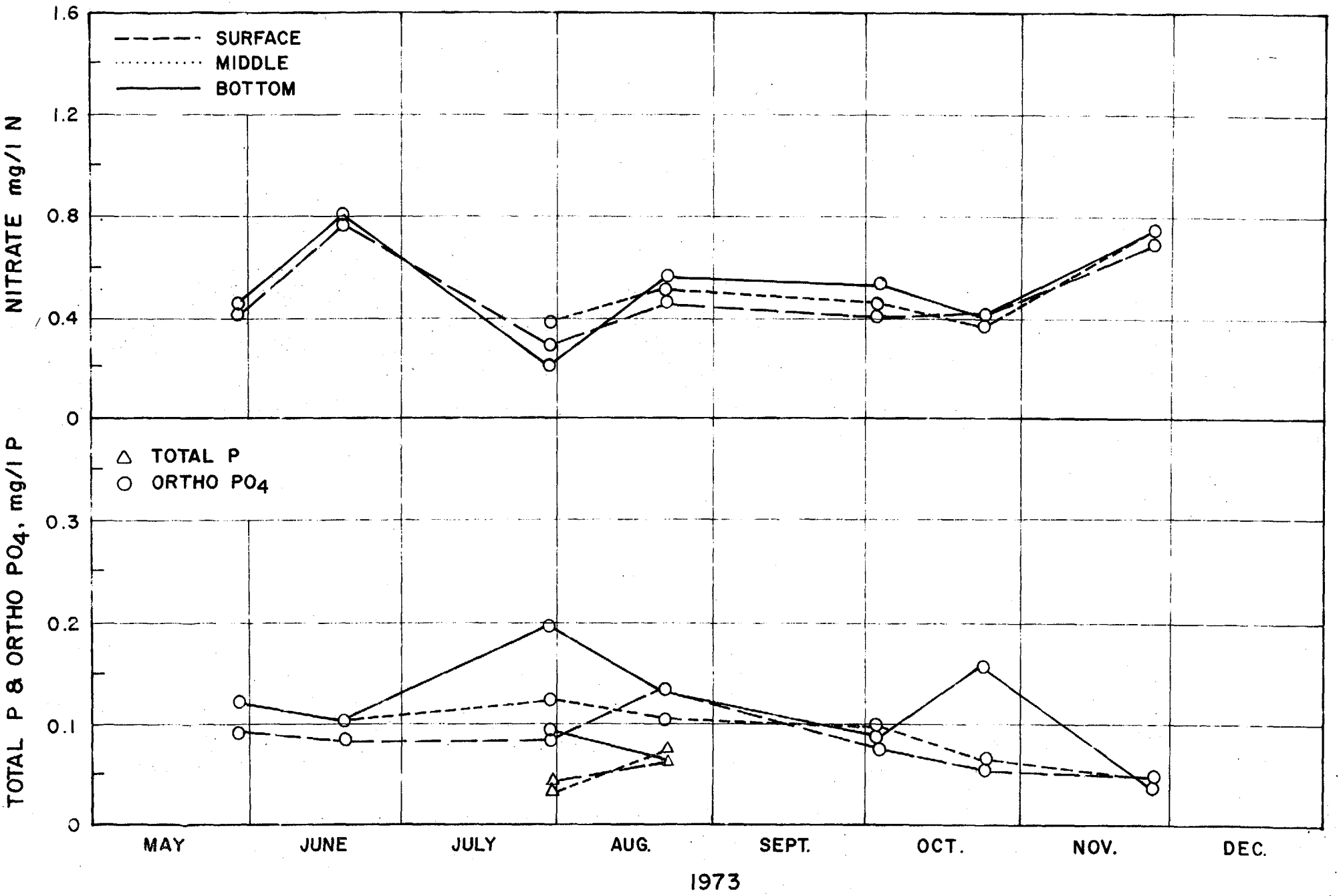
ROSETON & DANSKAMMER

STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

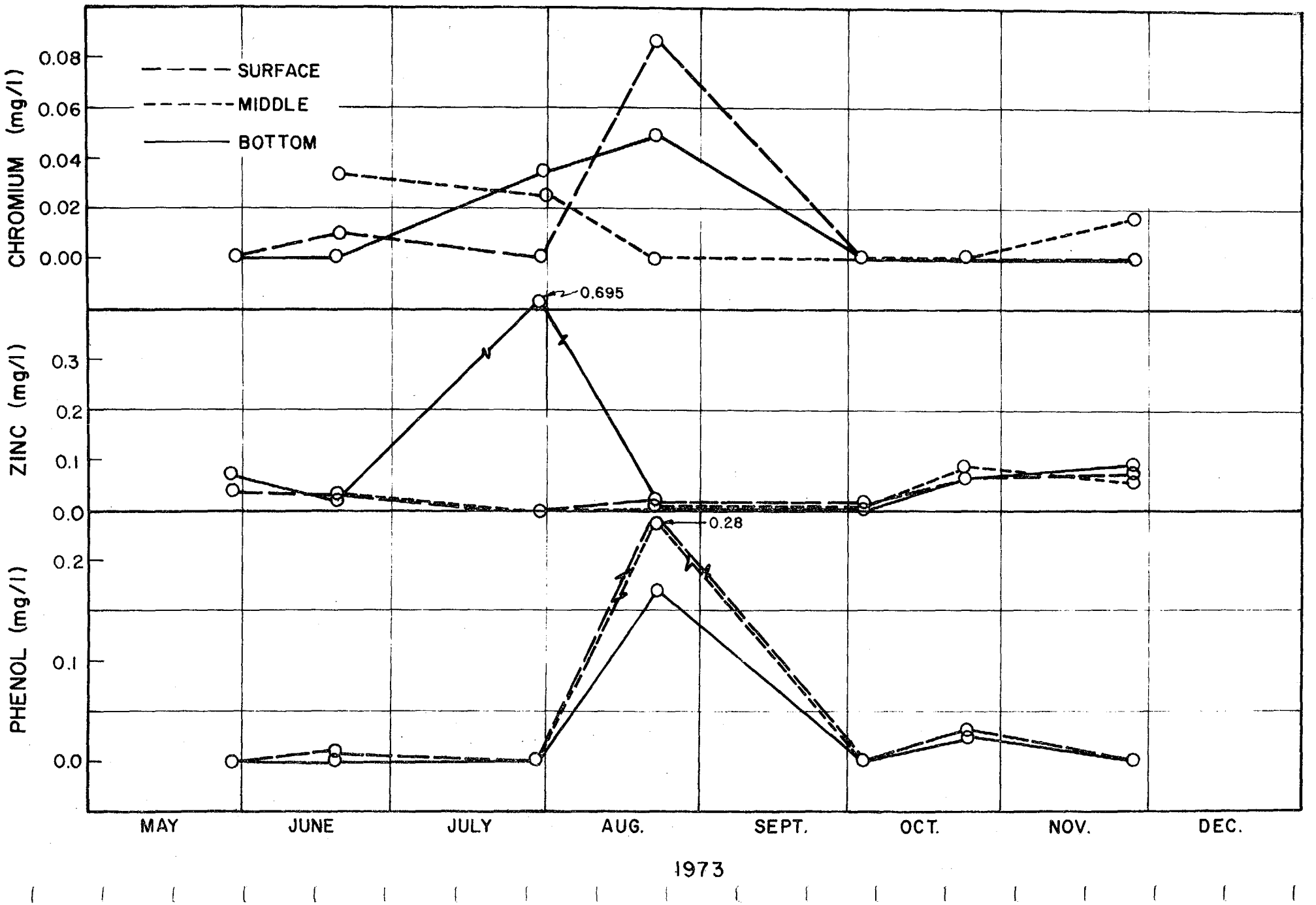
ROSETON & DANSKAMMER
STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-4 ROSETON DEEP EAST 80'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-4 ROSETON DEEP EAST 80'

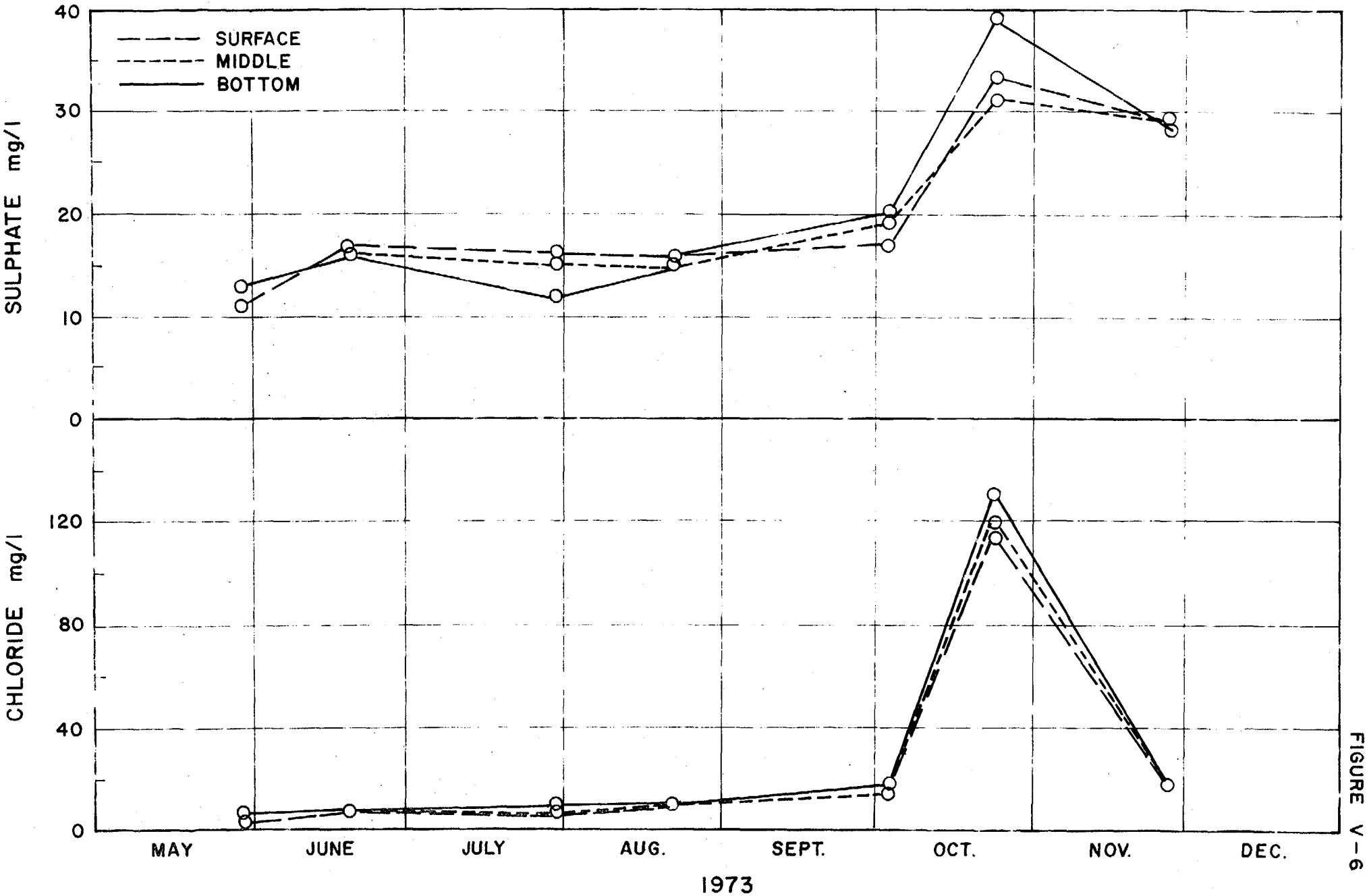
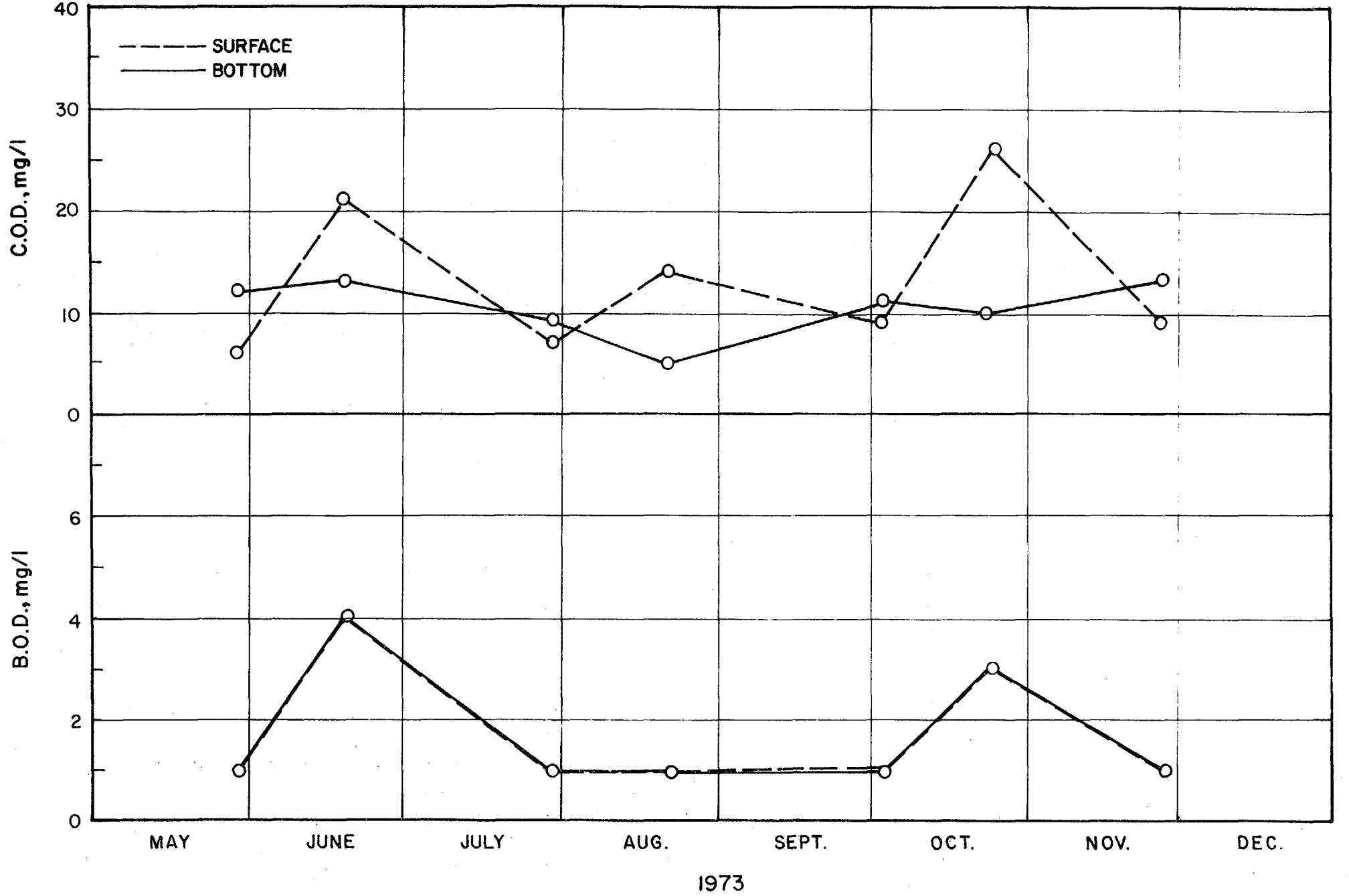


FIGURE V-6

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

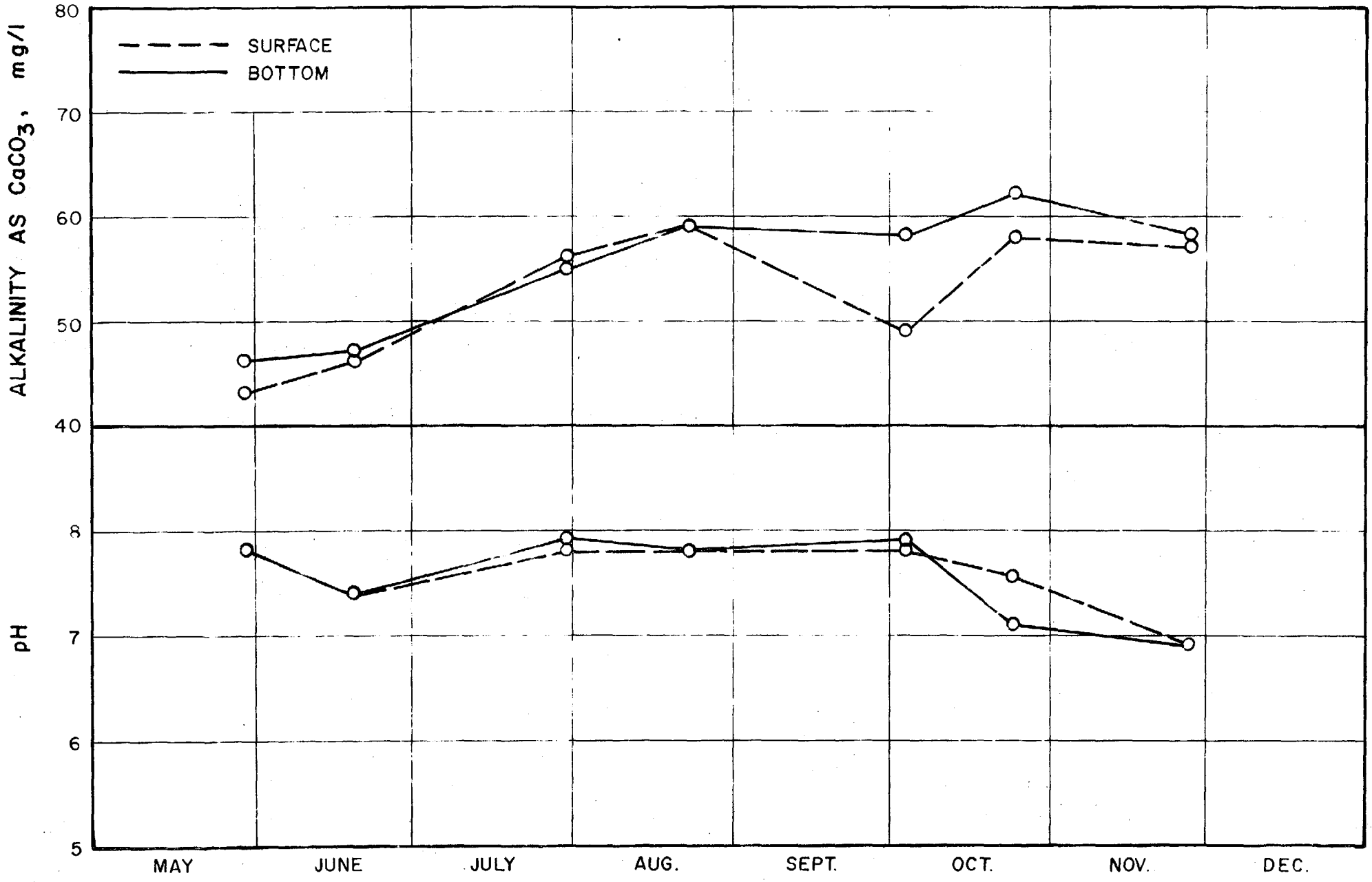
STATION CH-5 ROSETON SHALLOW EAST 25'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-5 ROSETON SHALLOW EAST 25'

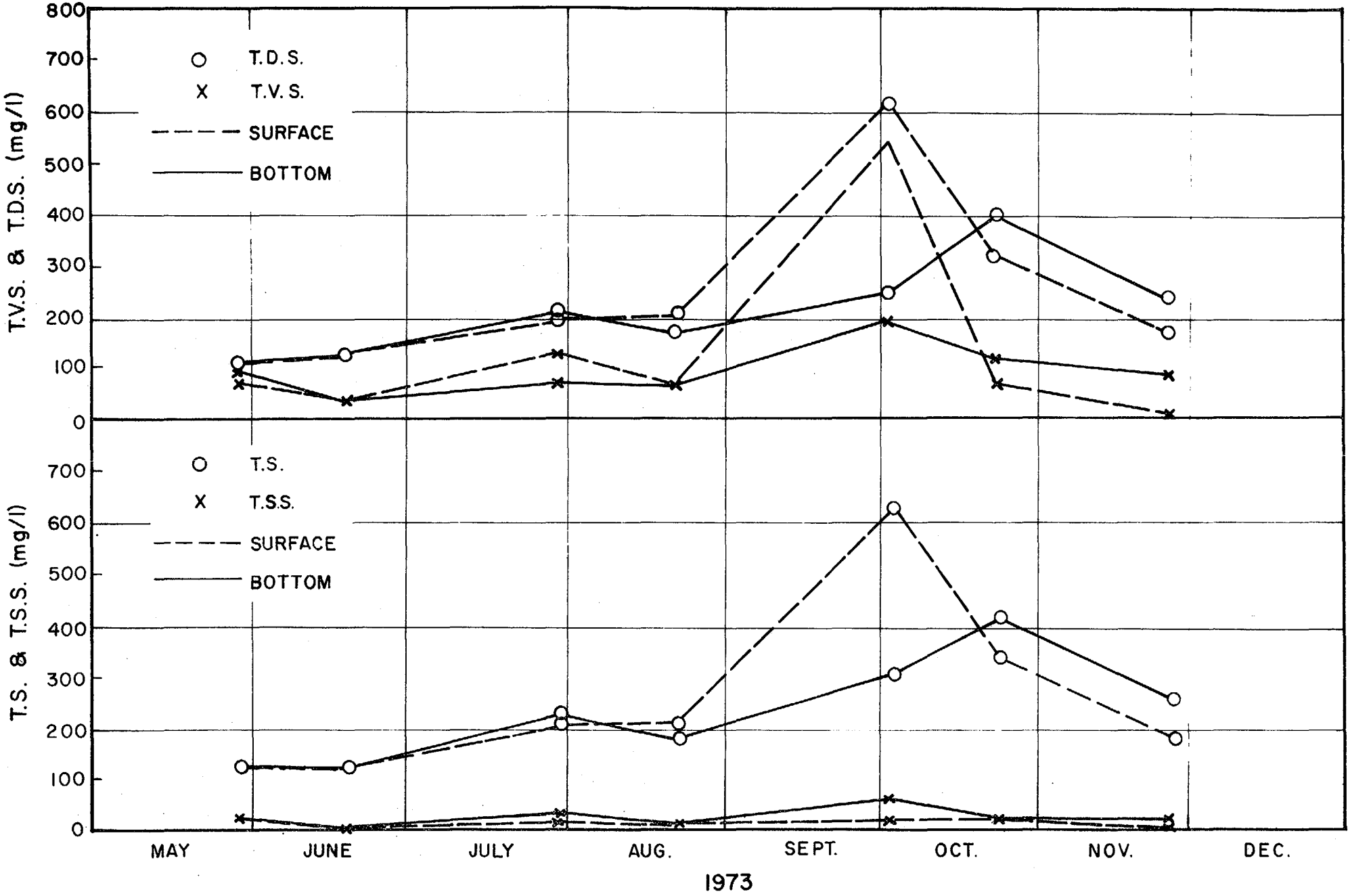


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CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

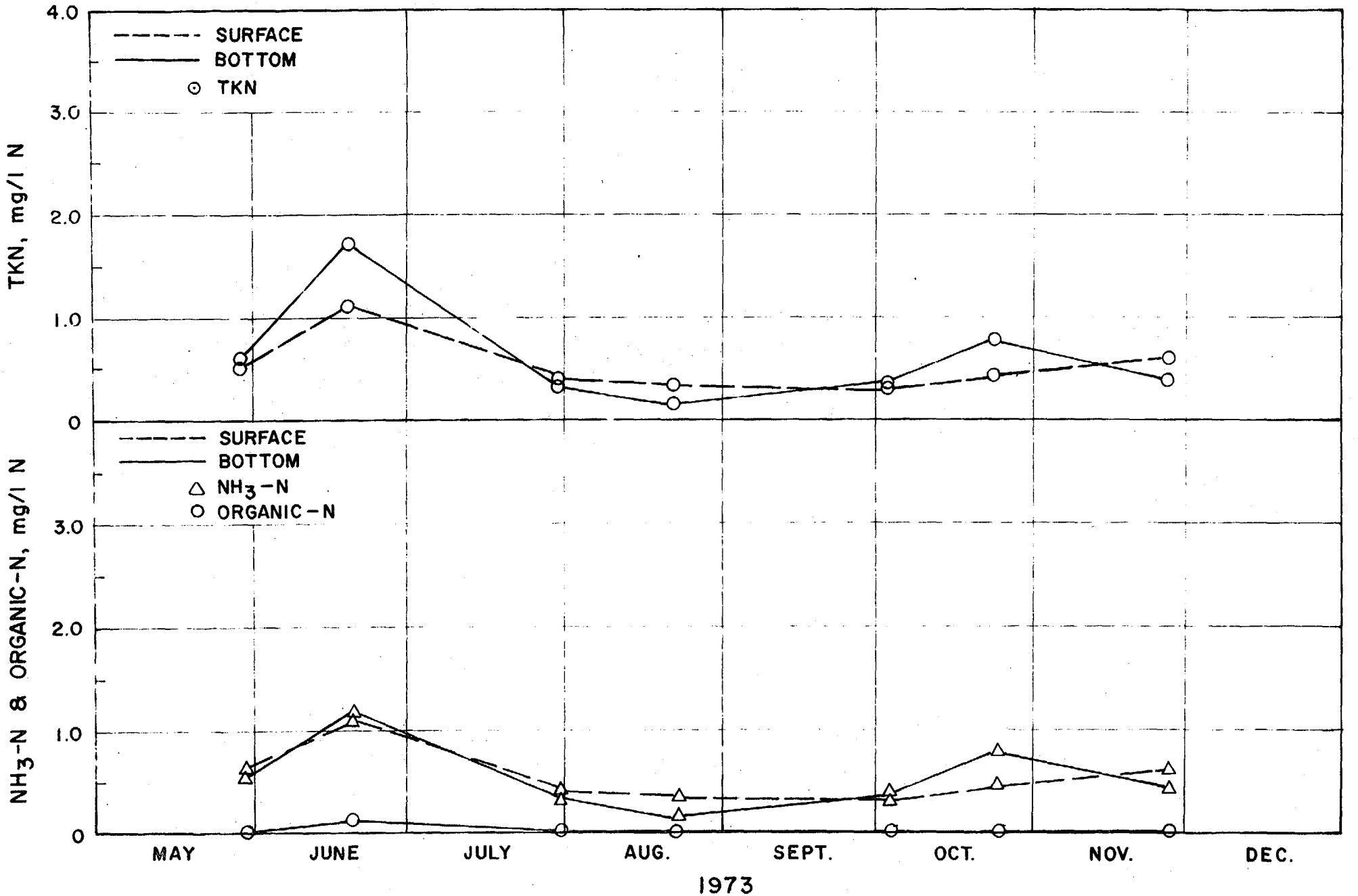
STATION CH-5 ROSETON SHALLOW EAST 25'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

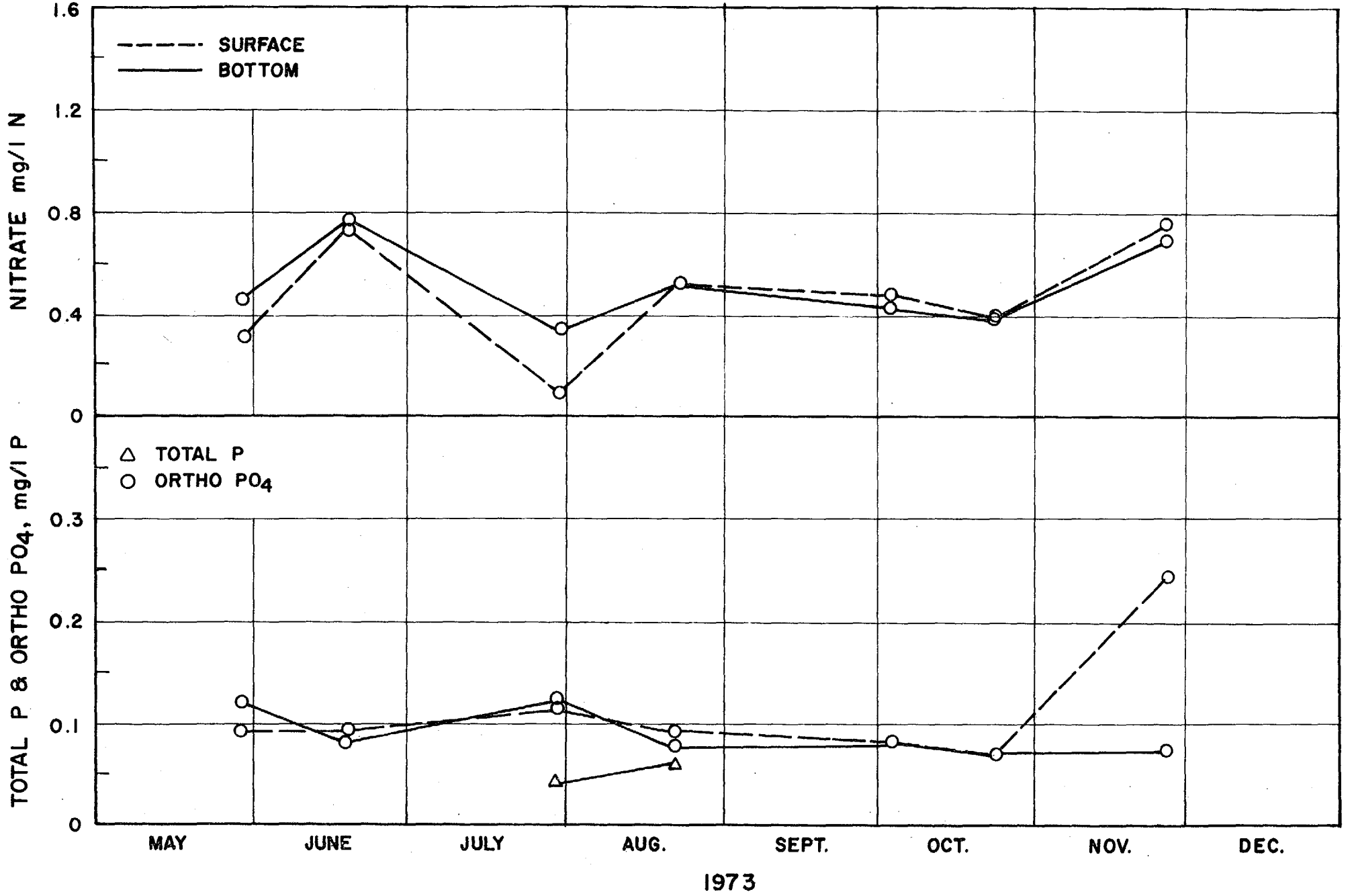
STATION CH-5 ROSETON SHALLOW, EAST 25'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

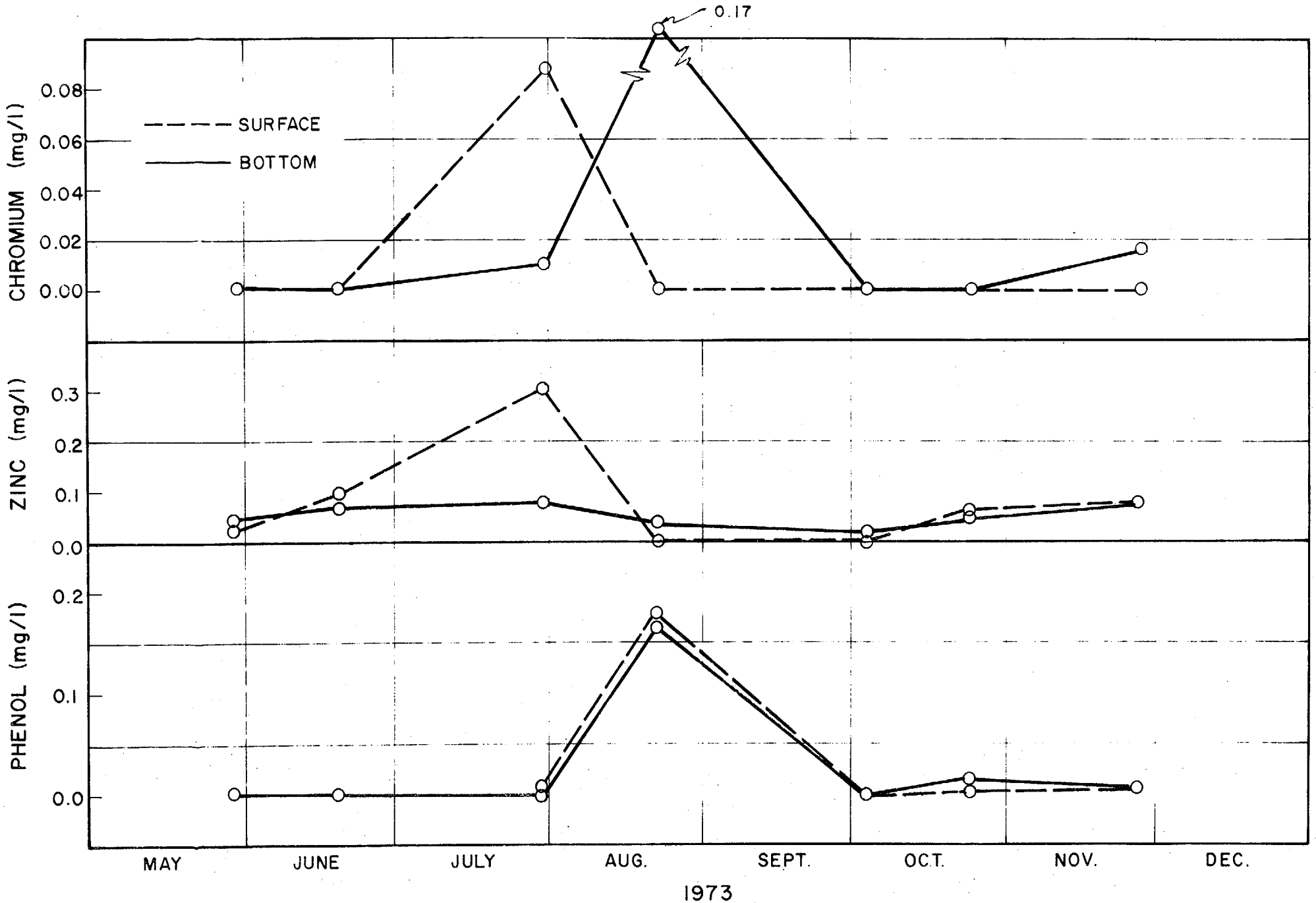
ROSETON & DANSKAMMER

STATION CH-5 ROSETON SHALLOW EAST 25'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER
STATION CH-5 ROSETON SHALLOW EAST 25'



CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

STATION CH-5 ROSETON SHALLOW EAST 25'

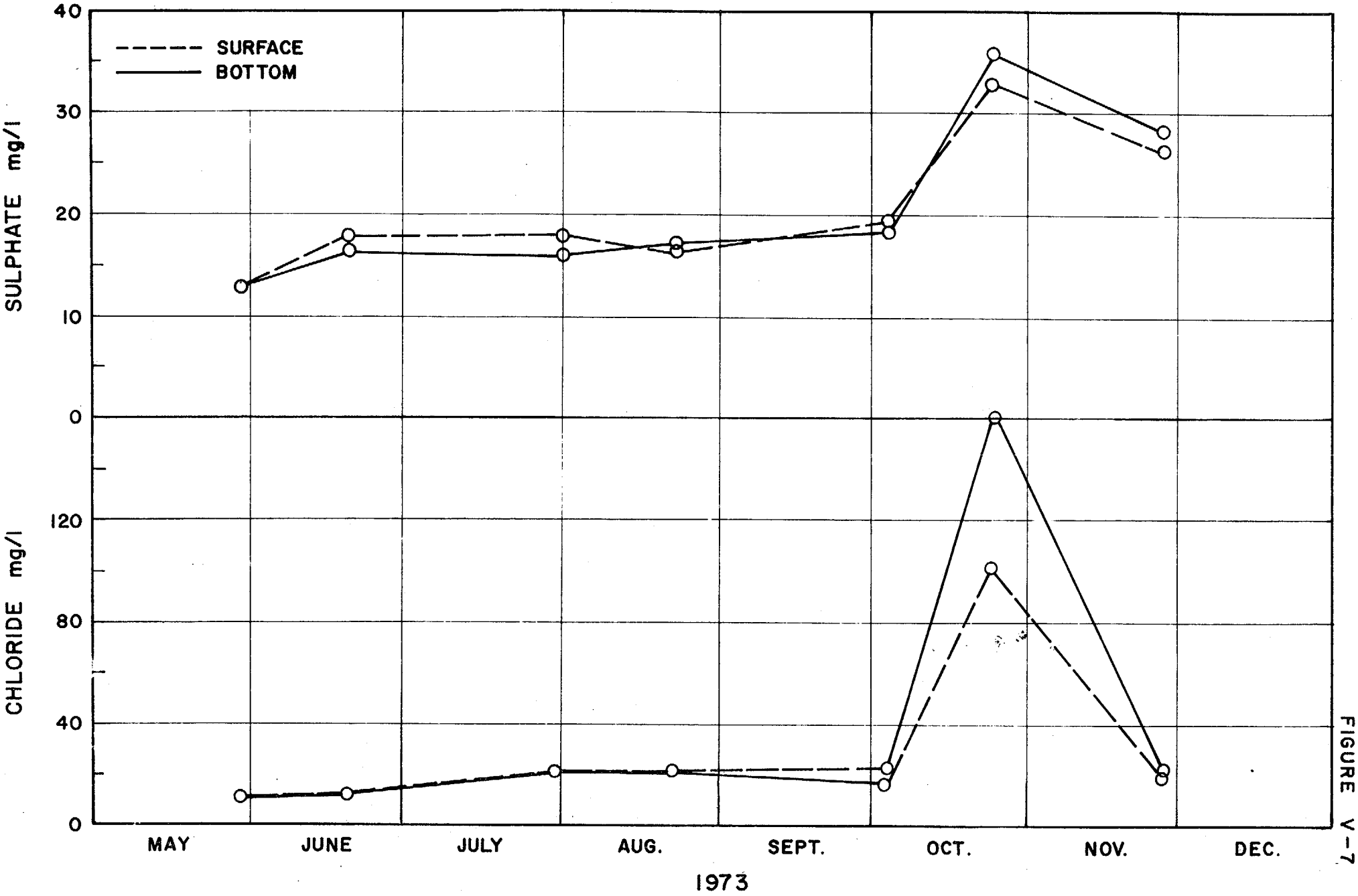
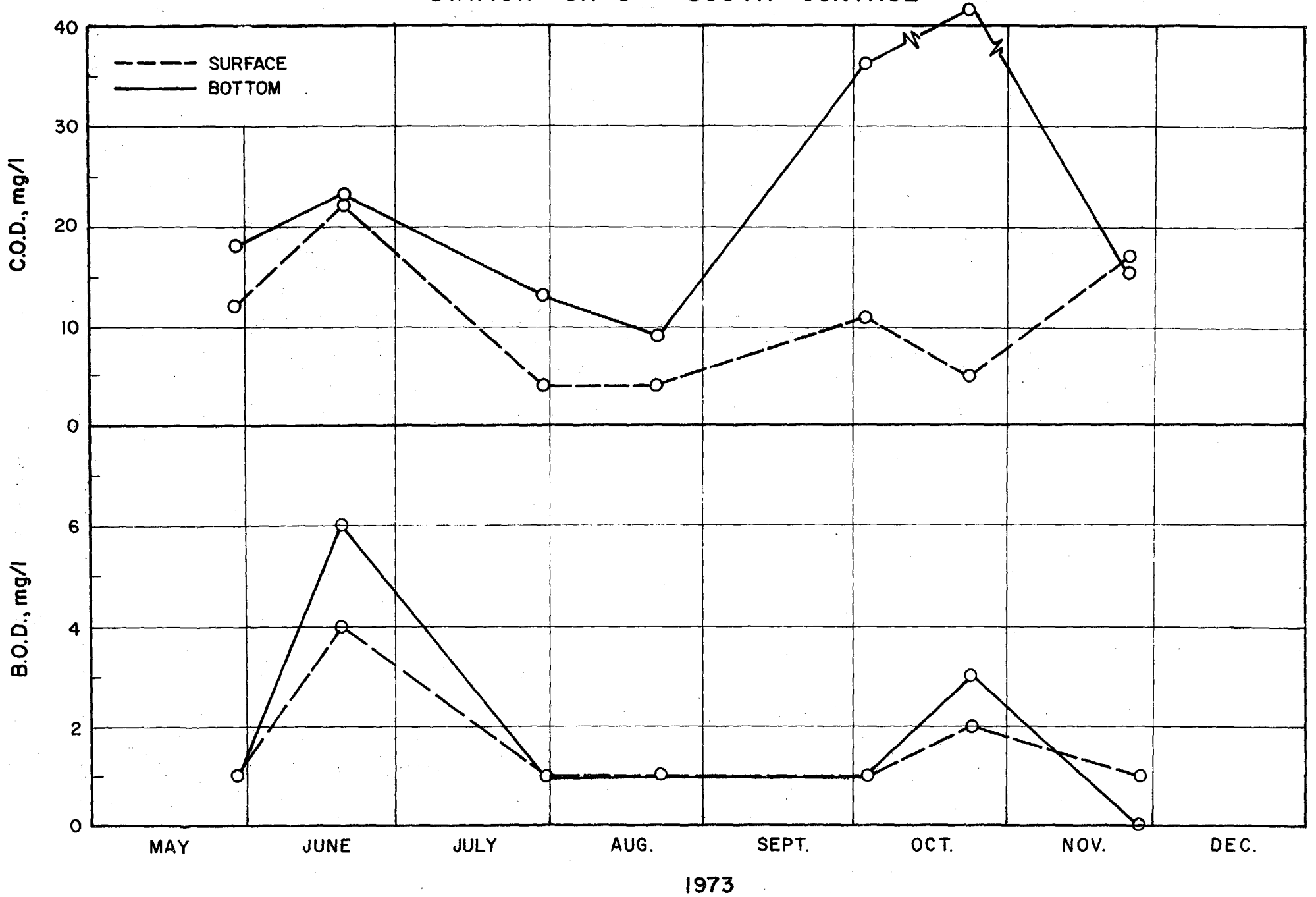


FIGURE V-7

CENTRAL HUDSON GAS & ELECTRIC CORPORATION

ROSETON & DANSKAMMER

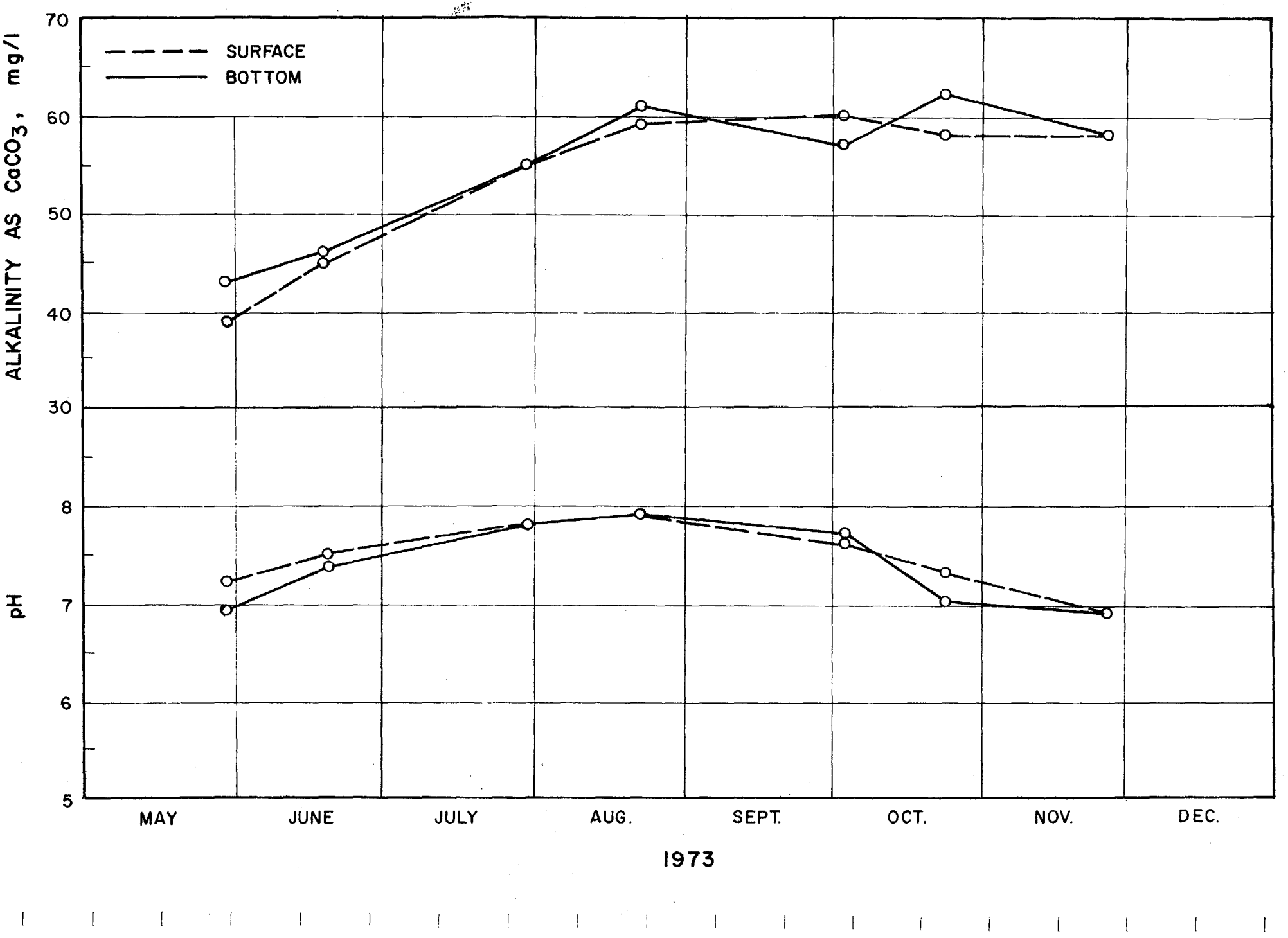
STATION CH-6 SOUTH CONTROL



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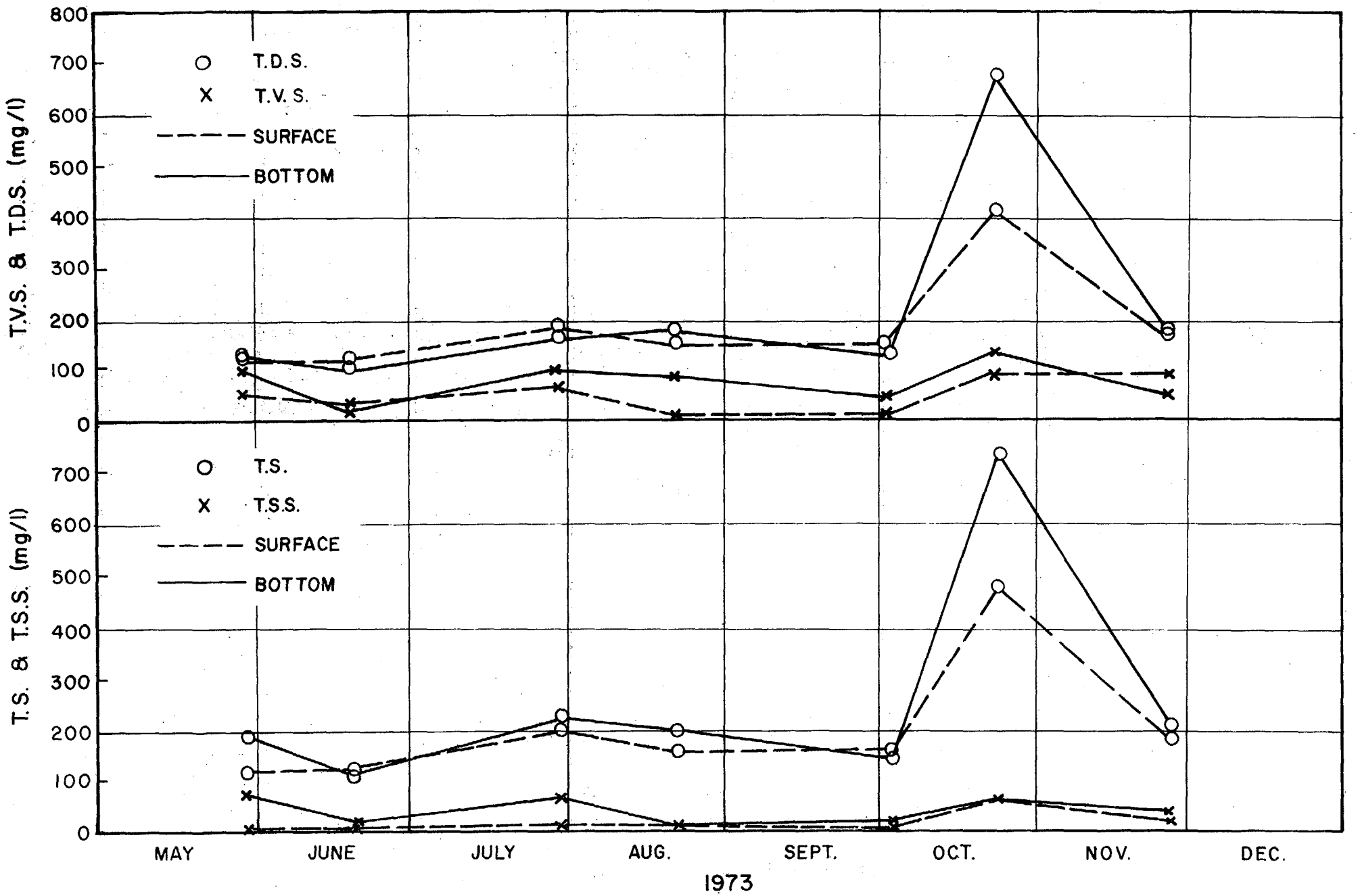
STATION CH-6 SOUTH CONTROL



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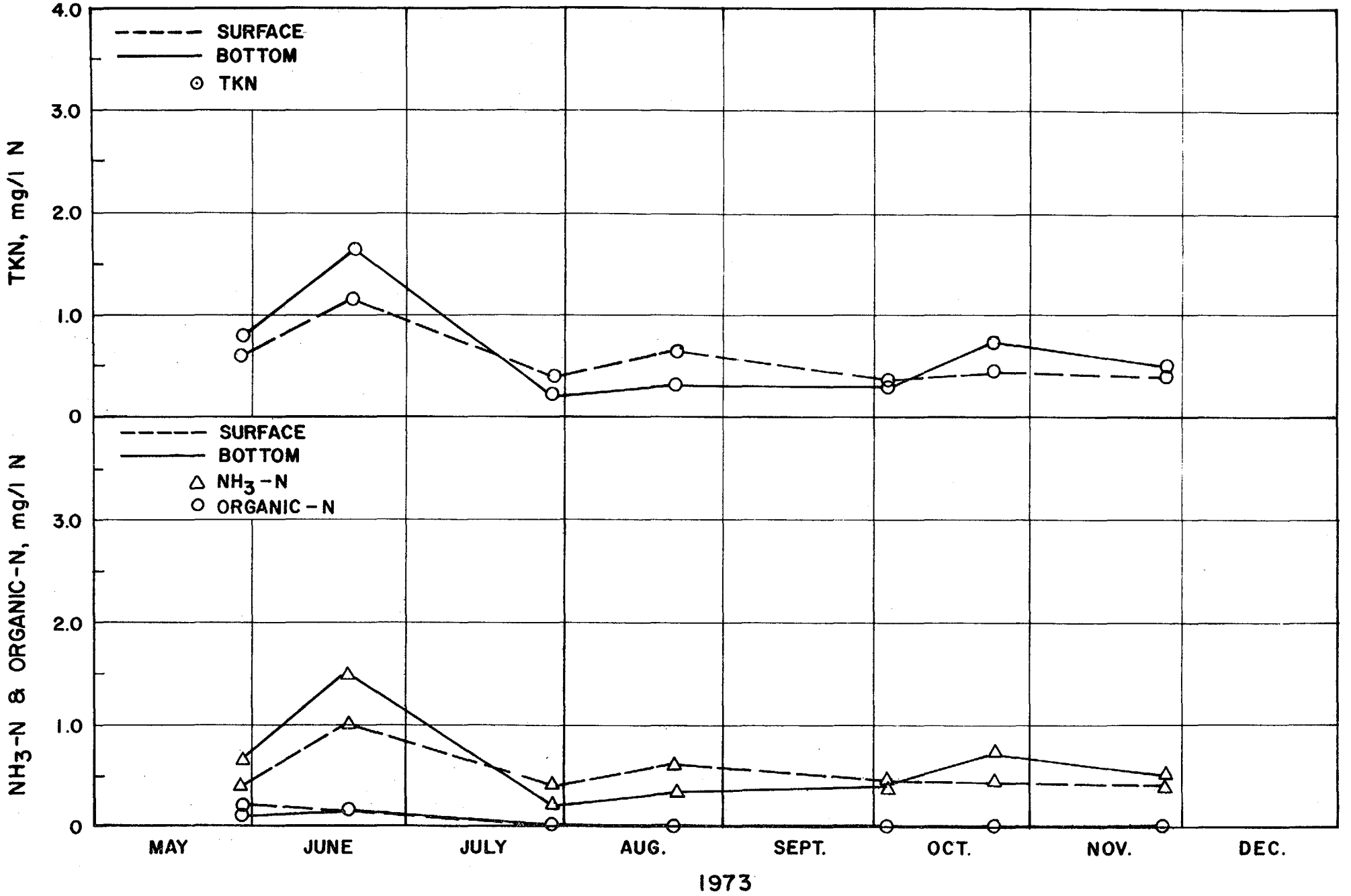
STATION CH-6 SOUTH CONTROL



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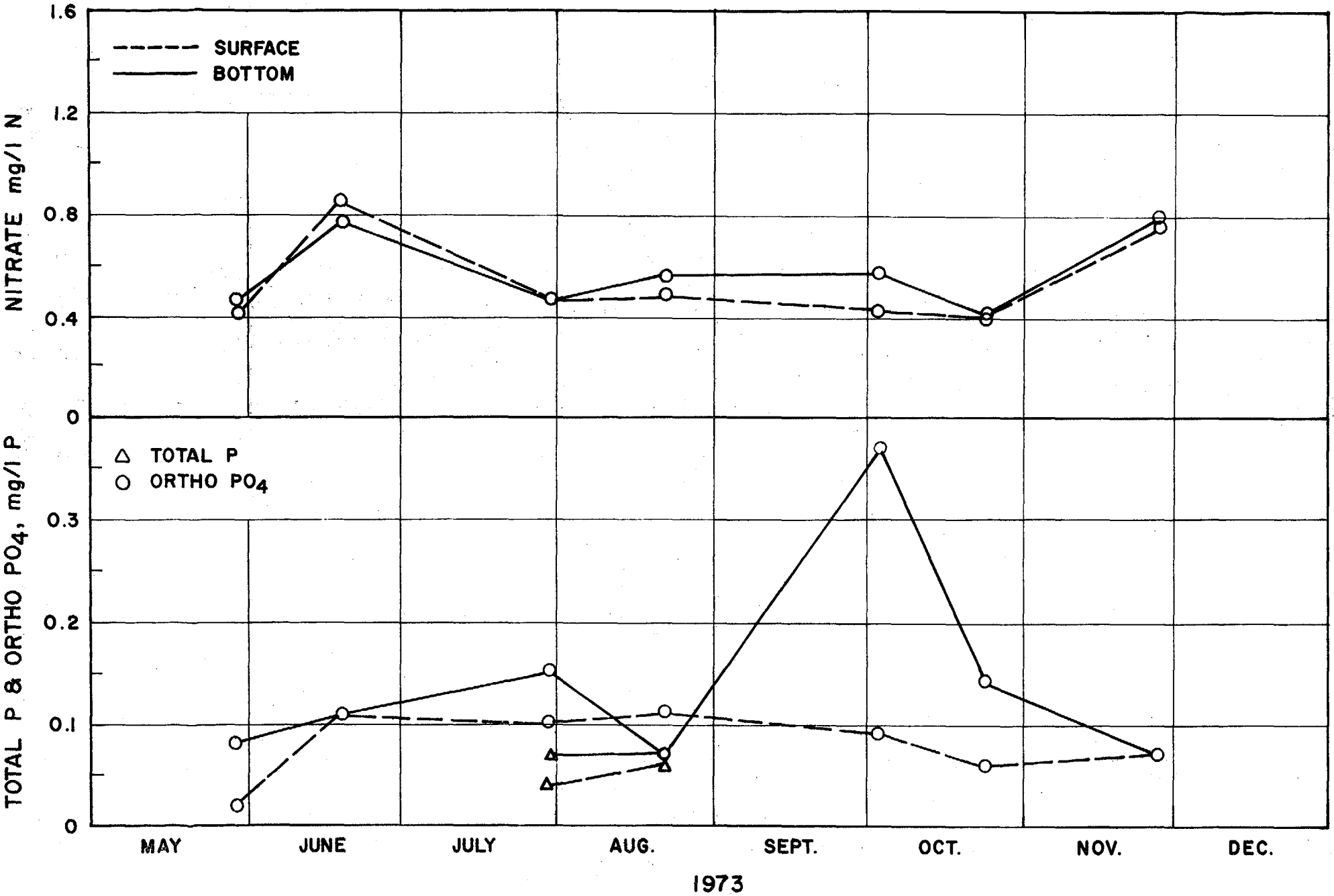
STATION CH-6 SOUTH CONTROL



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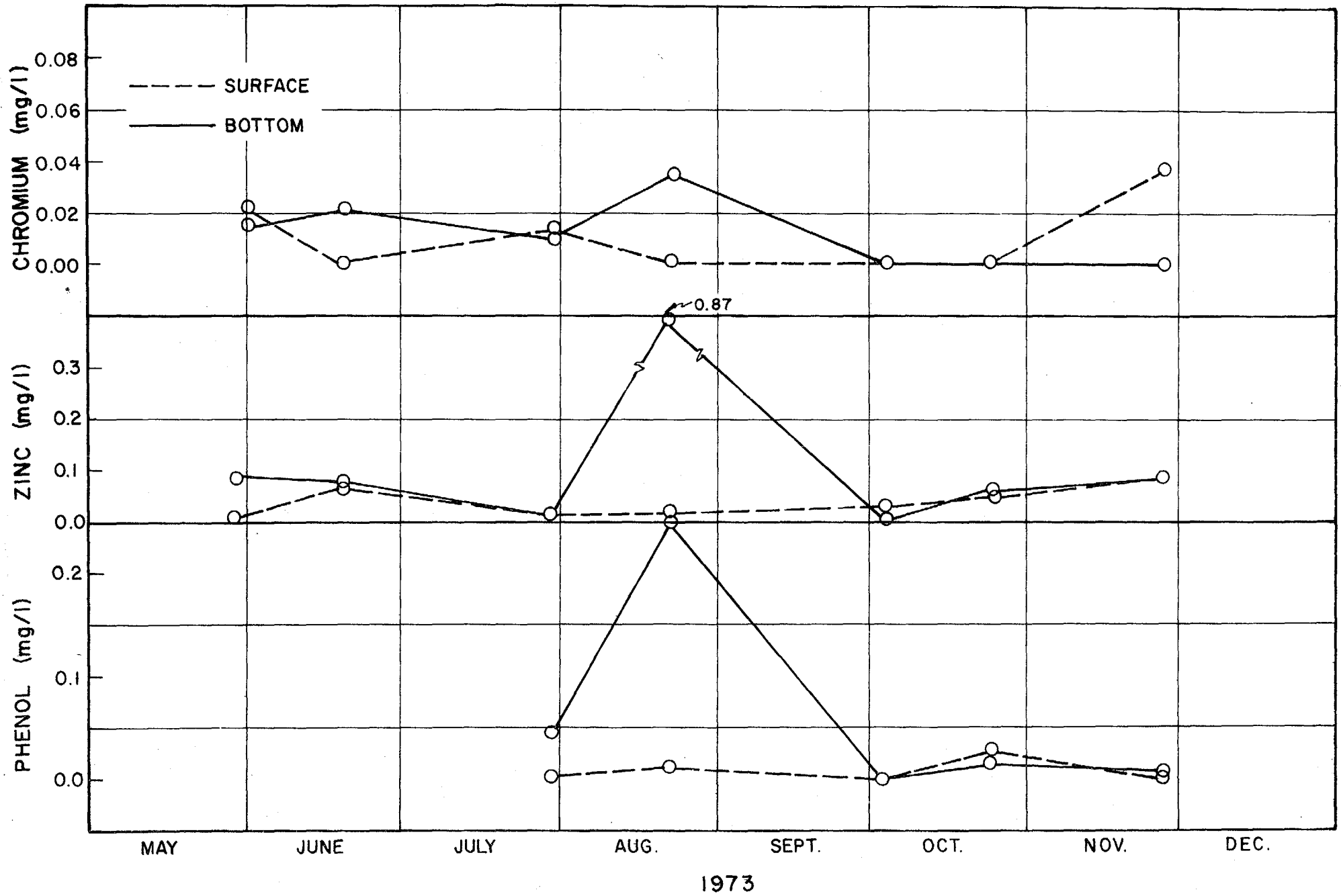
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STATION CH-6 SOUTH CONTROL



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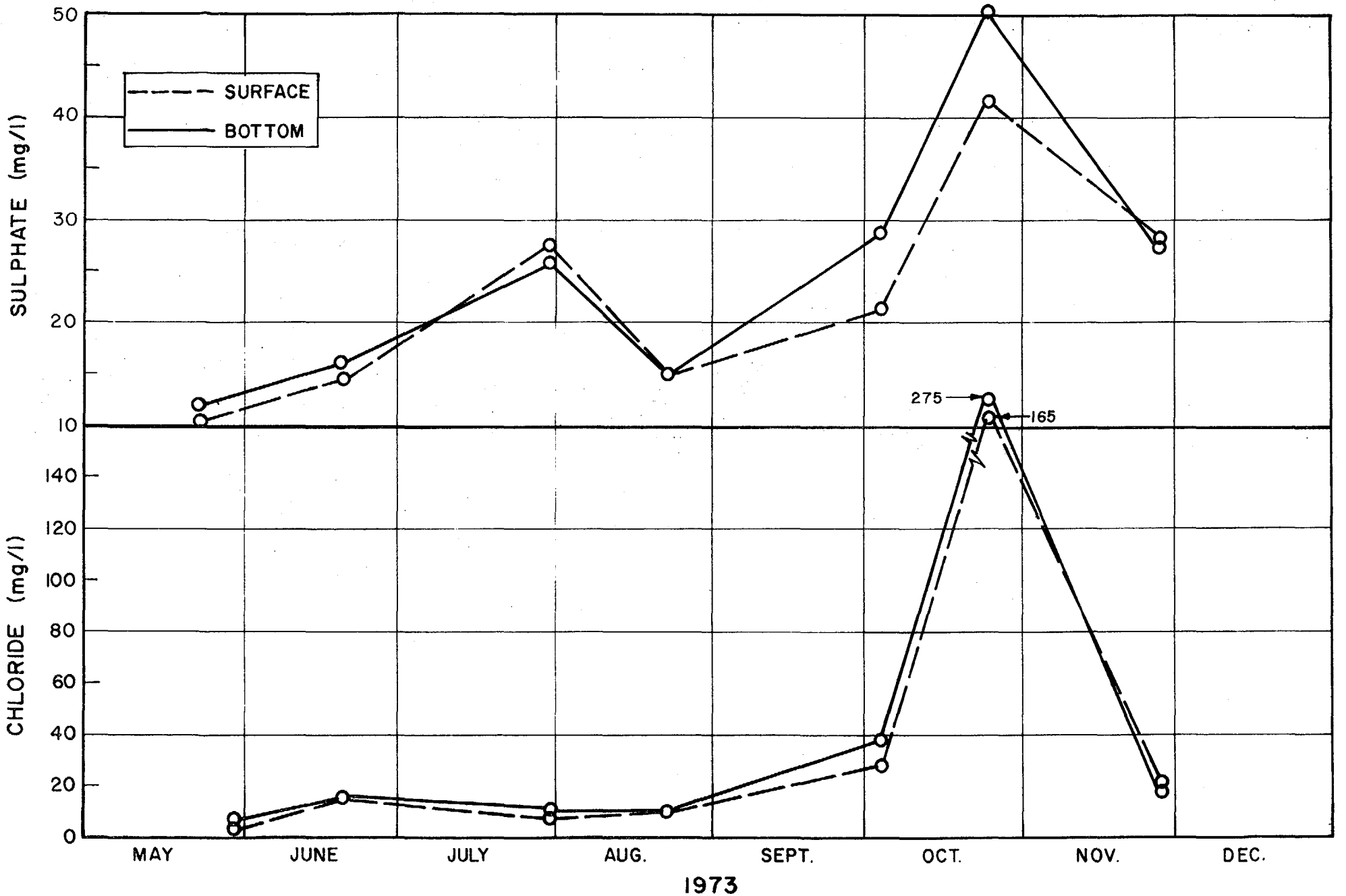
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STATION CH-6 SOUTH CONTROL



APPENDIX VII-D

APPENDIX VII-D

STATISTICAL SUMMARIES AND CORRELATIONS
1973 MONTHLY WATER QUALITY SAMPLING
ROSETON/DANSKAMMER POINT VICINITY

ALPHABETICAL LISTING OF PARAMETERS WITH ABBREVIATION

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Alkalinity	ALK	mg/l $CaCO_3$
Biochemical Oxygen Demand (Total)	TBOD	mg/l
Biochemical Oxygen Demand (Filtered)	FBOD	mg/l
Carbon Dioxide	CO_2	mg/l
Chemical Oxygen Demand (Total)	TCOD	mg/l
Chemical Oxygen Demand (Filtered)	FCOD	mg/l
Chloride	Cl	mg/l
Chlorophyll-A	Chla	µg/l
Coliforms:		
Total Coliform	TCol	# Colonies/100ml
Fecal Coliform	FCol	# Colonies/100ml
Color	Col	CU
Cyanide	CN	mg/l
Dissolved Oxygen (Lab Measurement)	DO	mg/l
Dissolved Oxygen (Field Measurement)	FDO	mg/l
Fluoride	F	mg/l
Nitrogen:		
Ammonia Nitrogen	NH_3N	mg/l N
Organic Nitrogen (Total)	ORGN	mg/l N
Organic Nitrogen (Dissolved/Filtered)	ORND	mg/l N
Total Kjeldahl Nitrogen	TKN	mg/l N
Nitrate Nitrogen	NO_3N	mg/l N
Nitrite Nitrogen (Total)	NO_2N	mg/l N
Nitrite Nitrogen (Filtered)	NO_2F	mg/l N
Oil & Grease	OG	mg/l
pH (Lab Measurement)	pH	

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals		
Aluminum	Al	mg/l
Antimony	Sb	mg/l
Arsenic	As	mg/l
Barium	Ba	mg/l
Beryllium	Be	mg/l
Cadmium	Cd	mg/l
Calcium	Ca	mg/l
Chromium	Cr	mg/l
Cobalt	Co	mg/l
Copper	Cu	mg/l
Iron	Fe	mg/l
Lead	Pb	mg/l
Magnesium	Mg	mg/l
Manganese	Mn	mg/l
Mercury	Hg	mg/l
Molybdenum	Mo	mg/l
Nickel	Ni	mg/l
Potassium	K	mg/l
Selenium	Se	mg/l
Silicon	Si	mg/l
Silver	Ag	mg/l
Sodium	Na	mg/l
Thallium	Tl	mg/l
Tin	Sn	mg/l
Titanium	Ti	mg/l

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
(Field Measurement)	FpH	
Phenols	Phl	mg/l
Phosphorus:		
Ortho-Phosphate	OP	mg/l P
Total Phosphorus	TP	mg/l P
Salinity (Field)	FSAL	ppt
Settleable Residue	SetR	ml/l/hr
Solids:		
Total Solids	TS	mg/l
Total Dissolved Solids	TDS	mg/l
Total Volatile Solids	TVS	mg/l
Total Suspended Solids	TSS	mg/l
Volatile Suspended Solids	VSS	mg/l
Specific Conductance:		
(Lab Measurements)	SpC	µmhos/cm at 25° C
(Field Measurements)	FCon	µmhos/cm at 25° C
Sulfate	SO_4	mg/l
Surfactant	Sur	µm/l LAS
Temperature	T	°F
Total Hardness	TH	mg/l $CaCO_3$
Total Inorganic Carbon (Total)	TTIC	mg/l
Total Inorganic Carbon (Filtered)	FTIC	mg/l
Total Organic Carbon (Total)	TTOC	mg/l
Total Organic Carbon (Filtered)	FTOC	mg/l
Turbidity	Tur	FTU

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals Cont'd.		
Vanadium	V	mg/l
Zinc	Zn	mg/l

TABLE VII-D-2
CH-1
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	17.0000	3.0000	8.7500	19.6429	4.4320
TSS	8	85.0000	1.0000	18.7500	774.5000	27.8298
TKN	8	0.6300	0.0000	0.4150	0.0399	0.1997
CL	8	50.0000	6.0000	15.5000	215.4286	14.6775
PHL	8	0.0350	0.0000	0.0091	0.0002	0.0131
CR	8	0.0350	0.0000	0.0128	0.0002	0.0144
ZN	8	0.1020	0.0060	0.0444	0.0008	0.0279
ALK	8	61.0000	43.0000	53.0000	56.0000	7.4833
NH3N	8	0.2000	0.0000	0.0375	0.0055	0.0744
TP	8	0.0900	0.0200	0.0625	0.0007	0.0260

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.422	1.000								
TKN	-0.311	0.436	1.000							
CL	-0.226	0.116	0.047	1.000						
PHL	-0.113	-0.070	-0.211	0.733	1.000					
CR	-0.109	0.581	0.525	-0.342	-0.653	1.000				
ZN	0.049	0.037	-0.121	0.172	0.054	-0.340	1.000			
ALK	0.302	-0.416	-0.483	0.475	0.598	-0.821	0.010	1.000		
NH3N	-0.141	0.323	0.466	-0.307	-0.403	0.624	-0.297	-0.744	1.000	
TP	-0.068	-0.021	-0.198	-0.284	-0.083	-0.478	-0.523	0.183	-0.424	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	210.0000	75.0000	140.6250	1710.2679	41.3554
CL	8	50.0000	6.0000	15.5000	215.4286	14.6775
SO4	8	28.0000	12.0000	18.6250	37.4107	6.1164
TBOD	8	2.0000	0.0000	1.1250	0.4107	0.6409
NO3N	8	0.7600	0.2700	0.5063	0.0375	0.1935
TCOD	8	17.0000	3.0000	8.7500	19.6429	4.4320
T	5	71.6000	46.4000	62.9600	142.9280	11.9552
PH	8	7.8000	6.9000	7.5250	0.0879	0.2964
TVS	8	80.0000	16.0000	46.1250	576.6964	24.0145
TS	8	235.0000	105.0000	160.0000	1357.1429	36.8394

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.727	1.000								
SO4	0.653	0.738	1.000							
TBOD	-0.650	-0.251	-0.569	1.000						
NO3N	-0.615	-0.195	-0.076	0.258	1.000					
TCOD	-0.100	-0.226	-0.215	-0.239	-0.244	1.000				
T	0.169	0.310	-0.097	0.733	-0.291	-0.453	1.000			
PH	-0.101	-0.378	-0.774	0.432	-0.586	0.049	0.584	1.000		
TVS	0.490	0.189	-0.025	-0.159	-0.699	-0.079	0.498	0.487	1.000	
TS	0.760	0.875	0.685	-0.363	-0.439	-0.424	0.146	-0.275	0.500	1.000

TABLE VII-D-3
CH-1
BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	23.0000	9.0000	16.2500	21.0714	4.5904
TSS	8	145.0000	11.0000	59.8750	2848.6964	53.3732
TKN	8	0.9500	0.0000	0.4813	0.1036	0.3219
CL	8	69.0000	6.0000	18.1250	436.1250	20.8836
PHL	8	0.0500	0.0000	0.0211	0.0005	0.0226
CR	8	0.0600	0.0000	0.0173	0.0005	0.0226
ZN	8	0.4560	0.0250	0.1154	0.0199	0.1409
ALK	8	61.0000	40.0000	52.1250	62.6964	7.9181
NH3N	8	0.0000	0.0000	0.0000	0.0000	0.0000
TP	8	0.2200	0.0500	0.1300	0.0033	0.0576

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.708	1.000								
TKN	0.291	0.092	1.000							
CL	-0.134	-0.284	0.086	1.000						
PHL	0.416	0.504	0.141	0.232	1.000					
CR	0.741	0.734	0.420	-0.397		1.000				
ZN	-0.291	-0.380	0.222	-0.124	-0.169	-0.128	1.000			
ALK	-0.441	-0.585	-0.629	0.555	-0.057	-0.822	-0.233	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	0.368	0.759	-0.059	-0.360	0.041	0.549	-0.264	-0.467	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD.DEV.
TDS	8	275.0000	75.0000	165.6250	4595.9821	67.7937
CL	8	69.0000	6.0000	18.1250	436.1250	20.8836
SO4	8	30.0000	13.0000	19.2500	48.2143	6.9437
TBOD	8	4.0000	0.0000	2.0000	1.4286	1.1952
NO3N	8	0.8300	0.3100	0.5713	0.0462	0.2149
TCOD	8	23.0000	9.0000	16.2500	21.0714	4.5904
T	5	72.5000	46.4000	62.8600	141.3230	11.8879
PH	8	7.8000	6.9000	7.4500	0.1114	0.3338
TVS	8	120.0000	28.0000	69.2500	938.7857	30.6396
TS	8	320.0000	120.0000	226.3750	5097.9821	71.4002

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.613	1.000								
SO4	0.713	0.669	1.000							
TBOD	-0.379	0.217	-0.310	1.000						
NO3N	-0.238	-0.364	0.241	-0.317	1.000					
TCOD	0.055	-0.134	-0.061	0.078	0.058	1.000				
T	-0.320	0.391	-0.168	0.352	-0.494	-0.785	1.000			
PH	-0.724	-0.624	-0.949	0.215	-0.284	0.009	0.271	1.000		
TVS	0.803	0.186	0.442	-0.636	-0.223	0.023	-0.485	-0.346	1.000	
TS	0.706	0.369	0.457	-0.392	-0.287	0.591	-0.579	-0.395	0.649	1.000

TABLE VII-D-4
CH-2
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	25.0000	3.0000	11.2500	49.3571	7.0255
TSS	8	70.0000	3.0000	24.6250	427.1250	20.6670
TKN	8	0.8900	0.1500	0.5325	0.0838	0.2891
CL	8	47.0000	4.0000	15.0000	189.4286	13.7633
PHL	8	0.0500	0.0000	0.0125	0.0003	0.0170
CR	8	0.0240	0.0000	0.0060	0.0001	0.0091
ZN	8	0.1440	0.0000	0.0513	0.0025	0.0503
ALK	8	58.0000	40.0000	50.8750	47.5536	6.8959
NH3N	8	0.1000	0.0000	0.0250	0.0021	0.0463
TP	8	0.1200	0.0300	0.0875	0.0010	0.0315

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.454	1.000								
TKN	0.743	-0.225	1.000							
CL	0.697	-0.212	0.278	1.000						
PHL	-0.409	0.876	-0.401	0.030	1.000					
CR	-0.178	0.457	0.300	-0.107	0.092	1.000				
ZN	0.590	-0.123	0.857	0.200	-0.224	-0.172	1.000			
ALK	0.237	-0.645	-0.090	0.509	-0.428	-0.245	-0.028	1.000		
NH3N	-0.329	0.668	-0.091	-0.022	0.455	0.878	-0.156	-0.257	1.000	
TP	-0.332	0.128	-0.512	-0.250	0.491	-0.735	-0.195	-0.061	-0.441	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	210.0000	95.0000	158.1250	1878.1250	43.3373
CL	8	47.0000	4.0000	15.0000	189.4286	13.7633
SO4	8	27.0000	10.0000	18.2500	41.0714	6.4087
TBOD	8	4.0000	0.0000	1.5000	1.4286	1.1952
NO3N	8	0.7700	0.3400	0.5525	0.0315	0.1774
TCOD	8	25.0000	3.0000	11.2500	49.3571	7.0255
T	5	72.0000	48.2000	63.4400	131.1480	11.4520
PH	8	7.8000	6.9000	7.5375	0.0913	0.3021
TVS	8	95.0000	25.0000	66.2500	667.9286	25.8443
TS	8	235.0000	110.0000	183.1250	2106.6964	45.8988

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.659	1.000								
SO4	0.784	0.794	1.000							
TBOD	-0.545	0.026	-0.224	1.000						
NO3N	-0.258	-0.201	0.106	0.128	1.000					
TCOD	0.182	0.697	0.398	0.425	-0.130	1.000				
T	-0.196	0.325	0.017	0.822	-0.278	0.366	1.000			
PH	-0.245	-0.158	-0.611	0.099	-0.767	-0.146	0.411	1.000		
TVS	0.612	0.439	0.377	0.462	-0.211	-0.291	0.179	0.191	1.000	
TS	0.896	0.526	0.679	0.671	-0.091	-0.032	-0.322	-0.247	0.735	1.000

Cat 1

TABLE VII-D-5
CH-3
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	20.0000	4.0000	11.5000	23.1429	4.8107
TSS	8	70.0000	9.0000	24.3750	372.8393	19.3090
TKN	8	1.3100	0.2300	0.6350	0.1363	0.3691
CL	8	93.0000	5.0000	20.7500	872.7857	29.5429
PHL	8	0.1110	0.0000	0.0270	0.0015	0.0393
CR	8	0.0180	0.0000	0.0066	0.0001	0.0091
ZN	8	0.1900	0.0000	0.0704	0.0038	0.0616
ALK	8	61.0000	43.0000	53.0000	49.1429	7.0102
NH3N	8	0.1000	0.0000	0.0250	0.0021	0.0463
TP	8	0.1100	0.0500	0.0763	0.0004	0.0200

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.394	1.000								
TKN	0.856	-0.051	1.000							
CL	-0.138	-0.089	0.253	1.000						
PHL	-0.240	0.303	-0.389	0.074	-1.000					
CR	-0.190	0.340	0.232	-0.321	-0.231	1.000				
ZN	-0.302	-0.225	0.134	0.013	-0.570	0.491	1.000			
ALK	-0.165	-0.602	-0.383	0.366	0.372	-0.619	-0.126	1.000		
NH3N	0.257	0.547	0.577	-0.235	-0.031	0.734	-0.069	-0.748	1.000	
TP	0.097	0.019	0.189	-0.230	0.222	0.719	0.187	-0.255	0.580	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	285.0000	80.0000	179.3750	5324.5536	72.9695
CL	8	93.0000	5.0000	20.7500	872.7857	29.5429
SO4	8	31.0000	12.0000	19.1250	45.2679	6.7281
TBOD	8	4.0000	0.0000	1.6250	1.4107	1.1877
NO3N	8	0.7900	0.2900	0.5125	0.0312	0.1765
TCOD	8	20.0000	4.0000	11.5000	23.1429	4.8107
T	5	71.6000	48.2000	63.2000	118.5800	10.8894
PH	8	7.8000	6.9000	7.5000	0.0800	0.2828
TVS	8	185.0000	16.0000	79.2500	2871.0714	53.5824
TS	8	305.0000	130.0000	203.7500	3905.3571	62.4929

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.614	1.000								
SO4	0.581	0.802	1.000							
TBOD	-0.440	0.042	-0.315	1.000						
NO3N	-0.410	-0.295	0.049	0.271	1.000					
TCOD	-0.172	-0.138	-0.126	0.513	0.675	1.000				
T	0.445	0.376	-0.030	0.532	-0.309	0.071	1.000			
PH	0.298	0.044	-0.383	0.128	-0.609	-0.367	0.871	1.000		
TVS	0.599	-0.162	-0.146	-0.492	-0.314	0.038	0.228	0.404	1.000	
TS	0.971	0.688	0.636	-0.460	-0.479	-0.309	0.427	0.343	0.531	1.000

TABLE VII-D-6
CH-3
BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	82.0000	7.0000	24.2500	396.5000	19.9123
TSS	8	240.0000	16.0000	102.1250	7382.1250	85.9193
TKN	8	2.4700	0.3300	0.7825	0.4864	0.6974
CL	8	150.0000	6.0000	28.8750	2414.6964	49.1396
PHL	8	0.1770	0.0000	0.0380	0.0043	0.0656
CR	8	0.0330	0.0000	0.0073	0.0002	0.0136
ZN	8	0.2000	0.0000	0.0804	0.0047	0.0684
ALK	8	59.0000	43.0000	52.7500	48.7857	6.9847
NH3N	8	0.1000	0.0000	0.0375	0.0027	0.0518
TP	8	0.6000	0.0600	0.2438	0.0371	0.1925

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.825	1.000								
TKN	0.828	0.458	1.000							
CL	0.438	0.606	-0.114	1.000						
PHL	-0.204	-0.076	-0.233	-0.143	1.000					
CR	-0.121	0.096	-0.075	-0.257	0.047	1.000				
ZN	0.892	0.656	0.777	0.331	-0.222	-0.010	1.000			
ALK	-0.216	-0.290	-0.391	0.419	0.035	-0.851	-0.279	1.000		
NH3N	0.336	0.432	0.480	-0.335	0.013	0.066	0.145	-0.484	1.000	
TP	0.973	0.858	0.787	0.429	-0.075	-0.165	0.781	-0.185	0.443	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	425.0000	30.0000	214.3750	19988.8393	141.3819
CL	8	150.0000	6.0000	28.8750	2414.6964	49.1396
SO4	8	32.0000	11.0000	18.8750	54.1250	7.3570
TBOD	8	5.0000	0.0000	1.7500	2.5000	1.5811
NO3N	8	1.5000	0.3700	0.6688	0.1358	0.3685
TCOD	8	82.0000	7.0000	24.2500	396.5000	19.9123
T	5	71.6000	48.2000	63.1200	117.1120	10.8218
PH	8	7.9000	6.9000	7.5000	0.1171	0.3423
TVS	8	390.0000	21.0000	114.7500	13684.2143	116.9795
TS	8	855.0000	200.0000	319.3750	25195.9821	158.7324

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.604	1.000								
SO4	0.646	0.769	1.000							
TBOD	-0.145	0.270	-0.163	1.000						
NO3N	-0.455	-0.321	-0.360	0.679	1.000					
TCOD	-0.075	0.438	0.037	0.942	0.628	1.000				
T	0.474	0.405	0.014	0.658	-0.063	0.489	1.000			
PH	-0.331	-0.508	-0.800	-0.053	-0.152	-0.306	0.320	1.000		
TVS	0.767	0.012	0.229	-0.301	-0.335	-0.407	0.392	0.030	1.000	
TS	0.853	0.860	0.716	0.281	-0.260	0.364	0.697	-0.459	0.468	1.000

TABLE VII-D-7
CH-4
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	16.0000	3.0000	9.7500	23.0714	4.8033
TSS	8	55.0000	1.0000	12.2500	307.3571	17.5316
TKN	8	0.8200	0.1400	0.3963	0.0574	0.2396
CL	8	114.0000	4.0000	23.2500	1361.6429	36.9004
PHL	8	0.2830	0.0000	0.0591	0.0108	0.1039
CR	8	0.0850	0.0000	0.0155	0.0009	0.0297
ZN	8	0.0710	0.0000	0.0336	0.0006	0.0251
ALK	8	61.0000	43.0000	53.0000	50.8571	7.1314
NH3N	8	0.1000	0.0000	0.0250	0.0021	0.0463
TP	8	0.8100	0.0500	0.1750	0.0663	0.2576

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.652	1.000								
TKN	0.494	-0.245	1.000							
CL	0.341	-0.259	-0.171	1.000						
PHL	-0.215	0.374	-0.501	-0.118	1.000					
CR	-0.086	0.184	-0.398	-0.219	0.967	1.000				
ZN	0.624	-0.203	0.038	0.614	-0.216	-0.269	1.000			
ALK	0.017	-0.498	-0.690	0.352	0.194	0.246	0.080	1.000		
NH3N	-0.032	0.572	0.396	-0.247	0.124	0.083	-0.138	-0.649	1.000	
TP	0.173	-0.103	-0.179	-0.123	-0.161	-0.136	0.566	0.228	-0.216	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	350.0000	90.0000	190.3750	9162.5536	95.7212
CL	8	114.0000	4.0000	23.2500	1361.6429	36.9004
SO4	8	33.0000	11.0000	19.6250	59.9821	7.7448
TBOD	8	4.0000	0.0000	1.3750	1.4107	1.1877
NO3N	7	0.6900	0.2700	0.4729	0.0251	0.1584
TCOD	8	16.0000	3.0000	9.7500	23.0714	4.8033
T	5	72.3000	47.3000	63.6400	137.4730	11.7249
PH	8	7.9000	6.9000	7.5750	0.1050	0.3240
TVS	8	210.0000	2.0000	80.0000	3960.8571	62.9353
TS	8	350.0000	100.0000	203.7500	7926.7857	89.0325

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.737	1.000								
SO4	0.597	0.751	1.000							
TBOD	-0.216	0.157	-0.138	1.000						
NO3N	-0.259	-0.157	0.472	-0.529	1.000					
TCOD	0.160	0.341	0.132	0.520	-0.015	1.000				
T	0.211	0.376	-0.044	0.713	-0.787	0.140	1.000			
PH	-0.284	-0.165	-0.665	0.139	-0.745	-0.317	0.508	1.000		
TVS	0.705	0.115	0.159	-0.503	-0.143	-0.271	0.051	-0.192	1.000	
TS	0.985	0.732	0.662	-0.292	-0.160	0.039	0.182	-0.316	0.737	1.000

TABLE VII-D-8
CH-4
MID-DEPTH
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	7	17.0000	9.0000	12.5714	8.2857	2.8785
TSS	7	70.0000	4.0000	24.5714	532.6190	23.0785
TKN	7	1.7300	0.3000	0.6386	0.2478	0.4978
CL	7	119.0000	6.0000	26.5714	1677.9524	40.9628
PHL	7	0.2240	0.0000	0.0437	0.0067	0.0816
CR	7	0.0330	0.0000	0.0143	0.0002	0.0140
ZN	7	0.0900	0.0000	0.0331	0.0010	0.0321
ALK	7	60.0000	44.0000	54.0000	36.3333	6.0277
NH3N	7	0.2000	0.0000	0.0286	0.0057	0.0756
TP	7	0.2500	0.0400	0.1086	0.0046	0.0679

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.116	1.000								
TKN	0.671	-0.442	1.000							
CL	0.206	0.101	-0.123	1.000						
PHL	-0.576	-0.130	-0.012	-0.113	1.000					
CR	0.666	0.180	0.495	-0.475	-0.466	1.000				
ZN	0.518	0.311	0.041	0.813	-0.276	-0.082	1.000			
ALK	-0.355	-0.560	-0.444	0.249	0.143	-0.643	-0.124	1.000		
NH3N	-0.241	0.868	-0.238	-0.157	0.034	0.149	0.094	-0.732	1.000	
TP	-0.362	0.729	-0.154	-0.337	0.117	0.181	-0.233	-0.716	0.918	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	7	350.0000	60.0000	197.8571	8873.8095	94.2009
CL	7	119.0000	6.0000	26.5714	1677.9524	40.9628
SO4	7	31.0000	14.0000	20.4286	43.6190	6.6045
TBOD	7	5.0000	1.0000	1.8571	2.4762	1.5736
NO3N	7	0.8400	0.2900	0.5671	0.0451	0.2123
TCOD	7	17.0000	9.0000	12.5714	8.2857	2.8785
T	4	72.5000	47.3000	65.4250	146.6758	12.1110
PH	7	7.9000	6.9000	7.4857	0.1248	0.3532
TVS	7	190.0000	8.0000	94.1429	3975.8095	63.0540
TS	7	380.0000	130.0000	223.0000	7794.6667	88.2874

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.745	1.000								
SO4	0.674	0.764	1.000							
TBOD	0.014	0.265	0.055	1.000						
NO3N	-0.599	-0.362	0.047	0.198	1.000					
TCOD	0.113	0.206	0.388	0.757	-0.339	1.000				
T	0.049	0.325	-0.360	0.495	-0.588	-0.251	1.000			
PH	-0.322	-0.416	-0.869	-0.154	0.454	-0.630	-0.782	1.000		
TVS	0.747	0.167	0.300	-0.411	-0.535	-0.245	-0.205	-0.049	1.000	
TS	0.971	0.822	0.781	-0.070	-0.559	0.087	-0.006	-0.419	0.669	1.000

Cat 1

TABLE VII-D-9
CH-4
BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	28.0000	10.0000	17.5000	34.0000	5.8310
TSS	8	325.0000	0.0000	92.0000	10915.7143	104.4783
TKN	8	1.1200	0.3500	0.6075	0.0684	0.2615
CL	8	130.0000	0.0000	24.6250	1846.8393	42.9749
PHL	8	0.1710	0.0000	0.0308	0.0035	0.0595
CR	8	0.0480	0.0000	0.0119	0.0004	0.0189
ZN	8	0.6950	0.0050	0.1270	0.0537	0.2318
ALK	8	62.0000	43.0000	53.2500	52.5000	7.2457
NH3N	8	0.1000	0.0000	0.0125	0.0013	0.0354
TP	8	0.1200	0.0300	0.1200	0.0025	0.0496

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.668	1.000								
TKN	0.075	-0.486	1.000							
CL	0.341	-0.057	0.068	1.000						
PHL	-0.615	-0.281	-0.195	-0.043	1.000					
CR	-0.598	-0.193	-0.434	-0.313	0.754	1.000				
ZN	-0.058	0.022	-0.400	-0.186	-0.263	0.413	1.000			
ALK	0.156	0.101	-0.472	0.343	0.390	0.446	-0.161	1.000		
NH3N	-0.173	-0.302	-0.166	-0.062	-0.209	-0.254	-0.061	0.098	1.000	
TP	-0.227	-0.046	-0.156	0.129	0.333	0.622	0.538	0.107	-0.734	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	430.0000	105.0000	210.0000	13264.2857	115.1707
CL	8	130.0000	0.0000	24.6250	1846.8393	42.9749
SO4	8	38.0000	11.0000	21.5000	105.1429	10.2539
TBOD	8	4.0000	1.0000	1.6250	1.1250	1.0607
NO3N	8	0.8400	0.2100	0.5650	0.0469	0.2166
TCOD	8	28.0000	10.0000	17.5000	34.0000	5.8310
T	8	73.0000	47.3000	63.3800	133.0420	11.5344
PH	8	7.8000	6.9000	7.4250	0.1307	0.3615
TVS	8	570.0000	15.0000	122.2500	34109.0714	184.6864
TS	8	665.0000	105.0000	302.5000	36050.0000	189.8684

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.805	1.000								
SO4	0.592	0.709	1.000							
TBOD	0.041	0.141	-0.020	1.000						
NO3N	-0.344	-0.234	0.347	0.295	1.000					
TCOD	0.579	0.341	0.029	0.381	-0.354	1.000				
T	0.612	0.447	0.176	0.674	-0.288	0.697	1.000			
PH	-0.129	-0.516	-0.555	-0.419	-0.337	-0.115	0.171	1.000		
TVS	0.808	0.080	0.039	0.098	-0.168	0.744	0.487	0.322	1.000	
TS	0.879	0.462	0.364	-0.023	-0.334	0.721	0.582	0.179	0.877	1.000

TABLE VII-D-10
CH-5
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	26.0000	6.0000	13.5000	51.1429	7.1514
TSS	8	60.0000	0.0000	18.2500	333.6429	18.2659
TKN	8	1.1900	0.1600	0.5050	0.0985	0.3139
CL	8	114.0000	5.0000	25.1250	1331.2679	36.4865
PHL	8	0.2000	0.0000	0.0490	0.0075	0.0864
CR	8	0.0870	0.0000	0.0123	0.0009	0.0304
ZN	8	0.3050	0.0000	0.0716	0.0100	0.0998
ALK	8	59.0000	43.0000	51.6250	42.8393	6.5452
NH3N	8	0.1000	0.0000	0.0125	0.0013	0.0354
TP	8	0.2400	0.0400	0.1000	0.0036	0.0600

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.033	1.000								
TKN	0.253	-0.625	1.000							
CL	0.659	0.018	-0.137	1.000						
PHL	0.138	0.570	-0.519	-0.224	1.000					
CR	-0.353	0.023	-0.193	-0.188	-0.118	1.000				
ZN	-0.217	-0.189	0.092	0.071	-0.342	0.931	1.000			
ALK	0.148	-0.414	0.234	0.448	0.015	-0.221	0.298	1.000		
NH3N	0.424	-0.404	0.882	-0.212	-0.229	-0.163	0.034	-0.347	1.000	
TP	-0.220	-0.284	0.106	-0.090	-0.143	0.051	0.243	0.489	-0.057	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	610.0000	70.0000	223.1250	29942.4107	173.0388
CL	8	114.0000	5.0000	25.1250	1331.2679	36.4865
SO4	8	32.0000	12.0000	19.7500	38.2143	6.1818
TBOD	8	4.0000	1.0000	1.7500	1.3571	1.1650
NO3N	8	0.7600	0.1900	0.4850	0.0399	0.1998
TCOD	8	26.0000	6.0000	13.5000	51.1429	7.1514
T	5	72.5000	47.3000	63.7200	139.1470	11.7961
PH	8	7.8000	6.9000	7.6125	0.1041	0.3227
TVS	8	540.0000	15.0000	119.8750	29928.9821	172.9999
TS	8	830.0000	125.0000	242.5000	29335.7143	171.2767

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.322	1.000								
SO4	0.251	0.873	1.000							
TBOD	-0.187	0.360	0.327	1.000						
NO3N	-0.202	-0.141	0.202	0.393	1.000					
TCOD	-0.044	0.659	0.604	0.857	-0.322	1.000				
T	0.518	0.384	0.166	0.626	-0.213	0.659	1.000			
PH	0.176	-0.089	-0.435	-0.181	-0.732	-0.090	0.555	1.000		
TVS	0.914	-0.025	-0.095	-0.314	-0.283	-0.299	0.430	0.356	1.000	
TS	0.995	0.328	0.262	-0.200	-0.221	-0.042	0.507	0.219	0.923	1.000

TABLE VII-D-11
CH-5
BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	13.0000	5.0000	10.7500	7.6429	2.7646
TSS	8	70.0000	1.0000	28.6250	538.5536	23.2068
TKN	8	1.2700	0.0000	0.4838	0.1551	0.3938
CL	8	161.0000	5.0000	31.0000	2788.0000	52.8015
PHL	8	0.1650	0.0000	0.0354	0.0039	0.0626
CR	8	0.1690	0.0000	0.0244	0.0035	0.0588
ZN	8	0.1100	0.0130	0.0595	0.0012	0.0345
ALK	8	82.0000	44.0000	53.6250	47.6964	6.9063
NH3N	8	0.1000	0.0000	0.0125	0.0013	0.0354
TP	8	0.1200	0.0700	0.0938	0.0005	0.0213

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.292	1.000								
TKN	0.309	-0.649	1.000							
CL	-0.115	-0.095	0.258	1.000						
PHL	-0.801	0.075	-0.556	-0.149	1.000					
CR	-0.838	-0.358	-0.344	-0.178	0.817	1.000				
ZN	0.144	-0.474	0.576	0.604	-0.317	-0.243	1.000			
ALK	-0.559	-0.210	-0.073	0.544	0.021	0.349	0.257	1.000		
NH3N	0.329	-0.481	0.807	-0.191	-0.228	-0.169	-0.357	-0.388	1.000	
TP	0.091	0.716	-0.502	-0.430	-0.008	-0.278	-0.546	-0.484	-0.260	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	395.0000	80.0000	194.3750	10117.4107	100.5853
CL	8	161.0000	5.0000	31.0000	2788.0000	52.8015
SO4	8	35.0000	12.0000	20.2500	58.2143	7.6298
TBOD	8	4.0000	1.0000	1.7500	1.3571	1.1650
NO3N	8	0.7700	0.3300	0.5513	0.0294	0.1713
TCOD	8	13.0000	5.0000	10.7500	7.6429	2.7646
T	5	73.0000	48.2000	63.7000	128.3900	11.3309
PH	8	7.9000	6.9000	7.5750	0.1536	0.3919
TVS	8	190.0000	31.0000	88.2500	2547.6429	50.4742
TS	8	415.0000	120.0000	223.1250	10156.6964	100.7804

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.847	1.000								
SO4	0.724	0.812	1.000							
TBOD	0.078	0.386	0.313	1.000						
NO3N	-0.495	-0.375	0.097	0.388	1.000					
TCOD	-0.229	-0.115	0.159	0.333	0.577	1.000				
T	0.348	0.436	0.134	0.627	-0.275	-0.585	1.000			
PH	-0.513	-0.503	-0.738	-0.391	-0.319	-0.338	0.272	1.000		
TVS	0.612	0.287	0.157	-0.344	-0.516	-0.068	0.250	0.028	1.000	
TS	0.971	0.820	0.746	0.002	-0.477	-0.169	0.354	-0.408	0.676	1.000

Cat 1

TABLE VII-D-12
CH-6
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	22.0000	4.0000	10.1250	44.4107	6.6641
TSS	8	90.0000	3.0000	25.8750	1164.1250	34.1193
TKN	8	1.1500	0.0600	0.5050	0.0983	0.3135
CL	8	166.0000	4.0000	31.6250	3010.8393	54.8711
PHL	8	0.0500	0.0000	0.0108	0.0003	0.0182
CR	8	0.0560	0.0000	0.0113	0.0004	0.0197
ZN	8	0.0920	0.0000	0.0379	0.0010	0.0313
ALK	8	62.0000	39.0000	52.6250	79.1250	8.8952
NH3N	8	0.2000	0.0000	0.0375	0.0055	0.0744
TP	8	0.1100	0.0200	0.0900	0.0009	0.0293

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.425	1.000								
TKN	0.614	-0.591	1.000							
CL	-0.300	0.510	-0.127	1.000						
PHL	-0.473	0.948	-0.557	0.293	1.000					
CR	0.366	-0.253	-0.126	-0.203	-0.385	1.000				
ZN	0.710	-0.102	0.233	0.200	-0.051	0.460	1.000			
ALK	-0.324	-0.028	-0.185	0.516	-0.156	0.050	-0.141	1.000		
NH3N	0.450	-0.386	0.511	-0.283	-0.340	0.061	-0.121	-0.753	1.000	
TP	-0.132	-0.040	0.078	-0.246	0.098	-0.368	-0.027	0.351	-0.656	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	410.0000	115.0000	181.2500	9076.7857	95.2722
CL	8	166.0000	4.0000	31.6250	3010.8393	54.8711
SO4	8	41.0000	10.0000	20.0000	101.7143	10.0854
TBOD	8	4.0000	1.0000	1.5000	1.1429	1.0690
NO3N	8	0.8400	0.4000	0.5625	0.0322	0.1795
TCOD	8	22.0000	4.0000	10.1250	44.4107	6.6641
T	5	73.4000	48.2000	63.7400	129.6680	11.3872
PH	8	7.9000	6.9000	7.4375	0.1055	0.3249
TVS	8	94.0000	12.0000	51.1250	972.4107	31.1835
TS	8	480.0000	120.0000	208.1250	13563.8393	116.4639

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.973	1.000								
SO4	0.899	0.893	1.000							
TBOD	0.063	0.140	0.040	1.000						
NO3N	-0.374	-0.379	-0.198	0.489	1.000					
TCOD	-0.412	-0.300	-0.145	0.612	-0.643	1.000				
T	0.327	0.407	0.174	0.474	-0.243	-0.255	1.000			
PH	-0.113	-0.181	-0.331	-0.103	0.377	-0.570	-0.904	1.000		
TVS	0.612	0.532	0.656	-0.011	-0.034	0.025	-0.501	-0.645	1.000	
TS	0.970	0.942	0.845	0.026	-0.279	-0.461	0.326	-0.139	0.577	1.000

TABLE VII-D-13

CH-6

BOTTOM

MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	130.0000	9.0000	32.5000	1618.5714	40.2315
TSS	8	70.0000	10.0000	42.0000	652.2857	25.5399
TKN	8	1.6400	0.0600	0.5700	0.2508	0.5008
CL	8	275.0000	5.0000	46.8750	8597.5536	92.7230
PHL	8	0.2480	0.0000	0.0451	0.0071	0.0845
CR	8	0.1400	0.0000	0.0253	0.0023	0.0480
ZN	8	0.8750	0.0000	0.1540	0.0861	0.2934
ALK	8	61.0000	43.0000	52.8750	53.5536	7.3180
NH3N	8	0.1000	0.0000	0.0250	0.0021	0.0463
TP	8	0.3700	0.0800	0.1300	0.0107	0.1032

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.269	1.000								
TKN	0.168	-0.365	1.000							
CL	0.989	-0.305	-0.083	1.000						
PHL	-0.257	-0.295	-0.336	-0.167	1.000					
CR	-0.233	-0.249	-0.246	-0.255	-0.010	1.000				
ZN	-0.229	-0.448	-0.119	-0.154	0.948	-0.128	1.000			
ALK	0.313	-0.365	-0.325	0.382	-0.410	-0.535	-0.412	1.000		
NH3N	-0.184	-0.085	-0.801	-0.272	-0.330	-0.704	-0.149	-0.708	1.000	
TP	0.211	-0.286	-0.122	0.129	-0.295	-0.291	-0.308	0.310	-0.209	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	870.0000	95.0000	206.2500	36119.6429	190.0517
CL	8	275.0000	5.0000	46.8750	8597.5536	92.7230
SO4	8	50.0000	12.0000	22.8750	153.8393	12.4032
TBOD	8	6.0000	0.0000	1.7500	3.6429	1.9086
NO3N	8	0.7800	0.4100	0.5875	0.0204	0.1429
TCOD	8	130.0000	9.0000	32.5000	1618.5714	40.2315
T	5	73.4000	48.2000	63.3600	131.0880	11.4494
PH	8	7.9000	6.9000	7.4250	0.1793	0.4234
TVS	8	134.0000	23.0000	73.6250	1432.8393	37.8529
TS	8	735.0000	115.0000	247.5000	39964.2857	199.9107

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.981	1.000								
SO4	0.879	0.921	1.000							
TBOD	0.176	0.223	0.095	1.000						
NO3N	-0.521	-0.500	-0.251	0.165	1.000					
TCOD	0.950	0.989	0.916	0.307	-0.485	1.000				
T	0.409	0.517	0.455	0.817	-0.321	0.606	1.000			
PH	-0.412	-0.391	-0.396	0.009	0.070	-0.398	0.659	1.000		
TVS	0.707	0.616	0.372	-0.225	-0.860	0.545	0.038	-0.289	1.000	
TS	0.993	0.978	0.863	0.131	-0.555	0.943	0.371	-0.425	0.739	1.000

Cd 1

TABLE VII-D-14
CH-2
BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	8	155.0000	8.0000	32.5000	2514.8571	50.1484
TSS	8	560.0000	9.0000	129.3750	34491.9821	185.7202
TKN	8	3.6400	0.1500	0.7850	1.3647	1.1682
CL	8	73.0000	7.0000	18.8750	494.9821	22.2482
PHL	8	0.0500	0.0000	0.0140	0.0003	0.0179
CR	8	0.0840	0.0000	0.0268	0.0012	0.0350
ZN	8	0.1800	0.0000	0.0854	0.0046	0.0679
ALK	8	60.0000	43.0000	53.5000	38.8571	6.2335
NH3N	8	0.2000	0.0000	0.0250	0.0050	0.0707
TP	8	1.4300	0.0800	0.2963	0.2138	0.4624

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.973	1.000								
TKN	0.985	0.928	1.000							
CL	-0.204	-0.255	-0.136	1.000						
PHL	-0.347	-0.292	-0.387	0.011	1.000					
CR	0.595	0.497	0.604	-0.388	-0.119	1.000				
ZN	0.630	0.623	0.617	0.394	-0.547	0.012	1.000			
ALK	0.071	0.017	0.057	0.476	-0.354	0.043	0.470	1.000		
NH3N	0.987	0.937	0.987	-0.198	-0.317	0.614	0.563	0.032	1.000	
TP	0.997	0.971	0.978	-0.231	-0.313	0.611	0.587	0.067	0.991	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	8	310.0000	120.0000	195.0000	4764.2857	69.0238
CL	8	73.0000	7.0000	18.8750	494.9821	22.2482
SO4	8	27.0000	12.0000	19.0000	25.1429	5.0143
TBOD	8	9.0000	0.0000	2.1250	8.1250	2.8504
NO3N	8	1.5800	0.2700	0.6163	0.1686	0.4106
TCOD	8	155.0000	8.0000	32.5000	2514.8571	50.1484
T	5	71.6000	47.3000	63.0400	133.6030	11.5587
PH	8	7.8000	6.9000	7.4500	0.1114	0.3338
TVS	8	140.0000	35.0000	80.7500	1213.6429	34.8374
TS	8	870.0000	160.0000	324.3750	52231.8964	228.5425

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.360	1.000								
SO4	0.237	0.750	1.000							
TBOD	0.675	-0.074	0.040	1.000						
NO3N	0.581	-0.265	-0.033	0.938	1.000					
TCOD	0.622	-0.204	0.061	0.963	0.943	1.000				
T	0.740	0.369	0.167	0.423	0.341	0.277	1.000			
PH	-0.081	-0.530	-0.888	-0.098	-0.113	-0.159	-0.193	1.000		
TVS	0.794	0.066	-0.156	0.298	0.314	0.275	0.813	-0.306	1.000	
TS	0.713	-0.100	0.164	0.929	0.919	0.979	0.316	-0.256	0.367	1.000

TABLE VII-D-15
CH-1
SURFACE AND BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	23.0000	3.0000	12.5000	34.0000	5.8310
TSS	16	145.0000	1.0000	39.3125	2141.8292	46.2799
TKN	16	0.9500	0.0000	0.4481	0.0681	0.2611
CL	16	69.0000	6.0000	16.8125	305.8958	17.4899
PHL	16	0.0500	0.0000	0.0151	0.0004	0.0189
CR	16	0.0600	0.0000	0.0150	0.0003	0.0185
ZN	16	0.4560	0.0060	0.0799	0.0110	0.1047
ALK	16	61.0000	40.0000	52.5625	55.5958	7.4563
NH3N	16	0.2000	0.0000	0.0188	0.0030	0.0544
TP	16	0.2300	0.0200	0.0963	0.0031	0.0555

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.515	1.000								
TKN	0.303	0.215	1.000							
CL	-0.075	-0.120	0.083	1.000						
PHL	0.373	0.462	0.088	0.379	1.000					
CR	0.387	0.669	0.459	-0.366	-0.123	1.000				
ZN	0.093	-0.112	0.206	-0.048	-0.008	-0.021	1.000			
ALK	-0.105	-0.480	-0.565	0.510	-0.140	-0.807	-0.175	1.000		
NH3N	-0.305	-0.040	0.181	-0.192	-0.295	0.265	-0.175	-0.455	1.000	
TP	0.546	0.709	0.014	-0.212	0.242	0.323	0.017	-0.238	-0.351	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	275.0000	75.0000	153.1250	3109.5833	55.7636
CL	16	69.0000	6.0000	16.8125	305.8958	17.4899
SO4	16	30.0000	12.0000	18.9375	40.0625	6.3295
TBOD	16	4.0000	0.0000	1.5625	1.0625	1.0308
NO3N	16	0.8300	0.2700	0.5388	0.0402	0.2004
TCOD	16	23.0000	3.0000	12.5000	34.0000	5.8310
T	10	72.5000	46.4000	62.9100	126.3366	11.2400
PH	16	7.8000	6.9000	7.4875	0.0945	0.3074
TVS	16	120.0000	16.0000	57.6875	849.8292	29.1518
TS	16	320.0000	105.0000	193.1875	4187.2292	64.7088

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.645	1.000								
SO4	0.674	0.692	1.000							
TBOD	-0.288	0.113	-0.321	1.000						
NO3N	-0.311	-0.278	0.174	-0.038	1.000					
TCOD	0.152	-0.075	-0.064	0.272	0.217	1.000				
T	-0.132	0.350	-0.134	0.386	-0.392	-0.483	1.000			
PH	-0.509	-0.530	-0.871	0.192	-0.430	-0.063	0.416	1.000		
TVS	0.714	0.202	0.250	-0.220	-0.308	0.258	-0.117	-0.056	1.000	
TS	0.714	0.463	0.461	-0.062	-0.182	0.506	-0.258	-0.358	0.678	1.000

TABLE VII-D-16
CH-2
SURFACE AND BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	155.0000	3.0000	21.8750	1317.0500	36.2912
TSS	16	560.0000	3.0000	77.0000	19231.6000	138.6420
TKN	16	3.6400	0.1500	0.6588	0.6929	0.8324
CL	16	73.0000	4.0000	16.9375	323.3958	17.9832
PHL	16	0.0500	0.0000	0.0133	0.0003	0.0168
CR	16	0.0840	0.0000	0.0164	0.0007	0.0270
ZN	16	0.1800	0.0000	0.0683	0.0036	0.0604
ALK	16	60.0000	40.0000	52.1875	42.1625	6.4933
NH3N	16	0.2000	0.0000	0.0250	0.0033	0.0577
TP	16	1.4300	0.0300	0.1919	0.1119	0.3345

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.953	1.000								
TKN	0.962	0.870	1.000							
CL	-0.081	-0.165	-0.058	1.000						
PHL	-0.260	-0.114	-0.327	0.023	1.000					
CR	0.613	0.570	0.593	-0.260	0.109	1.000				
ZN	0.590	0.545	0.616	0.348	-0.379	0.147	1.000			
ALK	0.130	0.044	0.053	0.480	-0.372	0.067	0.286	1.000		
NH3N	0.756	0.755	0.804	-0.146	-0.021	0.567	0.411	-0.084	1.000	
TP	0.983	0.966	0.928	-0.157	-0.180	0.630	0.513	0.106	0.767	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	310.0000	95.0000	176.5625	3462.3958	58.8421
CL	16	73.0000	4.0000	16.9375	323.3958	17.9832
SO4	16	27.0000	10.0000	18.6250	31.0500	5.5723
TBOD	16	9.0000	0.0000	1.8125	4.5625	2.1360
NO3N	16	1.5800	0.2700	0.5844	0.0945	0.3073
TCOD	16	155.0000	3.0000	21.8750	1317.0500	36.2912
T	10	72.0000	47.3000	63.2400	117.7116	10.8495
PH	16	7.8000	6.9000	7.4938	0.0966	0.3108
TVS	16	140.0000	25.0000	73.5000	934.1333	30.5636
TS	16	870.0000	110.0000	253.7500	30678.3333	175.1523

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.453	1.000								
SO4	0.449	0.724	1.000							
TBOD	0.437	-0.035	-0.034	1.000						
NO3N	0.409	-0.234	0.022	0.816	1.000					
TCOD	0.580	-0.081	0.098	0.896	0.838	1.000				
T	0.355	0.337	0.079	0.487	-0.157	0.200	1.000			
PH	-0.176	-0.400	-0.729	-0.062	-0.292	-0.167	0.297	1.000		
TVS	0.752	0.204	0.114	0.147	0.201	0.254	0.510	0.212	1.000	
TS	0.725	0.020	0.214	0.772	0.786	0.949	0.151	-0.257	0.433	1.000

TABLE VII-D-17
CH-3
SURFACE AND BOTTOM
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	62.0000	4.0000	17.8750	239.1833	15.4656
TSS	16	240.0000	9.0000	63.2500	5231.0000	72.3257
TKN	16	2.4700	0.2300	0.7088	0.2954	0.5434
CL	16	150.0000	5.0000	24.8125	1551.7625	39.3924
PHL	16	0.1770	0.0000	0.0325	0.0028	0.0526
CR	16	0.0330	0.0000	0.0069	0.0001	0.0112
ZN	16	0.2000	0.0000	0.0754	0.0040	0.0631
ALK	16	61.0000	43.0000	52.8750	45.7167	6.7614
NH3N	16	0.1000	0.0000	0.0313	0.0023	0.0479
TP	16	0.6000	0.0500	0.1600	0.0250	0.1580

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.810	1.000								
TKN	0.782	0.398	1.000							
CL	0.359	0.470	-0.010	1.000						
PHL	-0.133	0.036	-0.251	-0.073	1.000					
CR	-0.099	0.115	0.009	-0.270	-0.029	1.000				
ZN	0.573	0.412	0.556	0.222	-0.326	0.179	1.000			
ALK	-0.167	-0.255	-0.370	0.383	0.154	-0.743	-0.207	1.000		
NH3N	0.312	0.400	0.506	-0.276	0.012	0.315	0.060	-0.605	1.000	
TP	0.947	0.884	0.657	0.353	0.016	-0.063	0.537	-0.135	0.379	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	425.0000	30.0000	196.8750	12139.5833	110.1798
CL	16	150.0000	5.0000	24.8125	1551.7625	39.3924
SO4	16	32.0000	11.0000	19.0000	46.4000	6.8118
TBOD	16	5.0000	0.0000	1.6875	1.8292	1.3525
NO3N	16	1.5000	0.2900	0.5906	0.0844	0.2906
TCOD	16	62.0000	4.0000	17.8750	239.1833	15.4656
T	10	71.6000	48.2000	63.1600	104.7538	10.2349
PH	16	7.9000	6.9000	7.5000	0.0920	0.3033
TVS	16	390.0000	16.0000	97.0000	8061.8667	89.7879
TS	16	655.0000	130.0000	261.5625	17145.7292	130.9417

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.611	1.000								
SO4	0.592	0.759	1.000							
TBOD	-0.213	0.202	-0.224	1.000						
NO3N	-0.377	-0.270	-0.222	0.550	1.000					
TCOD	-0.005	0.359	-0.002	0.747	0.656	1.000				
T	0.419	0.378	-0.007	0.596	-0.047	-0.308	1.000			
PH	-0.138	-0.319	-0.620	-0.016	-0.262	-0.257	0.580	1.000		
TVS	0.742	-0.003	0.106	-0.324	-0.255	-0.228	0.305	0.126	1.000	
TS	0.837	0.770	0.569	0.118	-0.125	0.438	0.475	-0.222	0.508	1.000

TABLE VII-D-18

CH-4

SURFACE, MID-DEPTH, AND BOTTOM

MAY 29, 1973 THROUGH JANUARY 3, 1974

CL	23	130.0000	0.0000	24.7391	1480.3834	38.4758
PHL	23	0.2830	0.0000	0.0446	0.0065	0.0808
CR	23	0.0850	0.0000	0.0139	0.0005	0.0212
ZN	23	0.6950	0.0000	0.0660	0.0197	0.1402
ALK	23	62.0000	43.0000	53.3913	42.9763	5.5556
NH3N	23	0.2000	0.0000	0.0217	0.0027	0.0518
TP	23	0.8100	0.0300	0.1357	0.0240	0.1550

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.573	1.000								
TKN	0.383	-0.151	1.000							
CL	0.252	-0.038	-0.059	1.000						
PHL	-0.394	-0.141	-0.222	-0.093	1.000					
CR	-0.191	-0.087	-0.104	-0.284	0.638	1.000				
ZN	0.196	0.185	-0.109	-0.022	-0.176	0.146	1.000			
ALK	0.020	-0.040	-0.435	0.320	0.221	0.152	-0.086	1.000		
NH3N	-0.164	-0.010	-0.096	-0.147	-0.040	-0.032	-0.064	-0.441	1.000	
TP	-0.048	-0.043	-0.185	-0.097	-0.047	-0.020	0.114	0.055	0.012	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	23	430.0000	60.0000	199.4783	9627.1700	98.1181
CL	23	130.0000	0.0000	24.7391	1480.3834	38.4758
SO4	23	38.0000	11.0000	20.5217	65.0791	8.0672
TBOD	23	5.0000	0.0000	1.6087	1.5217	1.2336
NO3N	22	0.8400	0.2100	0.5364	0.0377	0.1940
TCOD	23	28.0000	3.0000	13.3043	31.5850	5.6201
T	14	73.0000	47.3000	64.0571	117.9026	10.8583
PH	23	7.9000	6.9000	7.4957	0.1132	0.3364
TVS	24	570.0000	2.0000	99.0000	13532.8182	116.3306
TS	23	865.0000	100.0000	243.9565	18092.3162	134.5077

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.764	1.000								
SO4	0.612	0.723	1.000							
TBOD	-0.041	0.183	-0.024	1.000						
NO3N	-0.389	-0.250	0.293	0.195	1.000					
TCOD	0.333	0.252	0.150	0.418	-0.041	1.000				
T	0.351	0.389	-0.017	0.612	-0.447	0.186	1.000			
PH	-0.241	-0.376	-0.659	-0.158	0.495	-0.326	-0.440	1.000		
TVS	0.599	0.092	0.104	-0.109	-0.189	0.425	0.241	-0.107	1.000	
TS	0.860	0.538	0.488	-0.071	-0.278	0.545	0.318	-0.114	0.826	1.000

PLOT DATA?

N

TYPE Y FOR MORE STATISTICAL RETRIEVAL

N

TABLE VII-D-19

CH-5

SURFACE AND BOTTOM

MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	26.0000	5.0000	12.1250	29.4500	5.4268
TSS	16	70.0000	0.0000	23.4375	435.7292	20.8741
TKN	16	1.2700	0.0000	0.4944	0.1185	0.3442
CL	16	161.0000	5.0000	28.0625	1931.5292	43.9492
PHL	16	0.2000	0.0000	0.0422	0.0054	0.0732
CR	16	0.1690	0.0000	0.0183	0.0021	0.0456
ZN	16	0.3050	0.0000	0.0656	0.0052	0.0724
ALK	16	62.0000	43.0000	52.6250	43.3167	6.5815
NH3N	16	0.1000	0.0000	0.0125	0.0012	0.0342
TP	16	0.2400	0.0400	0.0969	0.0019	0.0436

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.028	1.000								
TKN	0.234	-0.626	1.000							
CL	0.286	-0.035	0.115	1.000						
PHL	0.003	0.283	-0.512	-0.181	1.000					
CR	-0.437	-0.198	-0.296	-0.167	0.363	1.000				
ZN	-0.145	-0.246	0.203	0.117	-0.312	0.318	1.000			
ALK	-0.090	-0.242	-0.145	0.503	0.002	0.310	0.237	1.000		
NH3N	0.351	-0.429	0.834	-0.196	-0.225	-0.157	0.105	-0.363	1.000	
TP	-0.156	0.003	-0.067	-0.171	-0.102	-0.070	0.162	0.177	-0.106	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	610.0000	70.0000	208.7500	18915.0000	137.5318
CL	16	161.0000	5.0000	28.0625	1931.5292	43.9492
SO4	16	35.0000	12.0000	20.0000	45.0667	6.7132
TBOD	16	4.0000	1.0000	1.7500	1.2667	1.1255
NO3N	16	0.7700	0.1900	0.5181	0.0335	0.1830
TCOD	16	26.0000	5.0000	12.1250	29.4500	5.4268
T	10	73.0000	47.3000	63.7100	118.9054	10.9044
PH	16	7.9000	6.9000	7.5938	0.1206	0.3473
TVS	16	540.0000	15.0000	104.0625	15422.4625	124.1972
TS	16	630.0000	120.0000	232.8125	18529.8958	136.1246

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.497	1.000								
SO4	0.413	0.832	1.000							
TBOD	-0.086	0.368	0.318	1.000						
NO3N	-0.308	-0.243	0.150	0.383	1.000					
TCOD	-0.046	0.286	0.375	0.628	-0.296	1.000				
T	0.439	0.404	0.148	0.627	-0.237	0.402	1.000			
PH	-0.096	-0.354	-0.618	-0.294	-0.514	-0.127	0.402	1.000		
TVS	0.847	0.043	-0.028	-0.279	-0.317	-0.229	0.340	0.228	1.000	
TS	0.988	0.495	0.432	-0.121	-0.310	-0.043	0.437	-0.036	0.860	1.000

PLOT DATA?

TABLE VII-D-20

CH-6

SURFACE AND BOTTOM

MAY 29, 1973 TO JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	130.0000	4.0000	21.3125	909.5625	30.1590
TSS	16	90.0000	3.0000	33.9375	416.9958	30.2819
TKN	16	1.6400	0.0600	0.5375	0.1840	0.4058
CL	16	275.0000	4.0000	39.2500	5479.2667	74.0221
PHL	16	0.2480	0.0000	0.0279	0.0038	0.0617
CR	16	0.1400	0.0000	0.0183	0.0013	0.0362
ZN	16	0.8750	0.0000	0.0959	0.0442	0.2103
ALK	16	62.0000	39.0000	52.7500	61.9333	7.8698
NH3N	16	0.2000	0.0000	0.0313	0.0036	0.0602
TP	16	0.3700	0.0200	0.1050	0.0060	0.0777

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.197	1.000								
TKN	0.210	-0.395	1.000							
CL	0.789	0.378	-0.035	1.000						
PHL	-0.124	0.068	-0.301	-0.073	1.000					
CR	-0.095	0.112	0.180	-0.215	0.020	1.000				
ZN	-0.078	-0.160	-0.060	-0.085	0.927	-0.185	1.000			
ALK	0.150	-0.146	-0.248	0.411	0.224	-0.290	0.265	1.000		
NH3N	-0.072	-0.306	0.575	-0.255	-0.251	0.333	-0.116	-0.728	1.000	
TP	0.296	-0.068	-0.055	0.104	-0.150	-0.208	-0.172	0.254	-0.278	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	670.0000	95.0000	193.7500	21258.3333	145.8024
CL	16	275.0000	4.0000	39.2500	5479.2667	74.0221
SO4	16	50.0000	10.0000	21.4375	121.4625	11.0210
TBOD	16	5.0000	0.0000	1.6250	2.2500	1.5000
NO3N	16	0.8400	0.4000	0.5750	0.0247	0.1573
TCOD	16	130.0000	4.0000	21.3125	909.5625	30.1590
T	16	73.4000	48.2000	63.5500	115.9317	10.7672
PH	16	7.9000	6.9000	7.4313	0.1330	0.3646
TVS	16	134.0000	12.0000	62.3750	1257.4500	35.4605
TS	16	735.0000	115.0000	227.8125	25393.2292	159.3525

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.977	1.000								
SO4	0.864	0.903	1.000							
TBOD	0.158	0.209	-0.087	1.000						
NO3N	-0.411	-0.406	-0.205	0.285	1.000					
TCOD	0.777	0.789	0.680	0.321	-0.167	1.000				
T	0.357	0.455	0.320	0.538	-0.277	0.351	1.000			
PH	-0.323	-0.323	-0.370	-0.026	-0.146	-0.348	0.743	1.000		
TVS	0.652	0.581	0.499	-0.118	-0.347	0.490	-0.198	-0.409	1.000	
TS	0.985	0.969	0.849	0.115	-0.393	0.750	0.335	-0.334	0.677	1.000

TABLE VII-D-21
ALL STATIONS, ALL DEPTHS
FULL YEAR
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	103	155.0000	3.0000	16.2816	394.9886	19.8743
TSS	103	560.0000	0.0000	46.5728	5505.0118	74.1958
TKN	103	3.6400	0.0000	0.5637	0.2307	0.4803
CL	103	275.0000	0.0000	25.0777	1783.9155	42.2364
PHL	103	0.2830	0.0000	0.0303	0.0034	0.0584
CR	103	0.1690	0.0000	0.0147	0.0008	0.0280
ZN	103	0.8750	0.0000	0.0745	0.0144	0.1198
ALK	103	62.0000	39.0000	52.7767	45.9987	6.7822
NH3N	103	0.2000	0.0000	0.0233	0.0026	0.0509
TP	103	1.4300	0.0200	0.1313	0.0281	0.1677

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.663	1.000								
TKN	0.641	0.464	1.000							
CL	0.371	0.048	-0.003	1.000						
PHL	-0.112	-0.037	-0.218	-0.065	1.000					
CR	0.101	0.164	0.121	-0.194	0.253	1.000				
ZN	0.106	0.115	0.120	0.001	0.118	0.151	1.000			
ALK	0.041	-0.105	-0.215	0.377	0.127	-0.091	0.099	1.000		
NH3N	0.250	0.265	0.471	-0.178	-0.083	0.183	-0.024	-0.451	1.000	
TP	0.687	0.707	0.580	-0.006	-0.049	0.147	0.119	0.033	0.276	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	103	870.0000	30.0000	188.8641	11061.3343	105.1729
CL	103	275.0000	0.0000	25.0777	1783.9155	42.2364
SO4	103	50.0000	10.0000	19.8058	56.7955	7.5356
TBOD	103	9.0000	0.0000	1.6699	1.9488	1.3960
NO3N	102	1.5800	0.1900	0.5560	0.0497	0.2230
TCOD	103	155.0000	3.0000	16.2816	394.9886	19.8743
T	64	73.4000	46.4000	63.4766	107.8663	10.3859
PH	103	7.9000	6.9000	7.5000	0.1055	0.3248
TVS	103	570.0000	2.0000	83.4078	7158.9694	84.6107
TS	103	870.0000	100.0000	236.0874	18476.0805	135.9267

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.731	1.000								
SO4	0.626	0.789	1.000							
TBOD	0.024	0.164	-0.018	1.000						
NO3N	-0.229	-0.230	0.022	0.461	1.000					
TCOD	0.345	0.371	0.262	0.585	-0.426	1.000				
T	0.319	0.357	0.083	0.520	-0.148	0.171	1.000			
PH	-0.206	-0.329	-0.593	-0.061	-0.347	-0.203	0.458	1.000		
TVS	0.653	0.108	0.105	-0.127	-0.190	0.051	0.204	0.104	1.000	
TS	0.842	0.592	0.511	0.236	-0.046	0.628	0.274	-0.193	0.621	1.000

TABLE VII-D-22
ALL STATIONS, ALL DEPTHS
MAY 29, 1973 THROUGH JANUARY 3, 1974
BOTTOM SAMPLES WITH HIGH TSS DELETED

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	99	130.0000	3.0000	13.9798	176.4078	13.2819
TSS	99	210.0000	0.0000	35.2727	1556.3636	39.4508
TKN	99	1.7300	0.0000	0.5139	0.1035	0.3218
CL	99	275.0000	0.0000	24.2525	1689.8233	41.1075
PHL	99	0.2830	0.0000	0.0313	0.0035	0.0593
CR	99	0.1690	0.0000	0.0145	0.0008	0.0277
ZN	99	0.8750	0.0000	0.0723	0.0146	0.1207
ALK	99	62.0000	39.0000	52.6970	46.9481	6.8519
NH3N	99	0.2000	0.0000	0.0212	0.0023	0.0480
TP	99	0.8100	0.0200	0.1105	0.0082	0.0905

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.202	1.000								
TKN	0.231	-0.142	1.000							
CL	0.577	0.023	0.059	1.000						
PHL	-0.094	0.064	-0.269	-0.061	1.000					
CR	-0.057	0.093	-0.013	-0.187	0.269	1.000				
ZN	0.023	0.081	0.030	-0.009	0.126	0.143	1.000			
ALK	0.037	-0.307	-0.307	0.370	0.135	-0.094	0.197	1.000		
NH3N	-0.027	0.053	0.313	-0.166	-0.070	0.119	-0.077	-0.480	1.000	
TP	0.145	0.266	-0.096	-0.049	0.007	-0.015	0.016	0.042	-0.054	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	99	670.0000	30.0000	184.6263	10526.5834	102.5991
CL	99	275.0000	0.0000	24.2525	1689.8233	41.1075
SO4	99	50.0000	10.0000	19.7778	56.7868	7.5357
TBOD	99	6.0000	0.0000	1.5455	1.3321	1.1542
NO3N	98	0.8400	0.1900	0.5379	0.0312	0.1766
TCOD	99	130.0000	3.0000	13.9798	176.4078	13.2819
T	80	73.4000	46.4000	62.9783	111.0855	10.5397
PH	99	7.9000	6.9000	7.5030	0.1076	0.3281
TVS	99	540.0000	2.0000	78.3737	4977.6038	70.5521
TS	99	735.0000	100.0000	220.5758	11189.1243	105.7787

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.737	1.000								
SO4	0.623	0.788	1.000							
TBOD	-0.058	0.214	-0.001	1.000						
NO3N	-0.317	-0.235	-0.115	0.190	1.000					
TCOD	0.378	0.577	0.420	0.274	-0.034	1.000				
T	0.299	0.366	0.090	0.556	-0.341	0.099	1.000			
PH	-0.195	-0.311	-0.592	-0.042	-0.443	-0.255	0.465	1.000		
TVS	0.711	0.138	0.116	-0.230	-0.267	-0.009	0.182	0.093	1.000	
TS	0.930	0.724	0.629	-0.096	-0.279	0.442	0.216	-0.211	0.664	1.000

TABLE VII-D-23

ALL STATIONS
ALL DEPTHS

MAY 29, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	12	23.0000	6.0000	14.2500	22.5682	4.7506
TSS	12	86.0000	3.0000	38.1667	901.4242	30.0237
TKN	12	0.8500	0.5000	0.6750	0.0139	0.1177
CL	12	7.0000	4.0000	5.6667	1.5152	1.2309
PHL	12	0.0000	0.0000	0.0000	0.0000	0.0000
CR	12	0.1400	0.0000	0.0257	0.0016	0.0403
ZN	12	0.0860	0.0120	0.0458	0.0006	0.0253
ALK	12	46.0000	39.0000	43.3333	3.3333	1.8257
NH3N	12	0.2000	0.0000	0.0417	0.0063	0.0793
TP	12	0.1400	0.0200	0.0800	0.0016	0.0402

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.880	1.000								
TKN	0.760	0.811	1.000							
CL	0.529	0.644	0.188	1.000						
PHL	1.000	1.000	1.000	1.000	1.000					
CR	0.480	0.474	0.464	0.431	1.000	1.000				
ZN	0.835	0.871	0.693	0.726	1.000	0.605	1.000			
ALK	0.010	0.103	-0.275	-0.458	1.000	-0.176	-0.220	1.000		
NH3N	-0.271	-0.381	-0.268	-0.124	1.000	0.289	-0.314	-0.607	1.000	
TP	0.804	0.795	0.701	0.367	1.000	0.164	0.729	0.297	-0.627	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	12	130.0000	105.0000	116.6667	96.9697	9.8473
CL	12	7.0000	4.0000	5.6667	1.5152	1.2309
SO4	12	13.0000	10.0000	11.6667	0.7879	0.8876
TBOD	12	4.0000	1.0000	1.4167	0.8106	0.9003
NO3N	12	0.5000	0.3000	0.4308	0.0031	0.0557
TCOD	12	23.0000	6.0000	14.2500	22.5682	4.7506
T	12	55.0000	54.0000	54.5833	0.2652	0.5149
PH	12	7.8000	6.9000	7.5917	0.0827	0.2875
TVS	12	100.0000	25.0000	55.0000	600.0000	24.4949
TS	12	220.0000	120.0000	155.4167	1247.5379	35.3205

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.538	1.000								
SO4	0.381	0.804	1.000							
TBOD	0.376	0.547	0.531	1.000						
NO3N	0.563	0.416	0.245	0.428	1.000					
TCOD	0.525	0.529	0.388	0.547	0.855	1.000				
T	-0.568	-0.382	-0.133	-0.376	-0.272	-0.214	1.000			
PH	-0.348	-0.291	-0.059	-0.015	-0.090	-0.305	0.097	1.000		
TVS	-0.047	0.181	0.188	-0.082	-0.100	-0.066	0.180	-0.491	1.000	
TS	0.632	0.683	0.614	0.523	0.714	0.907	-0.314	-0.232	-0.076	1.000

TABLE VII-D-24

ALL STATIONS
ALL DEPTHS

JUNE 19, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	155.0000	10.0000	31.1538	1553.6410	39.4163
TSS	13	560.0000	0.0000	61.7692	24757.0256	157.3437
TKN	13	3.6400	0.5500	1.4138	0.7080	0.8414
CL	13	8.0000	5.0000	6.3846	0.5897	0.7679
PHL	13	0.0170	0.0000	0.0032	0.0000	0.0053
CR	13	0.0800	0.0000	0.0148	0.0005	0.0223
ZN	13	0.4560	0.0200	0.1174	0.0134	0.1159
ALK	13	54.0000	45.0000	47.1538	4.9744	2.2303
NH3N	13	0.2000	0.0000	0.0692	0.0040	0.0630
TP	13	1.4300	0.0800	0.2385	0.1476	0.3842

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.995	1.000								
TKN	0.917	0.892	1.000							
CL	0.681	0.687	0.553	1.000						
PHL	0.055	0.062	0.167	0.223	1.000					
CR	0.787	0.801	0.709	0.468	-0.160	1.000				
ZN	0.191	0.240	0.053	0.031	-0.188	0.079	1.000			
ALK	0.918	0.933	0.815	0.741	-0.046	0.795	-0.211	1.000		
NH3N	0.693	0.649	0.692	0.437	-0.052	0.457	-0.064	0.511	1.000	
TP	0.995	0.998	0.905	0.691	-0.105	0.775	0.246	0.927	0.648	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	310.0000	95.0000	126.0000	3155.5000	56.1738
CL	13	8.0000	5.0000	6.3846	0.5897	0.7679
SO4	13	19.0000	11.0000	15.2308	3.6923	1.9215
TBOD	13	9.0000	2.0000	4.3846	3.0897	1.7578
NO3N	12	1.5800	0.7400	0.9025	0.0896	0.2994
TCOD	13	155.0000	10.0000	31.1538	1553.6410	39.4163
T	13	72.3000	69.4000	70.7462	0.7544	0.8685
PH	13	7.6000	7.1000	7.4308	0.0140	0.1182
TVS	13	110.0000	2.0000	32.9231	656.9103	25.6303
TS	13	870.0000	100.0000	188.0769	44364.7436	210.6294

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.605	1.000								
SO4	0.631	0.161	1.000							
TBOD	0.798	0.437	0.440	1.000						
NO3N	0.697	0.729	-0.030	0.674	1.000					
TCOD	0.933	0.681	0.371	0.842	0.894	1.000				
T	0.189	0.096	0.373	-0.056	-0.132	0.042	1.000			
PH	-0.089	-0.325	-0.217	-0.142	-0.063	-0.051	0.123	1.000		
TVS	0.938	0.527	0.435	0.759	0.792	0.919	-0.001	-0.068	1.000	
TS	0.984	0.675	0.439	0.812	0.852	0.992	0.100	-0.034	0.935	1.000

TABLE VII-D-25

ALL STATIONS
ALL DEPTHS

JULY 30, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	20.0000	3.0000	9.3846	29.5897	5.4396
TSS	13	145.0000	7.0000	47.2308	1899.8590	43.5874
TKN	13	0.5300	0.0000	0.2746	0.0254	0.1595
CL	13	19.0000	0.0000	8.6923	17.0641	4.1309
PHL	13	0.0450	0.0000	0.0104	0.0002	0.0151
CR	13	0.0870	0.0000	0.0178	0.0006	0.0241
SH	13	0.6950	0.0000	0.1052	0.0399	0.1997
ALK	13	57.0000	52.0000	54.8462	1.8077	1.3445
NH3N	13	0.1000	0.0000	0.0077	0.0008	0.0277
TP	13	0.2200	0.0800	0.1323	0.0019	0.0430

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	SH	ALK	NH3N	TP
TCOD	1.000									
TSS	0.931	1.000								
TKN	-0.105	-0.227	1.000							
CL	-0.109	-0.191	0.050	1.000						
PHL	0.395	0.422	-0.696	0.089	1.000					
CR	0.181	0.075	0.186	-0.059	-0.152	1.000				
SH	0.289	0.281	0.172	-0.485	-0.280	0.548	1.000			
ALK	-0.151	-0.319	0.637	-0.324	-0.552	0.227	0.479	1.000		
NH3N	0.200	0.233	0.481	0.022	-0.207	-0.221	-0.158	0.034	1.000	
TP	0.953	0.980	-0.130	-0.146	0.403	0.113	0.261	-0.267	0.333	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	200.0000	160.0000	181.5385	172.4359	13.1315
CL	13	19.0000	0.0000	8.6923	17.0641	4.1309
SO4	13	17.0000	11.0000	15.2308	2.8590	1.6909
TDOD	13	1.0000	0.0000	0.9231	0.0769	0.2774
NO3N	13	0.4800	0.1900	0.3146	0.0074	0.0862
TCOD	13	20.0000	3.0000	9.3846	29.5897	5.4396
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	13	7.9000	7.7000	7.7923	0.0041	0.0641
TVS	13	125.0000	64.0000	80.8462	264.3077	16.2575
TS	13	320.0000	170.0000	229.3077	1683.7308	41.0333

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TDOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.278	1.000								
SO4	0.001	0.285	1.000							
TDOD	-0.079	0.123	-0.137	1.000						
NO3N	-0.371	0.285	0.204	0.156	1.000					
TCOD	-0.301	-0.109	-0.790	-0.034	-0.008	1.000				
T							1.000			
PH	0.114	0.852	0.172	0.433	0.218	-0.230		1.000		
TVS	-0.241	0.097	0.129	0.034	-0.239	0.166		0.135	1.000	
TS	0.006	-0.113	-0.820	-0.188	-0.164	0.880		-0.303	-0.058	1.000

TABLE VII-D-26

ALL STATIONS
ALL DEPTHS

AUGUST 22, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	17.0000	4.0000	10.2308	16.1923	4.0240
TSS	13	27.0000	7.0000	14.5385	60.6026	7.7848
TKN	13	0.6600	0.1400	0.3762	0.0256	0.1600
CL	13	16.0000	5.0000	10.1538	5.3077	2.3038
PHL	13	0.2830	0.0000	0.1252	0.0101	0.1004
CR	13	0.1690	0.0000	0.0323	0.0027	0.0522
ZN	13	0.8750	0.0000	0.0852	0.0565	0.2376
ALK	13	62.0000	58.0000	59.5385	2.1026	1.4500
NH3N	13	0.0000	0.0000	0.0000	0.0000	0.0000
TP	13	0.1700	0.0700	0.1146	0.0011	0.0328

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.299	1.000								
TKN	-0.027	-0.198	1.000							
CL	-0.040	0.079	0.153	1.000						
PHL	-0.142	-0.270	-0.260	0.042	1.000					
CR	-0.220	-0.115	-0.491	-0.078	0.293	1.000				
ZN	-0.087	-0.011	-0.102		0.350	0.031	1.000			
ALK	0.134	-0.168	-0.145	-0.301	0.399	0.079	0.294	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	0.168	0.652	0.026	0.287	-0.256	-0.068	-0.404	-0.267	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	230.0000	140.0000	175.7692	695.1923	26.3665
CL	13	16.0000	5.0000	10.1538	5.3077	2.3038
SO4	13	16.0000	13.0000	14.6923	0.7308	0.8549
TBOD	13	2.0000	1.0000	1.0769	0.0769	0.2774
NO3N	13	0.5600	0.4500	0.5177	0.0015	0.0388
TCOD	13	17.0000	4.0000	10.2308	16.1923	4.0240
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	13	7.9000	7.8000	7.8385	0.0026	0.0506
TVS	13	140.0000	16.0000	81.6154	990.5897	31.4736
TS	13	255.0000	150.0000	191.1538	883.9744	29.7317

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.050	1.000								
SO4	0.474	-0.016	1.000							
TBOD	-0.351	-0.020	-0.249	1.000						
NO3N	0.471	-0.070	0.153	0.328	1.000					
TCOD	0.179	-0.040	-0.293	0.281	0.169	1.000				
T							1.000			
PH	-0.149	0.445	0.104	-0.228	-0.121	-0.374		1.000		
TVS	0.714	-0.186	-0.057	0.032	0.503	0.444		-0.325	1.000	
TS	0.974	-0.015	0.409	-0.163	0.585	0.259		-0.170	0.777	1.000

TABLE VII-D-27.

ALL STATIONS
ALL DEPTHS

OCTOBER 3, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	36.0000	7.0000	13.0000	76.1667	8.7274
TSS	13	325.0000	1.0000	37.6923	7646.5641	87.4446
TKN	13	0.4000	0.1500	0.3038	0.0069	0.0828
CL	13	37.0000	13.0000	18.3846	47.2564	6.8743
PHL	13	0.0150	0.0000	0.0012	0.0000	0.0042
CR	13	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	13	0.0980	0.0000	0.0180	0.0007	0.0270
ALK	13	60.0000	49.0000	57.3077	9.0641	3.0107
NH3N	13	0.0000	0.0000	0.0000	0.0000	0.0000
TP	13	0.3700	0.0600	0.1046	0.0065	0.0806

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.532	1.000								
TKN	0.271	-0.370	1.000							
CL	0.671	-0.048	0.048	1.000						
PHL		-0.099	0.349	-0.192	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	-0.270	-0.154	-0.532	-0.086	-0.201	1.000	1.000			
ALK	0.073	0.054	0.246	-0.143	0.169	1.000	0.060	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	0.776	-0.054	0.010	0.819	-0.166	1.000	-0.148	-0.017	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	610.0000	130.0000	255.3846	19085.2564	138.1494
CL	13	37.0000	13.0000	18.3846	47.2564	6.8743
SO4	13	28.0000	16.0000	20.0769	8.0769	2.8420
TBOD	13	2.0000	1.0000	1.2308	0.1923	0.4385
NO3N	13	0.5600	0.3700	0.4515	0.0032	0.0570
TCOD	13	36.0000	7.0000	13.0000	76.1667	8.7274
T	13	73.4000	70.7000	71.6000	0.4217	0.6494
PH	13	7.9000	7.5000	7.6538	0.0127	0.1127
TVS	13	570.0000	12.0000	198.6923	35366.7308	188.0604
TS	13	665.0000	150.0000	295.7692	32266.0256	179.6275

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.187	1.000								
SO4	-0.378	0.779	1.000							
TBOD	-0.153	-0.198	0.051	1.000						
NO3N	0.027	0.413	0.586	0.118	1.000					
TCOD	-0.163	0.671	0.692	0.152	0.690	1.000				
T	0.039	0.401	0.095	-0.205	-0.119	-0.075	1.000			
PH	0.446	0.154	-0.118	-0.441	0.298	0.246	0.011	1.000		
TVS	0.893	-0.225	-0.321	0.119	0.248	0.103	-0.087	0.434	1.000	
TS	0.882	-0.173	-0.304	0.119	0.251	0.125	-0.028	0.457	0.995	1.000

TABLE VII-D-28

ALL STATIONS
ALL DEPTHS

OCTOBER 24, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	130.0000	5.0000	25.8462	1109.6410	33.3113
TSS	13	240.0000	1.0000	47.4615	3807.1026	61.7017
TKN	13	0.8400	0.3400	0.6077	0.0239	0.1547
CL	13	275.0000	47.0000	120.0769	3721.9103	61.0075
PHL	13	0.0400	0.0050	0.0219	0.0001	0.0103
CR	13	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	13	0.1400	0.0500	0.0838	0.0009	0.0307
ALK	13	62.0000	57.0000	59.2308	2.6923	1.6408
NH3N	13	0.0000	0.0000	0.0000	0.0000	0.0000
TP	13	0.4700	0.0500	0.1108	0.0126	0.1123

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.326	1.000								
TKN	0.293	0.150	1.000							
CL	0.754	0.350	0.156	1.000						
PHL	-0.396	-0.339	-0.070	-0.328	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	-0.068	0.409	0.276	-0.127	-0.381	1.000	1.000			
ALK	-0.165	0.077	0.065	0.226	0.070	1.000	0.163	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	0.367	0.962	0.242	0.273	-0.393	1.000	0.526	-0.037	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	670.0000	210.0000	350.7692	14974.3590	122.3698
CL	13	275.0000	47.0000	120.0769	3721.9103	61.0075
SO4	13	50.0000	27.0000	33.3077	42.8974	6.5496
TBOD	13	3.0000	1.0000	2.3846	0.4231	0.6504
NO3N	13	0.4100	0.3700	0.3908	0.0002	0.0138
TCOD	13	130.0000	5.0000	25.8462	1109.6410	33.3113
T	13	73.4000	71.6000	72.1923	0.4324	0.6576
PH	13	7.6000	7.0000	7.2692	0.0590	0.2428
TVS	13	134.0000	56.0000	93.9231	664.9103	25.7859
TS	13	735.0000	225.0000	398.5385	24610.2692	156.8766

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.980	1.000								
SO4	0.943	0.941	1.000							
TBOD	0.451	0.499	0.302	1.000						
NO3N	0.559	0.542	0.596	0.242	1.000					
TCOD	0.792	0.754	0.704	0.418	0.478	1.000				
T	0.646	0.613	0.614	0.572	0.404	0.513	1.000			
PH	-0.510	-0.444	-0.386	-0.394	-0.117	-0.346	-0.529	1.000		
TVS	0.771	0.706	0.641	0.429	0.639	0.530	0.629	-0.695	1.000	
TS	0.931	0.905	0.820	0.464	0.477	0.750	0.458	-0.549	0.750	1.000

TABLE VII-D-29

ALL STATIONS
ALL DEPTHS

NOVEMBER 27, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	34.0000	9.0000	15.2308	38.5256	6.2069
TSS	13	210.0000	7.0000	35.0769	2852.0769	53.4048
TKN	13	0.9000	0.3000	0.5077	0.0308	0.1754
CL	13	22.0000	17.0000	18.5385	1.7692	1.3301
PHL	13	0.0500	0.0000	0.0052	0.0002	0.0136
CR	13	0.0560	0.0000	0.0111	0.0003	0.0171
ZN	13	0.1580	0.0560	0.0965	0.0006	0.0249
ALK	13	58.0000	55.0000	56.9231	1.0769	1.0377
NH3N	13	0.1000	0.0000	0.0154	0.0014	0.0376
TP	13	0.8100	0.0200	0.1392	0.0468	0.2164

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.945	1.000								
TKN	-0.101	-0.004	1.000							
CL	-0.289	-0.188	0.266	1.000						
PHL	0.191	0.059	-0.207	-0.291	1.000					
CR	-0.095	-0.206	-0.164	0.184	-0.223	1.000				
ZN	0.733	0.767	0.167	-0.128	0.266	-0.258	1.000			
ALK	0.417	0.375	-0.363	0.093	0.361	0.052	-0.263	1.000		
NH3N	-0.124	-0.134	0.360	-0.180	-0.168	0.024	-0.036	-0.609	1.000	
TP	0.040	0.091	-0.320	-0.161	-0.123	-0.289	-0.136	0.174	-0.224	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	275.0000	125.0000	199.6154	2047.7564	45.2521
CL	13	22.0000	17.0000	18.5385	1.7692	1.3301
SO4	13	30.0000	25.0000	27.3846	1.7564	1.3253
TBOD	13	1.0000	0.0000	0.4615	0.2692	0.5189
NO3N	13	0.8200	0.5000	0.7308	0.0059	0.0766
TCOD	13	34.0000	9.0000	15.2308	38.5256	6.2069
T	13	48.2000	46.4000	47.5769	0.4569	0.6760
PH	13	6.9000	6.9000	6.9000	0.0000	0.0000
TVS	13	141.0000	15.0000	72.6923	1767.7308	42.0444
TS	13	335.0000	165.0000	234.6154	2985.2564	54.6375

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.322	1.000								
SO4	0.552	-0.553	1.000							
TBOD	-0.347	0.455	-0.401	1.000						
NO3N	0.494	0.102	0.555	-0.366	1.000					
TCOD	-0.332	-0.289	-0.224	0.301	-0.734	1.000				
T	-0.008	0.321	-0.296	0.033	0.053	-0.142	1.000			
PH								1.000		
TVS	0.852	-0.341	0.532	-0.169	0.239	-0.045	-0.109		1.000	
TS	0.441	-0.450	0.009	-0.037	-0.407	0.644	-0.119		0.528	1.000

TABLE VII-D-30

ALL STATIONS
ALL DEPTHS

JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	13	22.0000	3.0000	11.0000	35.8333	5.9861
TSS	13	180.0000	55.0000	90.0000	1237.5000	35.1781
TKN	13	0.9500	0.0000	0.3592	0.0795	0.2819
CL	13	13.0000	10.0000	11.2308	1.0256	1.0127
PHL	13	0.2000	0.0000	0.0731	0.0028	0.0525
CR	13	0.0350	0.0000	0.0171	0.0001	0.0113
ZN	13	0.0770	0.0260	0.0422	0.0003	0.0161
ALK	13	45.0000	40.0000	43.1538	2.3077	1.5191
NH3N	13	0.2000	0.0000	0.0538	0.0044	0.0660
TP	13	0.2600	0.0500	0.1262	0.0044	0.0664

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.609	1.000								
TKN	0.116	0.479	1.000							
CL	0.275	-0.363	-0.399	1.000						
PHL	0.239	-0.192	-0.334	0.048	1.000					
CR	0.033	0.337	0.807	-0.329	-0.179	1.000				
ZN	0.641	0.886	0.579	-0.305	-0.218	0.328	1.000			
ALK	0.055	-0.296	-0.488	0.354	0.370	-0.277	-0.250	1.000		
NH3N	-0.316	-0.108	0.311	0.048	-0.148	0.407	-0.036	-0.006	1.000	
TP	0.509	0.649	0.356	-0.147	-0.032	0.291	0.652	-0.175	0.412	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	13	185.0000	30.0000	99.6154	2118.5897	46.0281
CL	13	13.0000	10.0000	11.2308	1.0256	1.0127
SO4	13	33.0000	14.0000	20.2308	22.0256	4.6931
TBOD	13	2.0000	1.0000	1.4615	0.2692	0.5189
NO3N	13	0.8400	0.5400	0.7262	0.0091	0.0955
TCOD	13	22.0000	3.0000	11.0000	35.8333	5.9861
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	13	7.8000	7.3000	7.5308	0.0240	0.1548
TVS	13	95.0000	8.0000	43.3846	628.0897	25.0617
TS	13	305.0000	130.0000	189.6154	3076.9231	55.4700

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.266	1.000								
SO4	0.249	-0.240	1.000							
TBOD	-0.655	0.098	-0.150	1.000						
NO3N	0.190	-0.378	0.353	-0.331	1.000					
TCOD	-0.396	0.275	0.160	0.402	0.185	1.000				
T							1.000			
PH	-0.232	0.323	0.402	0.327	-0.245	0.360		1.000		
TVS	0.773	-0.227	0.153	-0.521	0.157	-0.343		-0.134	1.000	
TS	0.775	-0.451	0.284	-0.384	0.454	0.058		-0.343	0.607	1.000

TABLE VII-D-31
ALL STATIONS
SURFACE
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	48	26.0000	3.0000	10.8125	33.7301	5.8078
TSS	48	90.0000	0.0000	20.6875	526.6449	22.9487
TKN	48	1.3100	0.0000	0.4981	0.0829	0.2879
CL	48	166.0000	4.0000	21.8750	1073.2606	32.7607
PHL	48	0.2830	0.0000	0.0279	0.0035	0.0588
CR	48	0.0870	0.0000	0.0107	0.0004	0.0199
ZN	48	0.3050	0.0000	0.0515	0.0030	0.0548
ALK	48	62.0000	39.0000	52.3542	49.1698	7.0121
NH3N	48	0.2000	0.0000	0.0271	0.0029	0.0536
TP	48	0.8100	0.0200	0.0969	0.0122	0.1106

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.328	1.000								
TKN	0.519	-0.187	1.000							
CL	0.131	0.148	-0.018	1.000						
PHL	-0.045	0.241	-0.356	-0.034	1.000					
CR	-0.103	0.074	-0.102	-0.182	0.330	1.000				
ZN	0.149	-0.067	0.245	0.067	-0.224	0.441	1.000			
ALK	-0.003	-0.359	-0.307	0.412	0.090	-0.032	0.062	1.000		
NH3N	0.071	0.133	0.415	-0.214	-0.070	0.105	-0.069	-0.598	1.000	
TP	0.002	-0.097	-0.104	-0.075	-0.010	-0.063	0.079	0.136	-0.147	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	48	610.0000	70.0000	178.8125	9182.5811	95.8258
CL	48	166.0000	4.0000	21.8750	1073.2606	32.7607
SO4	48	41.0000	10.0000	19.2292	48.6059	6.9718
TBOD	48	4.0000	0.0000	1.4792	1.1059	1.0516
NO3N	47	0.8400	0.1900	0.5162	0.0306	0.1748
TCOD	48	26.0000	3.0000	10.8125	33.7301	5.8078
T	30	73.4000	46.4000	63.4500	110.2847	10.5017
PH	48	7.9000	6.9000	7.5313	0.0886	0.2976
TVS	48	540.0000	2.0000	73.7708	6405.7549	80.0360
TS	48	830.0000	100.0000	200.2083	9311.6578	96.4969

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.595	1.000								
SO4	0.519	0.799	1.000							
TBOD	-0.165	0.144	-0.094	1.000						
NO3N	-0.288	-0.215	0.077	0.243	1.000					
TCOD	-0.018	0.131	0.115	0.541	-0.277	1.000				
T	0.280	0.338	0.042	0.615	-0.301	0.176	1.000			
PH	0.020	-0.135	-0.490	0.060	-0.635	-0.208	0.600	1.000		
TVS	0.790	0.066	0.060	-0.220	-0.234	-0.090	0.176	0.172	1.000	
TS	0.972	0.623	0.538	-0.173	-0.240	-0.095	0.261	0.003	0.774	1.000

TABLE VII-D-32

ALL STATIONS
DEPTHS 20 TO 45 FT.
MAY 29, 1973 TO JANUARY 3, 1974
CATEGORY 6

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	39	155.0000	5.0000	22.7949	927.0621	30.4477
TSS	39	560.0000	1.0000	66.3846	9868.7692	99.3417
TKN	39	3.6400	0.0000	0.6523	0.4696	0.6853
CL	39	275.0000	5.0000	30.5385	2986.6235	54.6500
PHL	39	0.2410	0.0000	0.0350	0.0041	0.0638
CR	39	0.1690	0.0000	0.0197	0.0014	0.0376
ZN	39	0.8750	0.0000	0.0637	0.0196	0.1399
ALK	39	62.0000	43.0000	53.3333	40.7544	6.3839
NH3N	39	0.3000	0.0000	0.0333	0.0049	0.0701
TP	39	1.4300	0.0400	0.1764	0.0556	0.2359

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.744	1.000								
TKN	0.680	0.646	1.000							
CL	0.440	0.033	-0.019	1.000						
PHL	-0.178	-0.122	-0.215	-0.114	1.000					
CR	0.090	0.152	0.163	-0.210	0.187	1.000				
ZN	0.102	0.124	0.145	0.025	0.430	-0.068	1.000			
ALK	0.049	-0.105	-0.173	0.374	0.133	-0.122	0.188	1.000		
NH3N	0.520	0.627	0.803	-0.200	-0.126	0.240	0.079	-0.390	1.000	
TP	0.780	0.922	0.761	-0.011	-0.114	0.155	0.114	-0.027	0.717	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	39	670.0000	30.0000	201.6667	14539.9123	120.5816
CL	39	275.0000	5.0000	30.5385	2986.6235	54.6500
SO4	39	50.0000	11.0000	20.5385	65.5709	8.0976
TBOD	39	9.0000	0.0000	1.8462	3.2915	1.8142
NO3N	39	1.5800	0.2700	0.5990	0.0741	0.2723
TCOD	39	155.0000	5.0000	22.7949	927.0621	30.4477
T	24	73.4000	47.3000	63.6583	108.5695	10.4197
PH	39	7.9000	6.9000	7.4872	0.1259	0.3548
TVS	39	390.0000	8.0000	90.2051	4312.5358	65.6699
TS	39	870.0000	115.0000	268.6154	26636.3482	163.8180

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.815	1.000								
SO4	0.712	0.839	1.000							
TBOD	0.145	0.165	0.036	1.000						
NO3N	-0.218	-0.265	-0.124	0.625	1.000					
TCOD	0.465	0.440	0.369	0.660	-0.508	1.000				
T	0.381	0.389	0.130	0.513	-0.004	0.269	1.000			
PH	-0.349	-0.418	-0.641	-0.109	-0.161	-0.251	0.413	1.000		
TVS	0.627	0.163	0.150	-0.156	-0.239	0.004	0.214	-0.012	1.000	
TS	0.799	0.620	0.545	0.457	0.195	0.793	0.325	-0.356	0.428	1.000

TABLE VII-D-33
ALL STATIONS
DEPTHS 45 TO 80 FEET
MAY 29, 1973 THROUGH JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	16	28.0000	0.0000	16.8750	26.1167	5.1104
TSS	16	725.0000	0.0000	75.0375	6698.5959	81.8449
TKN	16	1.1200	0.0000	0.5444	0.0845	0.2907
CL	16	130.0000	0.0000	21.3750	1076.6500	32.8123
PHL	16	0.1710	0.0000	0.0259	0.0019	0.0438
CR	16	0.0600	0.0000	0.0146	0.0004	0.0203
ZN	16	0.6050	0.0050	0.1212	0.0348	0.1854
ALK	16	62.0000	40.0000	52.6875	54.0958	7.3550
NH3N	16	0.1000	0.0000	0.0063	0.0006	0.0250
TP	16	0.2200	0.0300	0.1250	0.0027	0.0522

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.673	1.000								
TKN	0.199	-0.184	1.000							
CL	0.215	-0.079	0.089	1.000						
PHL	-0.341	-0.125	-0.048	0.011	1.000					
CR	0.033	0.114	-0.042	-0.323	0.429	1.000				
ZN	-0.127	-0.065	-0.115	-0.157	-0.236	0.169	1.000			
ALK	-0.108	-0.117	-0.527	0.392	0.238	-0.280	0.006	1.000		
NH3N	-0.008	-0.002	-0.041	-0.007	-0.158	-0.191	-0.042	0.084	1.000	
TP	0.043	0.209	-0.118	-0.053	0.200	0.585	0.192	-0.220	-0.486	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	16	830.0000	75.0000	187.6125	8859.8958	94.1270
CL	16	130.0000	0.0000	21.3750	1076.6500	32.8123
SO4	16	98.0000	11.0000	30.3750	72.9167	8.5391
TBOD	16	4.0000	0.0000	1.8125	1.2292	1.1087
NO3N	16	0.8400	0.2100	0.5681	0.0435	0.2085
TCOD	16	28.0000	0.0000	16.8750	26.1167	5.1104
T	10	72.0000	45.0000	63.1200	122.0151	11.0460
PH	16	7.8000	6.0000	7.4375	0.1132	0.3364
TVS	16	570.0000	15.0000	95.7500	17104.7333	130.7851
TS	16	665.0000	105.0000	264.4375	20747.7292	144.0407

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.758	1.000								
SO4	0.634	0.696	1.000							
TBOD	-0.159	0.134	-0.161	1.000						
NO3N	-0.200	-0.261	0.294	-0.025	1.000					
TCOD	0.424	0.215	0.015	0.207	-0.173	1.000				
T	0.281	0.402	0.027	0.490	-0.400	-0.077	1.000			
PH	-0.330	-0.527	-0.597	-0.097	-0.311	-0.067	0.216	1.000		
TVS	0.605	0.103	0.099	-0.050	-0.143	0.588	0.281	0.183	1.000	
TS	0.845	0.455	0.392	-0.159	-0.280	0.664	0.256	0.017	0.854	1.000

TABLE VII-D-34
ALL STATIONS
SURFACE
MAY 29, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	14.0000	6.0000	11.0000	8.8000	2.9665
TSS	6	28.0000	1.0000	15.5000	96.7000	9.8336
TKN	6	0.8000	0.5000	0.6083	0.0064	0.0801
CL	6	4.0000	4.0000	5.0000	1.6000	1.2649
PPL	6	0.0000	0.0000	0.0000	0.0000	0.0000
CR	6	0.0250	0.0000	0.0092	0.0001	0.0111
ZP	6	0.0560	0.0120	0.0290	0.0002	0.0154
ALK	6	46.0000	39.0000	42.8333	4.9667	2.2286
NH3N	6	0.2000	0.0000	0.0667	0.0107	0.1033
TP	6	0.0900	0.0200	0.0500	0.0008	0.0253

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PPL	CR	ZP	ALK	NH3N	TP
TCOD	1.000									
TSS	0.130	1.000								
TKN	0.094	-0.209	1.000							
CL		0.499	-0.999	1.000						
PPL	1.000	1.000	1.000	1.000	1.000					
CR	-0.861	-0.618	-0.159	-0.971	1.000	1.000				
ZP	0.509	0.597	-0.358	0.659	1.000	-0.561	1.000			
ALK	0.121	0.709	-0.127	0.709	1.000	-0.570	0.979	1.000		
NH3N	-0.131	-0.749	-0.172		1.000	0.927	-0.539	-0.697	1.000	
TP	0.800	0.918	0.499	-0.195	1.000	-0.709	0.812	0.932	-0.775	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	125.0000	105.0000	112.5000	47.5000	6.8920
CL	6	7.0000	4.0000	5.0000	1.6000	1.2649
SO4	6	12.0000	10.0000	11.1667	0.9667	0.9832
TBOD	6	2.0000	1.0000	1.1667	0.1667	0.4082
NO3N	6	0.4300	0.3000	0.3900	0.0022	0.0469
TCOD	6	14.0000	6.0000	11.0000	8.8000	2.9665
T	6	55.0000	54.0000	54.6667	0.2667	0.5164
PH	6	7.8000	7.2000	7.6167	0.0657	0.2563
TVS	6	75.0000	25.0000	50.0000	400.0000	20.0000
TS	6	140.0000	129.0000	129.1667	74.1667	8.6120

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.229	1.000								
SO4	0.074	0.804	1.000							
TBOD	-0.178	0.775	0.415	1.000						
NO3N	0.747	-0.169	-0.607	0.209	1.000					
TCOD			-0.480	0.495	0.134	1.000				
T	-0.562		0.131	0.316	-0.248		1.000			
PH	-0.198	-0.185	0.225	-0.414	-0.116	-0.421	-0.803	1.000		
TVS	-0.883	0.356	0.305	0.612	-0.173	-0.034	0.775	-0.410	1.000	
TS	0.211	0.734	0.374	0.618	0.188	0.274	-0.000			

TABLE VII-D-35
ALL STATIONS
SURFACE
JUNE 19, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	22.0000	10.0000	17.5000	19.9000	4.4609
TSS	6	16.0000	0.0000	6.1667	43.7667	6.6156
TKN	6	1.3100	0.5500	0.9950	0.0803	0.2830
CL	6	7.0000	6.0000	6.3333	0.2667	0.5164
PHL	6	0.0100	0.0000	0.0033	0.0000	0.0041
CR	6	0.0180	0.0000	0.0090	0.0001	0.0090
ZN	6	0.1440	0.0100	0.0783	0.0015	0.0394
ALK	6	47.0000	45.0000	46.0000	0.8000	0.8325
NH3N	6	0.1000	0.0000	0.0667	0.0027	0.0516
TP	6	0.1100	0.0800	0.0950	0.0002	0.0138

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.000	1.000								
TKN	0.939	0.157	1.000							
CL	0.097	0.156	0.219	1.000						
PHL	-0.231	-0.017	-0.351	0.506	1.000					
CR	-0.536	0.054	-0.310	0.600	0.083	1.000				
ZN	0.162	0.799	0.262	-0.370	-0.282	-0.446	1.000			
ALK	-0.525	-0.048	-0.386	0.819	0.775	0.620	-0.330	1.000		
NH3N	0.781	-0.390	0.725	0.500	0.053	-0.096	-0.498		1.000	
TP	0.508	0.822	0.829		-0.120	-0.289	-0.823	-0.459		1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	125.0000	95.0000	108.8333	182.1667	12.7345
CL	6	7.0000	6.0000	6.3333	0.2667	0.5164
SO4	6	17.0000	13.0000	14.8333	1.7667	1.3292
TPOD	6	4.0000	2.0000	3.6667	0.6667	0.8165
PO4P	6	0.8400	0.7400	0.7750	0.0015	0.0300
TCOD	6	22.0000	10.0000	17.5000	19.9000	4.4609
F	6	72.3000	69.6000	71.1333	0.9267	0.9626
PP	6	7.6000	7.4000	7.4500	0.0070	0.0837
TVS	6	36.0000	2.0000	24.3333	174.6667	13.2162
TS	6	130.0000	100.0000	115.8333	154.1667	12.4164

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TPOD	PO4P	TCOD	F	PP	TVS	TS
TDS	1.000									
CL	-0.142	1.000								
SO4	0.577	0.097	1.000							
TPOD	0.380	0.316	-0.081	1.000						
PO4P	0.277	0.172	-0.441	0.258	1.000					
TCOD	0.704	0.087	0.186	0.934	0.441	1.000				
F	-0.370	-0.148	0.224	-0.034	-0.859	-0.326	1.000			
PP	-0.535		0.000	-0.878	-0.258	-0.885	0.323	1.000		
TVS	0.788	-0.401	0.072	0.909	0.463	0.689	-0.639	-0.705	1.000	
TS	0.868	-0.052	0.292	0.827	0.408	0.803	-0.706	-0.722	0.924	1.000

TABLE VII-D-36
ALL STATIONS
SURFACE
JULY 30, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	7.0000	3.0000	4.6667	3.4667	1.8619
TSS	6	35.0000	7.0000	14.8333	110.1667	10.4960
TKP	6	0.4000	0.0000	0.2650	0.0272	0.1648
CL	6	10.0000	6.0000	8.3333	1.8667	1.3663
PHL	6	0.0200	0.0000	0.0067	0.0001	0.0088
CR	6	0.0870	0.0000	0.0198	0.0011	0.0338
ZN	6	0.3050	0.0000	0.0910	0.0162	0.1274
ALK	6	56.0000	52.0000	54.8333	1.3667	1.1690
NH3N	6	0.0000	0.0000	0.0000	0.0000	0.0000
TP	6	0.1200	0.0800	0.0983	0.0002	0.0147

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKP	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.744	1.000								
TKP	0.130	-0.231	1.000							
CL	0.446	-0.116	0.808	1.000						
PHL	0.409	-0.633	-0.776	-0.557	1.000					
CR	0.577	-0.075	0.479	0.659	-0.242	1.000				
ZN	0.459	-0.019	0.252	0.618	-0.232	0.887	1.000			
ALK	-0.306	-0.801	0.524	0.292	-0.554	0.449	0.247	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	-1.000	-1.000	1.000	
TP	0.934	0.775	-0.054	0.133	0.569	0.357	0.200	-0.484	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	195.0000	160.0000	185.0000	170.0000	13.0384
CL	6	10.0000	6.0000	8.3333	1.8667	1.3663
SO4	6	17.0000	15.0000	16.3333	0.6667	0.8165
TROD	6	1.0000	1.0000	1.0000	0.0000	0.0000
NO3N	6	0.4700	0.1900	0.3050	0.0089	0.0942
TCOD	6	7.0000	3.0000	4.6667	3.4667	1.8619
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	6	7.9000	7.7000	7.8000	0.0040	0.0632
TVS	6	125.0000	64.0000	84.8333	458.1667	21.4048
TS	6	220.0000	170.0000	200.8333	294.1667	17.1513

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TROD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.898	1.000								
SO4	-0.564	-0.299	1.000							
TROD	1.000	1.000	1.000	1.000						
NO3N	-0.033	-0.326	0.130	1.000	1.000					
TCOD	0.247	0.446	0.219	1.000	-0.194	1.000				
T							1.000			
PH			-0.399	1.000	-0.067	-0.170		1.000		
TVS	0.197	0.584	0.107	1.000	-0.820	0.455		0.222	1.000	
TS	0.827	0.711	-0.524	1.000	0.003	0.605		-0.092	0.099	1.000

TABLE VII-D-37
ALL STATIONS
SURFACE
AUGUST 22, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	17.0000	4.0000	10.1667	25.3667	5.0365
TSS	6	22.0000	7.0000	10.6667	33.0667	5.7504
TKN	6	0.6300	0.1400	0.3617	0.0312	0.1766
CL	6	11.0000	5.0000	9.5000	5.1000	2.2583
PHL	6	0.2830	0.0110	0.1022	0.0124	0.1111
CR	6	0.0850	0.0000	0.0142	0.0012	0.0347
ZN	6	0.0360	0.0000	0.0167	0.0002	0.0124
ALK	6	61.0000	58.0000	59.8333	1.7667	1.3292
NH3N	6	0.0000	0.0000	0.0000	0.0000	0.0000
TP	6	0.1300	0.0800	0.1033	0.0004	0.0197

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.143	1.000								
TKN	-0.185	-0.344	1.000							
CL	-0.062	-0.955	0.529	1.000						
PHL	0.263	-0.973	-0.774	-0.173	1.000					
CR	-0.016	-0.227	-0.615	0.108	0.797	1.000				
ZN	0.158	-0.309	0.220	0.427	-0.369	0.131	1.000			
ALK	0.602	0.253	-0.365	-0.366	0.415	0.430	0.274	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	-0.714	-0.165	-0.313	0.225	0.320	0.668	0.038	-0.281	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	200.0000	140.0000	169.3333	696.6667	26.3944
CL	6	11.0000	5.0000	9.5000	5.1000	2.2583
SO4	6	16.0000	13.0000	14.6667	1.0667	1.0328
TPOD	6	1.0000	1.0000	1.0000	0.0000	0.0000
PO3H	6	0.5600	0.4500	0.4933	0.0016	0.0398
TCOD	6	17.0000	4.0000	10.1667	25.3667	5.0365
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	6	7.9000	7.8000	7.8333	0.0027	0.0516
TVS	6	125.0000	16.0000	71.0000	1352.0000	36.7696
TS	6	220.0000	150.0000	180.0000	840.0000	28.9828

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TPOD	PO3H	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.638	1.000								
SO4	0.636	-0.957	1.000							
TPOD	1.000	-1.000	1.000	1.000						
PO3H	0.881	-0.923	0.821	1.000	1.000					
TCOD	0.013	-0.062	-0.179	1.000	0.156	1.000				
T							1.000			
PH	-0.538	0.343	0.250	1.000	-0.551	-0.487		1.000		
TVS	0.816	-0.773	-0.147	1.000	0.665	0.338		-0.801	1.000	
TS	0.993	-0.764	0.601	1.000	0.918	0.096		-0.535	0.662	1.000

TABLE VII-D-38.
ALL STATIONS
SURFACE
OCTOBER 3, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	13.0000	8.0000	10.0000	3.2000	1.7889
TSS	6	17.0000	1.0000	7.3333	31.4667	5.6095
TKN	6	0.4000	0.2000	0.3083	0.0054	0.0736
CL	6	28.0000	14.0000	18.5000	29.5000	5.4314
PHL	6	0.0150	0.0000	0.0025	0.0000	0.0061
CR	6	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	6	0.0320	0.0000	0.0090	0.0002	0.0129
ALK	6	60.0000	49.0000	56.6667	19.0667	4.3665
NH3N	6	0.0000	0.0000	0.0000	0.0000	0.0000
TP	6	0.0800	0.0600	0.0767	0.0001	0.0103

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.060	1.000								
TKN	0.911	-0.032	1.000							
CL	0.041	0.249	0.188	1.000						
PHL	0.822	0.146	0.610	-0.408	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN		-0.194	-0.032	0.666	-0.342	1.000	1.000			
ALK	0.461	-0.680	0.353	-0.101	0.262	1.000	0.526	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	-0.325	-0.194	-0.008	0.784	-0.791	1.000	0.511	-0.118	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	610.0000	150.0000	269.1667	31364.1667	177.0993
CL	6	28.0000	14.0000	18.5000	29.5000	5.4314
SO4	6	37.0000	14.0000	19.5000	5.1000	2.2583
TBOD	6	3.0000	1.0000	1.1667	0.1667	0.4082
NO3N	6	0.4800	0.3700	0.4183	0.0013	0.0366
TCOD	6	13.0000	8.0000	10.0000	3.2000	1.7889
T	6	73.4000	71.6000	72.0333	0.4867	0.6976
PH	6	7.8000	7.5000	7.6333	0.0107	0.1033
TVS	6	540.0000	12.0000	176.6667	37849.4667	194.5494
TS	6	630.0000	155.0000	278.3333	33446.6667	182.8843

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.128	1.000								
SO4	-0.426	0.351	1.000							
TBOD	-0.330	-0.225	0.542	1.000						
NO3N	0.046	0.126	0.375	0.826	1.000					
TCOD	-0.253	0.041	0.099	-0.274	-0.183	1.000				
T	-0.204	0.024	0.444	-0.023	0.254	0.160	1.000			
PH	0.866	0.178	-0.429	-0.632	-0.247	0.217	-0.130	1.000		
TVS	0.994	0.029	-0.470	-0.289	0.064	-0.261	-0.290	0.846	1.000	
TS	1.000	0.139	-0.429	-0.330	0.053	-0.248	-0.191	0.867	0.994	1.000

TABLES VII-D-39
ALL STATIONS
SURFACE
OCTOBER 24, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	26.0000	5.0000	14.1667	88.5667	9.4110
TSS	6	70.0000	1.0000	25.1667	552.5667	23.5067
TKN	6	0.8400	0.3400	0.5517	0.0422	0.2055
CL	6	166.0000	47.0000	97.3333	2012.6667	44.8628
PHL	6	0.0400	0.0050	0.0250	0.0002	0.0130
CR	6	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	6	0.0800	0.0500	0.0633	0.0001	0.0121
ALK	6	62.0000	57.0000	58.8333	2.9667	1.7224
NH3N	6	0.0000	0.0000	0.0000	0.0000	0.0000
TP	6	0.0800	0.0500	0.0633	0.0001	0.0121

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.521	1.000								
TKN	0.204	-0.112	1.000							
CL	-0.250	0.532	-0.437	1.000						
PHL	-0.815	0.023	0.149	-0.097	1.000					
CR	1.000	-1.000	1.000	-1.000	-1.000	1.000				
ZN	0.626	-0.670	0.592	-0.404	0.127	1.000	-1.000			
ALK	-0.751	0.915	-0.253	0.707	0.312	1.000	-0.735	1.000		
NH3N	1.000	-1.000	1.000	-1.000	-1.000	1.000	-1.000	-1.000	1.000	
TP	0.679	-0.059	0.769	-0.212	-0.507	1.000	0.591	-0.352	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	410.0000	210.0000	296.6667	6236.6667	78.9726
CL	6	166.0000	47.0000	97.3333	2012.6667	44.8628
SO4	6	41.0000	27.0000	31.8333	26.5667	5.1543
TBOD	6	3.0000	1.0000	2.0000	0.4000	0.6325
NO3N	6	0.4100	0.3700	0.3900	0.0003	0.0167
TCOD	6	26.0000	5.0000	14.1667	88.5667	9.4110
T	6	72.5000	71.6000	71.8167	0.1377	0.3710
PH	6	7.8000	7.3000	7.5000	0.0160	0.1265
TVS	6	94.0000	56.0000	75.1667	256.5667	16.0177
TS	6	480.0000	225.0000	321.6667	8636.6667	92.9337

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.987	1.000								
SO4	0.959	0.975	1.000							
TBOD	0.420	0.451	0.307	1.000						
NO3N	0.288	0.234	0.278	0.378	1.000					
TCOD	-0.249	-0.250	-0.358	0.706	0.495	1.000				
T	0.258	0.200	0.064	0.767	0.129	0.606	1.000			
PH	-0.440	-0.451	-0.583	0.500		0.773	0.384	1.000		
TVS	0.484	0.433	0.521	0.197	0.933	0.159	-0.054	-0.336	1.000	
TS	0.975	0.989	0.997	0.340	0.257	-0.339	0.135	-0.561	0.492	1.000

TABLE VII-D-40
ALL STATIONS
SURFACE
NOVEMBER 27, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	17.0000	9.0000	12.3333	7.0667	2.6583
TSS	6	24.0000	7.0000	14.1667	41.3667	6.4317
TKN	6	0.9000	0.3000	0.5500	0.0670	0.2588
CL	6	22.0000	17.0000	19.0000	3.2000	1.7889
PHL	6	0.0050	0.0000	0.0013	0.0000	0.0022
CR	6	0.0560	0.0000	0.0173	0.0005	0.0223
ZN	6	0.1120	0.0710	0.0927	0.0002	0.0146
ALK	6	58.0000	56.0000	56.6667	0.6667	0.8165
NH3N	6	0.1000	0.0000	0.0167	0.0017	0.0408
TP	6	0.8100	0.0200	0.2033	0.0949	0.3080

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.441	1.000								
TKN	-0.087	0.807	1.000							
CL	-0.126	-0.156	-0.216	1.000						
PHL	0.720	-0.537	-0.179	0.621	1.000					
CR	0.747	0.478	-0.291	0.040	-0.277	1.000				
ZN	0.199	0.632	0.556	-0.023	-0.161	0.179	1.000			
ALK	0.522	-0.292	-0.473	0.411	-0.038	0.469	-0.565	1.000		
NH3N	-0.661	0.749	0.473	-0.274	-0.302	0.146	0.146	-0.400	1.000	
TP	-0.182	-0.476	-0.454	-0.319	-0.110	-0.467	-0.840	0.300	-0.276	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	245.0000	155.0000	190.0000	1090.0000	33.0151
CL	6	22.0000	17.0000	19.0000	3.2000	1.7889
SO4	6	28.0000	25.0000	27.3333	1.4667	1.2111
TBOD	6	1.0000	0.0000	0.3333	0.2667	0.5164
NO3N	6	0.7700	0.0300	0.3383	0.0008	0.0286
TCOD	6	17.0000	9.0000	12.3333	7.0667	2.6583
T	6	48.2000	46.4000	47.6000	0.5400	0.7348
PH	6	6.9000	6.9000	6.9000	0.0000	0.0000
TVS	6	114.0000	15.0000	62.5000	1446.7000	38.0355
TS	6	255.0000	165.0000	204.1667	1204.1667	34.7011

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.593	1.000								
SO4	0.200	-0.739	1.000							
TBOD	-0.469	0.866	-0.533	1.000						
NO3N	-0.503	0.587	-0.559	0.452	1.000					
TCOD	-0.011	-0.126	0.642	0.194	-0.018	1.000				
T	0.260	0.137	0.067	0.157	0.371	0.584	1.000			
PH								1.000		
TVS	0.710	-0.517	0.830	-0.183	-0.551	0.661	0.457		1.000	
TS	0.986	-0.596	0.198	-0.484	-0.385	0.036	0.365		0.697	1.000

TABLE VII-D-41
ALL STATIONS
SURFACE
JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	6	16.0000	3.0000	6.6667	23.4667	4.8442
TSS	6	90.0000	55.0000	71.6667	186.6667	13.6626
TKN	6	0.6500	0.0600	0.3550	0.0587	0.2422
CL	6	12.0000	10.0000	11.0000	0.8000	0.8944
PHL	6	0.2000	0.0000	0.0833	0.0057	0.0753
CR	6	0.0350	0.0000	0.0175	0.0002	0.0123
ZN	6	0.0400	0.0260	0.0322	0.0000	0.0057
ALK	6	45.0000	40.0000	43.1667	2.9867	1.7224
NH3N	6	0.1000	0.0000	0.0667	0.0027	0.0516
TP	6	0.1000	0.0700	0.0850	0.0001	0.0105

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-0.232	1.000								
TKN	-0.288	0.079	1.000							
CL	0.646	-0.245	-0.434	1.000						
PHL	0.612	-0.794	-0.554	0.140	1.000					
CR	-0.337	-0.104	0.698	0.018	-0.187	1.000				
ZN	-0.309	0.740	0.724	0.157	-0.900	0.301	1.000			
ALK	0.503	-0.184	-0.084	0.130	0.488	0.233	-0.146	1.000		
NH3N	-0.693	-0.189	0.783		-0.429	0.745	0.362	-0.375	1.000	
TP	-0.394	-0.209	-0.516	-0.426	0.127	-0.496	-0.518	-0.720		1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	6	150.0000	70.0000	100.0000	1150.0000	33.9116
CL	6	12.0000	10.0000	11.0000	0.8000	0.8944
SO4	6	24.0000	14.0000	19.1667	12.1667	3.4881
TROD	6	2.0000	1.0000	1.5000	0.3000	0.5477
NO3N	6	0.7500	0.5400	0.6500	0.0004	0.0917
TCOD	6	16.0000	3.0000	6.6667	23.4667	4.8442
T	6	0.0000	0.0000	0.0000	0.0000	0.0000
PH	6	7.8000	7.4000	7.5167	0.0217	0.1472
TVS	6	95.0000	16.0000	45.6667	701.8667	26.4928
TS	6	240.0000	130.0000	171.6667	1766.6667	42.0317

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TROD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.593	1.000								
SO4	-0.516		1.000							
TROD	-0.808	0.816	-0.052	1.000						
NO3N	0.711	-0.305	-0.307	-0.757	1.000					
TCOD	-0.450	0.646	0.075	0.603	-0.730	1.000				
T							1.000			
PH	-0.461	0.508	0.461	0.372	-0.652	0.851		1.000		
TVS	0.553	-0.312	-0.023	-0.648	0.697	-0.431		-0.080	1.000	
TS	0.958	-0.559	-0.718	-0.652	0.711	-0.439		-0.587	0.414	1.000

TABLE VII-D-42

ALL STATIONS
DEPTHS 20 TO 45 FT.
MAY 29, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	4	19.0000	12.0000	15.7500	10.9167	3.3040
TSS	4	67.0000	21.0000	46.7500	504.2500	22.4555
TKN	4	0.8000	0.5500	0.7000	0.0150	0.1225
CL	4	7.0000	5.0000	6.2500	0.9167	0.9574
PHL	4	0.0000	0.0000	0.0000	0.0000	0.0000
CR	4	0.1400	0.0000	0.0463	0.0039	0.0627
ZN	4	0.0860	0.0270	0.0603	0.0008	0.0281
ALK	4	46.0000	43.0000	44.2500	2.2500	1.5000
NH3N	4	0.1000	0.0000	0.0250	0.0025	0.0500
TP	4	0.1400	0.0800	0.1000	0.0008	0.0283

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.987	1.000								
TKN	0.988	1.000	1.000							
CL	0.446	0.578	0.569	1.000						
PHL	1.000	1.000	1.000	1.000	1.000					
CR	0.624	0.707	0.708	0.621	1.000	1.000				
ZN	0.980	0.996	0.996	0.566	1.000	0.761	1.000			
ALK	-0.992	-0.997	-0.998	-0.522	1.000	-0.714	-0.987	1.000		
NH3N	0.454	0.542	0.544	0.522	1.000	0.976	0.610	-0.556	1.000	
TP	0.426	0.283	0.289	-0.492	1.000	-0.358	0.243	-0.314	-0.471	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	4	130.0000	110.0000	122.5000	91.6667	9.5743
CL	4	7.0000	5.0000	6.2500	0.9167	0.9574
SO4	4	12.0000	12.0000	12.0000	0.0000	0.0000
TBOD	4	2.0000	1.0000	1.2500	0.2500	0.5000
NO3N	4	0.5000	0.4500	0.4700	0.0006	0.0245
TCOD	4	19.0000	12.0000	15.7500	10.9167	3.3040
T	4	55.0000	54.0000	54.5000	0.3333	0.5774
PH	4	7.8000	6.9000	7.5500	0.1900	0.4359
TVS	4	100.0000	40.0000	70.0000	1016.6667	31.8852
TS	4	200.0000	130.0000	170.0000	1000.0000	31.6228

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.636	1.000								
SO4	1.000	1.000	1.000							
TBOD	-0.174	0.522	1.000	1.000						
NO3N	0.426	0.142	1.000	-0.272	1.000					
TCOD	0.975	0.448	1.000	-0.353	0.453	1.000				
T	-0.302	-0.905	1.000	-0.577	0.236	-0.067	1.000			
PH	-0.599	-0.519	1.000	0.382	0.466	-0.544	0.530	1.000		
TVS	-0.273	-0.218	1.000	-0.523	-0.960	-0.253	-0.091	-0.576	1.000	
TS	0.991	0.550	1.000	-0.211	0.516	0.989	-0.183	-0.508	-0.347	1.000

TABLE VII-D-43

ALL STATIONS
DEPTHS 20 TO 45 FT.
JUNE 19, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	155.0000	13.0000	54.0000	3569.0000	59.7411
TSS	5	560.0000	1.0000	151.0000	58026.0000	240.8900
TKN	5	3.0400	1.2700	2.1500	0.8834	0.9399
CL	5	8.0000	5.0000	6.4000	1.3000	1.1402
PHL	5	0.0170	0.0090	0.0048	0.0001	0.0075
CR	5	0.0800	0.0000	0.0266	0.0011	0.0330
ZN	5	0.2000	0.0300	0.1160	0.0051	0.0716
ALK	5	54.0000	46.0000	48.4000	10.3000	3.2094
NH3N	5	0.3000	0.1000	0.1600	0.0080	0.0894
TP	5	1.4300	0.0800	0.4640	0.3392	0.5824

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.999	1.000								
TKN	0.982	0.977	1.000							
CL	0.885	0.899	0.889	1.000						
PHL	-0.069	-0.075	0.089	0.217	1.000					
CR	0.792	0.788	0.767	0.577	-0.414	1.000				
ZN	0.730	0.728	0.741	0.759	0.386	0.165	1.000			
ALK	0.973	0.981	0.933	0.902	-0.173	0.836	0.613	1.000		
NH3N	0.963	0.983	0.981	0.932	0.097	0.680	0.827	0.941	1.000	
TP	0.998	0.998	0.984	0.912	-0.014	0.757	0.763	0.970	0.992	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	310.0000	105.0000	154.0000	7667.5000	87.5643
CL	5	8.0000	5.0000	6.4000	1.3000	1.1402
SO4	5	19.0000	11.0000	15.6000	8.3000	2.8810
TBOD	5	9.0000	4.0000	5.8000	3.7000	1.9235
NO3N	5	1.5800	0.7000	1.0720	0.1833	0.4282
TCOD	5	155.0000	13.0000	54.0000	3569.0000	59.7411
T	5	71.4000	69.4000	70.4000	0.0550	0.8093
PH	5	7.5000	7.4000	7.4000	0.0030	0.0548
TVS	5	110.0000	23.0000	47.8000	1276.7000	35.7589
TS	5	870.0000	115.0000	305.0000	105100.0000	324.1913

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.794	1.000								
SO4	0.682	0.137	1.000							
TBOD	0.904	0.616	0.614	1.000						
NO3N	0.636	0.899	-0.125	0.617	1.000					
TCOD	0.927	0.885	0.382	0.901	0.867	1.000				
T	0.739	0.433	0.858	0.466	0.058	0.452	1.000			
PH	-0.636	-0.480	-0.602	-0.332	-0.209	-0.458	-0.846	1.000		
TVS	0.969	0.879	0.523	0.846	0.763	0.961	0.658	-0.682	1.000	
TS	0.964	0.883	0.474	0.904	0.814	0.993	0.556	-0.535	0.983	1.000

TABLE VII-D-44

ALL STATIONS
DEPTHS 20 TO 45 FT.
JULY 30, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	13.0000	9.0000	11.4000	3.3000	1.8166
TSS	5	81.0000	29.0000	54.0000	555.5000	23.5690
TKN	5	0.5300	0.2000	0.3260	0.0186	0.1365
CL	5	19.0000	7.0000	10.4000	24.8000	4.9800
PHL	5	0.0450	0.0000	0.0120	0.0004	0.0196
CR	5	0.0240	0.0000	0.0092	0.0001	0.0100
ZN	5	0.0760	0.0000	0.0152	0.0012	0.0340
ALK	5	56.0000	54.0000	55.0000	0.5000	0.7071
NH3N	5	0.1000	0.0000	0.0200	0.0020	0.0447
TP	5	0.1800	0.1200	0.1440	0.0006	0.0251

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.444	1.000								
TKN	0.260	0.121	1.000							
CL	-0.575	-0.486	0.117	1.000						
PHL	0.359	0.277	-0.708	-0.177	1.000					
CR	-0.365	-0.675	-0.128	-0.183	-0.477	1.000				
ZN	-0.739	-0.593	0.098	0.965	-0.343	0.045	1.000			
ALK	0.389	-0.600	0.389		-0.271	0.426		1.000		
NH3N	0.492	0.640	0.836	-0.157	-0.343	-0.516	-0.250		1.000	
TP	0.559	0.964	0.342	-0.396	0.163	-0.744	-0.535	-0.423	0.802	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	200.0000	160.0000	178.0000	257.5000	16.0468
CL	5	19.0000	7.0000	10.4000	24.8000	4.9800
SO4	5	16.0000	15.0000	15.6000	0.3000	0.5477
TBOD	5	1.0000	0.0000	0.8000	0.2000	0.4472
NO3N	5	0.4800	0.2700	0.3480	0.0069	0.0832
TCOD	5	13.0000	9.0000	11.4000	3.3000	1.8166
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	5	7.9000	7.7000	7.8000	0.0050	0.0707
TVS	5	105.0000	75.0000	92.0000	145.0000	12.0416
TS	5	255.0000	211.0000	232.2000	321.7000	17.9360

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.576	1.000								
SO4	0.313	0.440	1.000							
TBOD	-0.244	0.362	-0.408	1.000						
NO3N	-0.697	0.135	-0.198	0.524	1.000					
TCOD	-0.952	-0.575	-0.553	0.431	0.602	1.000				
T							1.000			
PH	0.330	-0.852		0.791	0.255	-0.195		1.000		
TVS	-0.944	-0.642	-0.606	0.325	0.504	-0.963		-0.294	1.000	
TS	0.106	-0.105	0.214	-0.711	-0.308	-0.295		-0.493	-0.135	1.000

TABLE VII-D-45

ALL STATIONS
DEPTHS 20 TO 45 FT.
AUGUST 22, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	15.0000	5.0000	9.6000	12.8000	3.5777
TSS	5	26.0000	6.0000	16.4000	74.3000	8.6197
TKN	5	0.6600	0.1700	0.3740	0.0318	0.1784
CL	5	16.0000	10.0000	11.2000	7.2000	2.6833
PHL	5	0.2480	0.0290	0.1666	0.0072	0.0851
CR	5	0.1690	0.0000	0.0574	0.0051	0.0712
ZN	5	0.6750	0.0000	0.1952	0.1445	0.3802
ALK	5	61.0000	58.0000	59.0000	1.5000	1.2247
NH3N	5	0.0000	0.0000	0.0000	0.0000	0.0000
TP	5	0.1500	0.0700	0.1100	0.0015	0.0361

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.736	1.000								
TKN	0.316	-0.188	1.000							
CL	0.063	0.623	-0.136	1.000						
PHL	-0.669	-0.596	0.196	0.055	1.000					
CR	-0.338	-0.248	-0.698	-0.450	-0.397	1.000				
ZN	-0.095	-0.144	-0.166	-0.246	0.507	-0.162	1.000			
ALK	-0.342	-0.118	-0.435		0.583	-0.046	0.920	1.000		
NH3N	1.000	1.000	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	
TP	0.734	0.861	0.129	0.587	-0.685	-0.283	-0.583	-0.590	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	230.0000	170.0000	191.0000	605.0000	24.5967
CL	5	16.0000	10.0000	11.2000	7.2000	2.6833
SO4	5	16.0000	14.0000	15.0000	0.5000	0.7071
TBOD	5	1.0000	1.0000	1.0000	0.0000	0.0000
NO3N	5	0.5600	0.5100	0.5320	0.0007	0.0259
TCOD	5	15.0000	5.0000	9.6000	12.8000	3.5777
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	5	7.9000	7.8000	7.8600	0.0030	0.0548
TVS	5	140.0000	65.0000	97.0000	745.0000	27.2947
TS	5	255.0000	180.0000	208.0000	995.0000	31.5436

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.205	1.000								
SO4	-0.072		1.000							
TBOD	1.000	1.000	1.000	1.000						
NO3N	0.114	0.605		1.000	1.000					
TCOD	0.929	0.063	-0.395	1.000	0.119	1.000				
T							1.000			
PH	-0.334	0.408	-0.645	1.000	0.600	-0.102		1.000		
TVS	0.955	0.061	-0.324	1.000	0.081	0.996		-0.184	1.000	
TS	0.994	0.301	-0.056	1.000	0.205	0.910		-0.275	0.935	1.000

TABLE VII-D-46

ALL STATIONS
DEPTHS 20 TO 45 FT.
SEPTEMBER 27, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	34.0000	13.0000	18.0000	81.0000	9.0000
TSS	5	210.0000	22.0000	63.4000	6728.8000	82.0293
TKN	5	0.5000	0.4000	0.4800	0.0020	0.0447
CL	5	19.0000	18.0000	18.4000	0.3000	0.5477
PHL	5	0.0030	0.0000	0.0018	0.0000	0.0018
CR	5	0.0240	0.0000	0.0060	0.0001	0.0113
ZN	5	0.1580	0.0560	0.0980	0.0015	0.0382
ALK	5	58.0000	56.0000	57.4000	0.8000	0.8944
NH3N	5	0.0000	0.0000	0.0000	0.0000	0.0000
TP	5	0.2700	0.0400	0.1020	0.0090	0.0947

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.996	1.000								
TKN	0.311	0.282	1.000							
CL	-0.507	-0.433	-0.612	1.000						
PHL	0.406	0.411	-0.408	-0.167	1.000					
CR	-0.373	-0.420	-0.395		-0.323	1.000				
ZN	0.840	0.882	-0.234	-0.084	0.395	-0.732	1.000			
ALK	0.342	0.379	-0.375	0.102	0.919	-0.593	0.549	1.000		
NH3N	1.000	1.000	1.000	-1.000	1.000	-1.000	1.000	1.000	1.000	
TP	0.980	0.991	0.189	-0.357	0.501	-0.467	0.911	0.490	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	245.0000	125.0000	205.0000	2687.5000	51.8411
CL	5	19.0000	18.0000	18.4000	0.3000	0.5477
SO4	5	29.0000	25.0000	27.6000	2.3000	1.5166
TBOD	5	1.0000	0.0000	0.6000	0.3000	0.5477
NO3N	5	0.7800	0.5000	0.7000	0.0133	0.1151
TCOD	5	34.0000	13.0000	18.0000	81.0000	9.0000
T	5	48.2000	47.3000	47.8400	0.2430	0.4930
PH	5	6.9000	6.9000	6.9000	0.0000	0.0000
TVS	5	141.0000	35.0000	86.4000	1796.8000	42.3887
TS	5	335.0000	210.0000	266.0000	2007.5000	44.8051

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.572	1.000								
SO4	0.890	-0.241	1.000							
TBOD	-0.088	-0.167	-0.241	1.000						
NO3N	0.769	-0.317	0.917	-0.595	1.000					
TCOD	-0.884	-0.507	-0.934	-0.406	-0.956	1.000				
T	0.352	0.667	0.361	-0.667	0.634	-0.659	1.000			
PH								1.000		
TVS	-0.915	-0.304	-0.812	0.084	-0.597	0.677	-0.034		1.000	
TS	-0.447	-0.112	-0.732	0.570	-0.870	0.803	-0.703		-0.201	1.000

TABLE VII-D-47

ALL STATIONS
DEPTHS 20 TO 45 FT.
OCTOBER 3, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	36.0000	7.0000	14.4000	148.3000	12.1778
TSS	5	56.0000	5.0000	21.2000	412.7000	20.3150
TKN	5	0.4000	0.2000	0.3100	0.0055	0.0742
CL	5	37.0000	13.0000	19.2000	100.7000	10.0349
PHL	5	0.0000	0.0000	0.0000	0.0000	0.0000
CR	5	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	5	0.0980	0.0040	0.0270	0.0016	0.0398
ALK	5	60.0000	56.0000	57.8000	2.2000	1.4832
NH3N	5	0.0000	0.0000	0.0000	0.0000	0.0000
TP	5	0.3700	0.0800	0.1480	0.0155	0.1246

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.044	1.000								
TKN	-0.075	0.405	1.000							
CL	0.991	0.028	-0.155	1.000						
PHL	1.000	1.000	1.000	1.000	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	-0.362	-0.297	-0.804	-0.249	1.000	1.000	-1.000			
ALK	-0.244	-0.056	0.477	-0.366	1.000	1.000	-0.648	1.000		
NH3N	1.000	1.000	-1.000	1.000	1.000	1.000	-1.000	-1.000	1.000	
TP	0.996	0.048	-0.024	0.990	1.000	1.000	-0.374	-0.273	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	425.0000	130.0000	240.0000	13637.5000	116.7797
CL	5	37.0000	13.0000	19.2000	100.7000	10.0349
SO4	5	29.0000	18.0000	21.2000	19.7000	4.4385
TBOD	5	1.0000	1.0000	1.0000	0.0000	0.0000
NO3N	5	0.5600	0.4500	0.4900	0.0018	0.0418
TCOD	5	36.0000	7.0000	14.4000	148.3000	12.1778
T	5	71.4000	70.9000	71.3000	0.0500	0.2236
PH	5	7.9000	7.6000	7.7000	0.0150	0.1225
TVS	5	390.0000	44.0000	174.2000	19439.2000	139.4245
TS	5	460.0000	150.0000	260.0000	15992.5000	126.4615

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.615	1.000								
SO4	-0.487	0.964	1.000							
TBOD	1.000	1.000	1.000	1.000						
NO3N	-0.325	0.923	0.929	1.000	1.000					
TCOD	-0.568	0.991	0.951	1.000	0.908	1.000				
T	-0.431	0.178	0.151	1.000	0.267	0.294	1.000			
PH	-0.149	0.061	-0.184	1.000		0.117	0.456	1.000		
TVS	0.998	-0.610	-0.493	1.000	-0.324	-0.557	0.470	-0.098	1.000	
TS	0.986	-0.590	-0.495	1.000	-0.281	-0.543	0.469	-0.010	0.990	1.000

TABLE VII-D-48

ALL STATIONS
DEPTHS 20 TO 45 FT.
OCTOBER 24, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	130.0000	10.0000	42.8000	2621.2000	51.1977
TSS	5	240.0000	21.0000	74.8000	8829.2000	93.9638
TKN	5	0.7800	0.5600	0.6600	0.0099	0.0992
CL	5	275.0000	73.0000	155.6000	5619.8000	74.9653
PHL	5	0.0250	0.0100	0.0160	0.0000	0.0055
CR	5	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	5	0.1400	0.0600	0.1080	0.0012	0.0342
ALK	5	62.0000	57.0000	59.4000	3.3000	1.8166
NH3N	5	0.0000	0.0000	0.0000	0.0000	0.0000
TP	5	0.4700	0.0600	0.1640	0.0302	0.1739

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.238	1.000								
TKN	0.402	0.116	1.000							
CL	0.899	0.124	0.701	1.000						
PHL	-0.280	-0.624	-0.483	-0.206	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	-0.650	-0.377	-0.309	-0.769	-0.454	1.000	1.000			
ALK	-0.192	-0.181	0.638	0.012	-0.553	1.000	0.298	1.000		
NH3N	1.000	1.000	1.000	1.000	-1.000	1.000	1.000	-1.000	1.000	
TP	0.229	0.997	0.129	0.109	-0.675	1.000	0.418	-0.125	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	670.0000	270.0000	420.0000	22637.5000	150.4576
CL	5	275.0000	73.0000	155.6000	5619.8000	74.9653
SO4	5	50.0000	27.0000	35.4000	77.3000	8.7920
TBOD	5	3.0000	2.0000	2.8000	0.2000	0.4472
NO3N	5	0.4100	0.3600	0.3920	0.0002	0.0130
TCOD	5	130.0000	10.0000	42.8000	2621.2000	51.1977
T	5	73.4000	71.6000	72.4200	0.6620	0.8136
PH	5	7.2000	7.0000	7.1000	0.0050	0.0707
TVS	5	134.0000	94.0000	113.6000	216.8000	14.7241
TS	5	735.0000	290.0000	495.0000	36212.5000	190.2958

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	0.991	1.000								
SO4	0.986	0.992	1.000							
TBOD	0.557	0.616	0.534	1.000						
NO3N	0.886	0.929	0.929	0.514	1.000					
TCOD	0.949	0.899	0.903	0.336	0.754	1.000				
T	0.719	0.777	0.809	0.563	0.773	0.511	1.000			
PH	-0.752	-0.736	-0.764		-0.813	-0.801	-0.391	1.000		
TVS	0.920	0.961	0.948	0.744	0.917	0.749	0.886	-0.570	1.000	
TS	0.873	0.849	0.792	0.602	0.725	0.873	0.350	-0.660	0.735	1.000

TABLE VII-D-49

ALL STATIONS
DEPTHS 20 TO 45 FT.
JANUARY 3, 1973
CATEGORY 9

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	5	23.0000	11.0000	15.0000	23.5000	4.8477
TSS	5	180.0000	70.0000	98.0000	2270.0000	47.6445
TKN	5	0.5600	0.0000	0.2260	0.0542	0.2327
CL	5	13.0000	11.0000	12.0000	0.5000	0.7071
PHL	5	0.1000	0.0500	0.0700	0.0008	0.0274
CR	5	0.0250	0.0000	0.0140	0.0001	0.0099
ZN	5	0.0770	0.0290	0.0456	0.0003	0.0183
ALK	5	44.0000	43.0000	43.6000	0.3000	0.5477
NH3N	5	0.2000	0.0000	0.0600	0.0080	0.0894
TP	5	0.2600	0.0600	0.1640	0.0076	0.0873

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	0.855	1.000								
TKN	0.578	0.771	1.000							
CL	-0.511	-0.810	-0.760	1.000						
PHL	0.565	0.517	0.204	-0.645	1.000					
CR	0.405	0.703	0.893	-0.606	-0.138	1.000				
ZN	0.917	0.848	0.745	-0.715	0.694	0.462	1.000			
ALK	-0.471	-0.805	-0.498	0.645	-0.107	-0.690	-0.369	1.000		
NH3N		0.153	0.740	-0.395	-0.102	0.591	0.309	-0.102	1.000	
TP	0.301	0.573	0.913	-0.810	0.272	0.747	0.601	-0.324	0.858	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	5	170.0000	30.0000	87.0000	2745.0000	52.3927
CL	5	13.0000	11.0000	12.0000	0.5000	0.7071
SO4	5	23.0000	18.0000	20.2000	3.2000	1.7889
TBOD	5	2.0000	1.0000	1.4000	0.3000	0.5477
NO3N	5	0.8400	0.7000	0.7620	0.0028	0.0526
TCOD	5	23.0000	11.0000	15.0000	23.5000	4.8477
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	5	7.8000	7.3000	7.5400	0.0430	0.2074
TVS	5	80.0000	6.0000	30.6000	754.3000	27.4645
TS	5	270.0000	130.0000	185.0000	3125.0000	55.9017

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-0.439	1.000								
SO4	-0.499		1.000							
TBOD	-0.558	-0.645	0.663	1.000						
NO3N	-0.523	-0.470	0.234	0.139	1.000					
TCOD	-0.566	-0.511		0.565	-0.225	1.000				
T							1.000			
PH	-0.331	0.341	0.849	0.464	-0.261	0.149		1.000		
TVS	0.930	0.283	-0.527	-0.352	-0.724	-0.231		-0.273	1.000	
TS	0.615	-0.285	-0.688	-0.082	-0.497	0.198		-0.501	0.804	1.000

PLOT DATA?

TABLE VII-D-50
ALL STATIONS
DEPTHS 45 TO 80 FEET
MAY 29, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	23.0000	19.0000	21.0000	8.0000	2.8284
TSS	2	86.0000	84.0000	85.0000	2.0000	1.4142
TKN	2	0.8500	0.8000	0.8250	0.0013	0.0354
CL	2	7.0000	6.0000	6.5000	0.5000	0.7071
PHL	2	0.0000	0.0000	0.0000	0.0000	0.0000
CR	2	0.0600	0.0000	0.0300	0.0018	0.0424
ZN	2	0.0690	0.0660	0.0675	0.0000	0.0021
ALK	2	43.0000	43.0000	43.0000	0.0000	0.0000
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.1400	0.1200	0.1300	0.0002	0.0141

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	-1.000	-1.000	1.000							
CL	1.000	1.000	-1.000	1.000						
PHL	1.000	1.000	-1.000	1.000	1.000					
CR	1.000	1.000	-1.000	1.000	1.000	1.000				
ZN	1.000	1.000	-1.000	1.000	1.000	1.000	1.000			
ALK	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
NH3N	1.000	1.000	-1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	1.000	1.000	-1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	130.0000	105.0000	117.5000	312.5000	17.6777
CL	2	7.0000	6.0000	6.5000	0.5000	0.7071
SO4	2	13.0000	12.0000	12.5000	0.5000	0.7071
TBOD	2	4.0000	1.0000	2.5000	4.5000	2.1213
NO3N	2	0.5000	0.4500	0.4750	0.0013	0.0354
TCOD	2	23.0000	19.0000	21.0000	8.0000	2.8284
T	2	55.0000	54.0000	54.5000	0.5000	0.7071
PH	2	7.6000	7.6000	7.6000	0.0000	0.0000
TVS	2	45.0000	35.0000	40.0000	50.0000	7.0711
TS	2	220.0000	190.0000	205.0000	450.0000	21.2132

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	1.000	1.000								
SO4	1.000	1.000	1.000							
TBOD	1.000	1.000	1.000	1.000						
NO3N	1.000	1.000	1.000	1.000	1.000					
TCOD	1.000	1.000	1.000	1.000	1.000	1.000				
T	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.000			
PH	1.000	1.000	1.000	1.000	1.000	1.000	-1.000	1.000		
TVS	1.000	1.000	1.000	1.000	1.000	1.000	-1.000	1.000	1.000	
TS	1.000	1.000	1.000	1.000	1.000	1.000	-1.000	1.000	1.000	1.000

TABLE VII-D-51
ALL STATIONS
DEPTHS 45 TO 80 FEET
JUNE 19, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	18.0000	12.0000	15.0000	18.0000	4.2426
TSS	2	11.0000	0.0000	5.5000	60.5000	7.7782
TKN	2	1.1200	0.6000	0.8600	0.1352	0.3677
CL	2	7.0000	6.0000	6.5000	0.5000	0.7071
PHL	2	0.0040	0.0000	0.0020	0.0000	0.0028
CR	2	0.0110	0.0000	0.0055	0.0001	0.0078
ZN	2	0.4560	0.0200	0.2380	0.0950	0.3083
ALK	2	48.0000	47.0000	47.5000	0.5000	0.7071
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.1100	0.1000	0.1050	0.0001	0.0071

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	-1.000	1.000								
TKN	1.000	-1.000	1.000							
CL	-1.000	1.000	-1.000	1.000						
PHL	-1.000	1.000	-1.000	-1.000	1.000					
CR	-1.000	1.000	-1.000	-1.000	1.000	1.000				
ZN	-1.000	1.000	-1.000	-1.000	1.000	-1.000	1.000			
ALK	1.000	-1.000	1.000	1.000	-1.000	-1.000	-1.000	1.000		
NH3N	1.000	1.000	-1.000	-1.000	1.000	1.000	1.000	-1.000	1.000	
TP	-1.000	1.000	-1.000	-1.000	1.000	1.000	1.000	-1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	110.0000	105.0000	107.5000	12.5000	3.5355
CL	2	7.0000	6.0000	6.5000	0.5000	0.7071
SO4	2	16.0000	15.0000	15.5000	0.5000	0.7071
TROD	2	4.0000	2.0000	3.0000	2.0000	1.4142
NO3N	2	0.7900	0.7900	0.7900	0.0000	0.0000
TCOD	2	18.0000	12.0000	15.0000	18.0000	4.2426
T	2	70.7000	70.2000	70.4500	0.1250	0.3536
PH	2	7.5000	7.1000	7.3000	0.0800	0.2828
TVS	2	28.0000	15.0000	21.5000	84.5000	9.1924
TS	2	120.0000	105.0000	112.5000	112.5000	10.6066

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TROD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-1.000	1.000								
SO4	-1.000	1.000	1.000							
TROD	-1.000	1.000	1.000	1.000						
NO3N					1.000					
TCOD	-1.000	1.000	1.000	1.000		1.000				
T	1.000	-1.000	-1.000	-1.000		-1.000	1.000			
PH	1.000	-1.000	-1.000	-1.000		-1.000	1.000	1.000		
TVS	1.000	-1.000	-1.000	-1.000		-1.000	1.000	1.000	1.000	
TS	1.000	-1.000	-1.000	-1.000		-1.000	1.000	1.000	1.000	1.000

TABLE VII-D-52
ALL STATIONS
DEPTHS 45 TO 80 FEET
JULY 30, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	20.0000	17.0000	18.5000	4.5000	2.1213
TSS	2	145.0000	110.0000	127.5000	612.5000	24.7487
TKN	2	0.3500	0.0000	0.1750	0.0613	0.2475
CL	2	11.0000	0.0000	5.5000	60.5000	7.7782
PHL	2	0.0350	0.0000	0.0175	0.0006	0.0247
CR	2	0.0340	0.0320	0.0330	0.0000	0.0014
ZN	2	0.6950	0.0500	0.3725	0.2080	0.4561
ALK	2	57.0000	52.0000	54.5000	12.5000	3.5355
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.2200	0.1900	0.2050	0.0005	0.0212

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	1.000	1.000	1.000							
CL	1.000	1.000	1.000	1.000						
PHL	1.000	1.000	1.000	1.000	1.000					
CR	-1.000	-1.000	1.000	-1.000	-1.000	1.000				
ZN	-1.000	-1.000	1.000	-1.000	-1.000	1.000	1.000			
ALK	-1.000	-1.000	1.000	-1.000	-1.000	1.000	1.000	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	-1.000	-1.000	-1.000	1.000	
TP	1.000	1.000	-1.000	1.000	1.000	-1.000	-1.000	-1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	185.0000	175.0000	180.0000	50.0000	7.0711
CL	2	11.0000	0.0000	5.5000	60.5000	7.7782
SO4	2	13.0000	11.0000	12.0000	2.0000	1.4142
TBOD	2	1.0000	1.0000	1.0000	0.0000	0.0000
NO3N	2	0.3100	0.2100	0.2600	0.0050	0.0707
TCOD	2	20.0000	17.0000	18.5000	4.5000	2.1213
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	2	7.8000	7.7000	7.7500	0.0050	0.0707
TVS	2	85.0000	75.0000	80.0000	50.0000	7.0711
TS	2	320.0000	295.0000	307.5000	312.5000	17.6777

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-1.000	1.000								
SO4	-1.000	1.000	1.000							
TBOD	1.000	1.000	1.000	1.000						
NO3N	-1.000	1.000	1.000	1.000	1.000					
TCOD	-1.000	1.000	1.000	1.000	1.000	1.000				
T							1.000			
PH	-1.000	1.000	1.000	1.000	1.000	1.000		1.000		
TVS	-1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
TS	-1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	1.000

TABLE VII-D-53
ALL STATIONS
DEPTHS 45 TO 80 FEET
AUGUST 22, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	14.0000	10.0000	12.0000	8.0000	2.8284
TSS	2	27.0000	16.0000	21.5000	60.5000	7.7782
TKN	2	0.5200	0.3300	0.4250	0.0181	0.1344
CL	2	10.0000	9.0000	9.5000	0.5000	0.7071
PHL	2	0.1710	0.0000	0.0855	0.0146	0.1209
CR	2	0.0480	0.0000	0.0240	0.0012	0.0339
ZN	2	0.0250	0.0060	0.0155	0.0002	0.0134
ALK	2	62.0000	58.0000	60.0000	8.0000	2.8284
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.1700	0.1500	0.1600	0.0002	0.0141

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	-1.000	-1.000	1.000							
CL	1.000	1.000	-1.000	1.000						
PHL	-1.000	-1.000	1.000	-1.000	1.000					
CR	-1.000	-1.000	1.000	-1.000	1.000	1.000				
ZN	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000			
ALK	-1.000	-1.000	1.000	-1.000	1.000	1.000	-1.000	1.000		
NH3N	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	-1.000	1.000	
TP	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	-1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	175.0000	145.0000	160.0000	450.0000	21.2132
CL	2	10.0000	9.0000	9.5000	0.5000	0.7071
SO4	2	14.0000	14.0000	14.0000	0.0000	0.0000
TROD	2	2.0000	1.0000	1.5000	0.5000	0.7071
NO3N	2	0.5600	0.5500	0.5550	0.0001	0.0071
TCOD	2	14.0000	10.0000	12.0000	8.0000	2.8284
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	2	7.8000	7.8000	7.8000	0.0000	0.0000
TVS	2	85.0000	65.0000	75.0000	200.0000	14.1421
TS	2	190.0000	175.0000	182.5000	112.5000	10.6066

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TROD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-1.000	1.000								
SO4	1.000	1.000	1.000							
TROD	-1.000	1.000	1.000	1.000						
NO3N	-1.000	1.000	1.000	1.000	1.000					
TCOD	-1.000	1.000	1.000	1.000	1.000	1.000				
T							1.000			
PH	1.000	1.000	1.000	1.000	1.000	1.000		1.000		
TVS	-1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	
TS	1.000	-1.000	1.000	-1.000	-1.000	-1.000		1.000	-1.000	1.000

TABLE VII-D-54
ALL STATIONS
DEPTHS 45 TO 80 FEET
OCTOBER 3, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	28.0000	9.0000	18.5000	180.5000	13.4350
TSS	2	325.0000	15.0000	170.0000	48050.0000	219.2031
TKN	2	0.4000	0.1500	0.2750	0.0313	0.1768
CL	2	17.0000	15.0000	16.0000	2.0000	1.4142
PHL	2	0.0000	0.0000	0.0000	0.0000	0.0000
CR	2	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	2	0.0400	0.0050	0.0225	0.0006	0.0247
ALK	2	58.0000	58.0000	58.0000	0.0000	0.0000
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.0800	0.0800	0.0800	0.0000	0.0000

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	1.000	1.000	1.000							
CL	1.000	1.000	1.000	1.000						
PHL	1.000	1.000	1.000	1.000	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
ALK	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	340.0000	165.0000	252.5000	15312.5000	123.7437
CL	2	17.0000	15.0000	16.0000	2.0000	1.4142
SO4	2	20.0000	19.0000	19.5000	0.5000	0.7071
TBOD	2	2.0000	2.0000	2.0000	0.0000	0.0000
NO3N	2	0.5300	0.3800	0.4550	0.0113	0.1061
TCOD	2	28.0000	9.0000	18.5000	180.5000	13.4350
T	2	71.4000	70.7000	71.0500	0.2450	0.4950
PH	2	7.7000	7.5000	7.6000	0.0200	0.1414
TVS	2	570.0000	82.0000	326.0000	119072.0000	345.0681
TS	2	865.0000	180.0000	422.5000	117612.5000	342.9468

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	1.000	1.000								
SO4	1.000	1.000	1.000							
TBOD	1.000	1.000	1.000	1.000						
NO3N	1.000	1.000	1.000	1.000	1.000					
TCOD	1.000	1.000	1.000	1.000	1.000	1.000				
T	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
PH	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
TVS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE VII-D-55
ALL STATIONS
DEPTHS 45 TO 80 FEET
OCTOBER 24, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	22.0000	15.0000	18.5000	24.5000	4.9497
TSS	2	87.0000	25.0000	46.0000	882.0000	29.6985
TKN	2	0.6700	0.6200	0.6450	0.0013	0.0354
CL	2	130.0000	69.0000	99.5000	1860.5000	43.1335
PHL	2	0.0300	0.0250	0.0275	0.0000	0.0035
CR	2	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	2	0.1000	0.0700	0.0850	0.0005	0.0212
ALK	2	61.0000	59.0000	60.0000	2.0000	1.4142
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.1300	0.0900	0.1200	0.0018	0.0424

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	1.000	1.000	1.000							
CL	1.000	1.000	1.000	1.000						
PHL	-1.000	-1.000	-1.000	-1.000	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	-1.000	-1.000	-1.000	-1.000	1.000	1.000	1.000			
ALK	-1.000	-1.000	-1.000	-1.000	1.000	1.000	1.000	1.000		
NH3N	1.000	1.000	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	
TP	1.000	1.000	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	430.0000	250.0000	340.0000	16200.0000	127.2792
CL	2	130.0000	69.0000	99.5000	1860.5000	43.1335
SO4	2	38.0000	29.0000	33.5000	40.5000	6.3640
TROD	2	3.0000	2.0000	2.5000	0.5000	0.7071
NO3N	2	0.4000	0.3800	0.3900	0.0002	0.0141
TCOD	2	22.0000	15.0000	18.5000	24.5000	4.9497
T	2	73.0000	72.5000	72.7500	0.1250	0.3536
PH	2	7.0000	7.0000	7.0000	0.0000	0.0000
TVS	2	130.0000	72.0000	101.0000	1682.0000	41.0122
TS	2	500.0000	276.0000	388.0000	25088.0000	158.3919

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TROD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	1.000	1.000								
SO4	1.000	-1.000	-1.000							
TROD	-1.000	-1.000	-1.000	1.000						
NO3N	1.000	1.000	1.000	-1.000	1.000					
TCOD	1.000	1.000	1.000	-1.000	1.000	1.000				
T	1.000	1.000	1.000	-1.000	1.000	1.000	1.000			
PH	1.000	1.000	1.000	-1.000	1.000	1.000	1.000	1.000		
TVS	1.000	1.000	1.000	-1.000	1.000	1.000	1.000	1.000	1.000	
TS	1.000	1.000	1.000	-1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE VII-D-56
ALL STATIONS
DEPTHS 45 TO 80 FEET
NOVEMBER 27, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	19.0000	15.0000	17.0000	8.0000	2.8284
TSS	2	40.0000	14.0000	27.0000	338.0000	18.3848
TKN	2	0.5000	0.4000	0.4500	0.0050	0.0707
CL	2	18.0000	17.0000	17.5000	0.5000	0.7071
PHL	2	0.0500	0.0000	0.0250	0.0013	0.0354
CR	2	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	2	0.1170	0.0920	0.1045	0.0003	0.0177
ALK	2	58.0000	55.0000	56.5000	4.5000	2.1213
NH3N	2	0.1000	0.0000	0.0500	0.0050	0.0707
TP	2	0.0500	0.0300	0.0400	0.0002	0.0141

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	-1.000	-1.000	1.000							
CL	-1.000	-1.000	1.000	1.000						
PHL	1.000	1.000	-1.000	-1.000	1.000					
CR	1.000	1.000	1.000	1.000	1.000	1.000				
ZN	1.000	1.000	-1.000	-1.000	1.000	1.000	1.000			
ALK	-1.000	-1.000	-1.000	-1.000	-1.000	1.000	-1.000	1.000		
NH3N	-1.000	-1.000	1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000	
TP	1.000	1.000	-1.000	-1.000	1.000	1.000	1.000	1.000	-1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	275.0000	155.0000	215.0000	7200.0000	84.8528
CL	2	18.0000	17.0000	17.5000	0.5000	0.7071
SO4	2	30.0000	28.0000	29.0000	2.0000	1.4142
TBOD	2	1.0000	0.0000	0.5000	0.5000	0.7071
NO3N	2	0.8200	0.7500	0.7850	0.0025	0.0495
TCOD	2	19.0000	15.0000	17.0000	8.0000	2.8284
T	2	47.3000	46.4000	46.8500	0.4050	0.6364
PH	2	6.9000	6.9000	6.9000	0.0000	0.0000
TVS	2	120.0000	18.0000	69.0000	5202.0000	72.1249
TS	2	315.0000	170.0000	242.5000	10512.5000	102.5305

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	-1.000	1.000								
SO4	1.000	-1.000	1.000							
TBOD	-1.000	1.000	-1.000	1.000						
NO3N	1.000	-1.000	1.000	-1.000	1.000					
TCOD	1.000	-1.000	1.000	-1.000	1.000	1.000				
T	-1.000	1.000	-1.000	1.000	-1.000	-1.000	1.000			
PH	1.000	-1.000	1.000	-1.000	1.000	1.000	-1.000	1.000		
TVS	1.000	-1.000	1.000	-1.000	1.000	1.000	-1.000	1.000	1.000	
TS	1.000	-1.000	1.000	-1.000	1.000	1.000	-1.000	1.000	1.000	1.000

TABLE VII-D-57
ALL STATIONS
DEPTHS 45 TO 80 FEET
JANUARY 3, 1974

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TCOD	2	18.0000	11.0000	14.5000	24.5000	4.9497
TSS	2	130.0000	120.0000	125.0000	50.0000	7.0711
TKN	2	0.9500	0.4500	0.7000	0.1250	0.3536
CL	2	10.0000	10.0000	10.0000	0.0000	0.0000
PHL	2	0.0500	0.0500	0.0500	0.0000	0.0000
CR	2	0.0350	0.0130	0.0240	0.0002	0.0156
ZN	2	0.0660	0.0620	0.0640	0.0000	0.0028
ALK	2	44.0000	40.0000	42.0000	8.0000	2.8284
NH3N	2	0.0000	0.0000	0.0000	0.0000	0.0000
TP	2	0.1800	0.1400	0.1600	0.0008	0.0283

CORRELATION MATRIX FOLLOWS:

	TCOD	TSS	TKN	CL	PHL	CR	ZN	ALK	NH3N	TP
TCOD	1.000									
TSS	1.000	1.000								
TKN	1.000	1.000	1.000							
CL	1.000	1.000	1.000	1.000						
PHL				1.000	1.000					
CR	1.000	1.000	1.000	1.000		1.000				
ZN	1.000	1.000	1.000	1.000		1.000	1.000			
ALK	-1.000	-1.000	-1.000	1.000		-1.000	-1.000	1.000		
NH3N	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
TP	1.000	1.000	1.000	1.000		1.000	1.000	-1.000	1.000	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
TDS	2	185.0000	75.0000	130.0000	6050.0000	77.7817
CL	2	10.0000	10.0000	10.0000	0.0000	0.0000
SO4	2	33.0000	21.0000	27.0000	72.0000	8.4853
TBOD	2	2.0000	1.0000	1.5000	0.5000	0.7071
NO3N	2	0.8400	0.8300	0.8350	0.0001	0.0071
TCOD	2	18.0000	11.0000	14.5000	24.5000	4.9497
T	0	0.0000	0.0000	0.0000	0.0000	0.0000
PH	2	7.6000	7.5000	7.5500	0.0050	0.0707
TVS	2	70.0000	37.0000	53.5000	544.5000	23.3345
TS	2	305.0000	205.0000	255.0000	5000.0000	70.7107

CORRELATION MATRIX FOLLOWS:

	TDS	CL	SO4	TBOD	NO3N	TCOD	T	PH	TVS	TS
TDS	1.000									
CL	1.000	1.000								
SO4	1.000	1.000	1.000							
TBOD	-1.000	1.000	-1.000	1.000						
NO3N	1.000	1.000	1.000	-1.000	1.000					
TCOD	-1.000	1.000	-1.000	1.000	-1.000	1.000				
T							1.000			
PH	1.000	1.000	1.000	-1.000	1.000	-1.000		1.000		
TVS	1.000	1.000	1.000	-1.000	1.000	-1.000		1.000	1.000	
TS	1.000	1.000	1.000	-1.000	1.000	-1.000		1.000	1.000	1.000

APPENDIX VII-E

APPENDIX VII-E

STATISTICAL SUMMARIES AND CORRELATIONS
1973 MONTHLY WATER QUALITY DATA

MILE POINTS 37, 42, 80.8 AND 96

ALPHABETICAL LISTING OF PARAMETERS WITH ABBREVIATION

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Alkalinity	ALK	mg/l $CaCO_3$
Biochemical Oxygen Demand (Total)	TBOD	mg/l
Biochemical Oxygen Demand (Filtered)	FBOD	mg/l
Carbon Dioxide	CO_2	mg/l
Chemical Oxygen Demand (Total)	TCOD	mg/l
Chemical Oxygen Demand (Filtered)	FCOD	mg/l
Chloride	Cl	mg/l
Chlorophyll-A	Chla	µg/l
Coliforms:		
Total Coliform	TCol	# Colonies/100ml
Fecal Coliform	FCol	# Colonies/100ml
Color	Col	C U
Cyanide	CN	mg/l
Dissolved Oxygen (Lab Measurement)	DO	mg/l
Dissolved Oxygen (Field Measurement)	FDO	mg/l
Fluoride	F	mg/l
Nitrogen:		
Ammonia Nitrogen	NH_3N	mg/l N
Organic Nitrogen (Total)	ORGN	mg/l N
Organic Nitrogen (Dissolved/Filtered)	ORND	mg/l N
Total Kjeldahl Nitrogen	TKN	mg/l N
Nitrate Nitrogen	NO_3N	mg/l N
Nitrite Nitrogen (Total)	NO_2N	mg/l N
Nitrite Nitrogen (Filtered)	NO_2F	mg/l N
Oil & Grease	OG	mg/l
pH (Lab Measurement)	pH	

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
(Field Measurement)	FpH	
Phenols	Phl	mg/l
Phosphorus:		
Ortho-Phosphate	OP	mg/l P
Total Phosphorus	TP	mg/l P
Salinity (Field)	FSAL	ppt
Settleable Residue	SetR	ml/l/hr
Solids:		
Total Solids	TS	mg/l
Total Dissolved Solids	TDS	mg/l
Total Volatile Solids	TVS	mg/l
Total Suspended Solids	TSS	mg/l
Volatile Suspended Solids	VSS	mg/l
Specific Conductance:		
(Lab Measurements)	SpC	µmhos/cm at 25° C
(Field Measurements)	FCon	µmhos/cm at 25° C
Sulfate	SO_4	mg/l
Surfactant	Sur	µm/l LAS
Temperature	T	°F
Total Hardness	TH	mg/l $CaCO_3$
Total Inorganic Carbon (Total)	TTIC	mg/l
Total Inorganic Carbon (Filtered)	FTIC	mg/l
Total Organic Carbon (Total)	TTOC	mg/l
Total Organic Carbon (Filtered)	FTOC	mg/l
Turbidity	Tur	FTU

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals		
Aluminum	Al	mg/l
Antimony	Sb	mg/l
Arsenic	As	mg/l
Barium	Ba	mg/l
Beryllium	Be	mg/l
Cadmium	Cd	mg/l
Calcium	Ca	mg/l
Chromium	Cr	mg/l
Cobalt	Co	mg/l
Copper	Cu	mg/l
Iron	Fe	mg/l
Lead	Pb	mg/l
Magnesium	Mg	mg/l
Manganese	Mn	mg/l
Mercury	Hg	mg/l
Molybdenum	Mo	mg/l
Nickel	Ni	mg/l
Potassium	K	mg/l
Selenium	Se	mg/l
Silicon	Si	mg/l
Silver	Ag	mg/l
Sodium	Na	mg/l
Thallium	Tl	mg/l
Tin	Sn	mg/l
Titanium	Ti	mg/l

PARAMETERS	ABBREVIATION	UNIT OF MEASUREMENT
Metals Cont'd.		
Vanadium	V	mg/l
Zinc	Zn	mg/l

MP 96
STATIONS CH-7, -8, -9
ALL DEPTHS
MAY 16 THROUGH DEC. 3, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
PH	32	7.9000	6.9000	7.5188	0.1061	0.3257
COL	4	35.0000	15.0000	20.0000	100.0000	10.0000
SPC	4	179.0000	173.0000	176.0000	12.0000	3.4641
T	19	75.5000	43.7000	57.8526	116.6404	10.8000
TUR	4	19.0000	6.0000	9.7500	38.9167	6.2383
ALK	32	66.0000	50.0000	54.7500	12.9032	3.5921
FDO	19	10.0000	6.1000	7.9211	1.5773	1.2559
TBOD	32	4.0000	1.0000	2.0938	0.8619	0.9284
TCOD	32	44.0000	4.0000	13.3125	49.6411	7.0456
TS	32	310.0000	125.0000	186.3438	2172.6200	46.6114
TDS	32	270.0000	105.0000	165.6250	1944.7581	44.0994
TVS	32	100.0000	37.0000	64.3125	485.2540	22.0285
TSS	32	87.0000	4.0000	20.3438	271.5877	16.4799

CORRELATION MATRIX FOLLOWS:

	PH	COL	SPC	T	TUR	ALK	FDO	TBOD	TCOD	TS
PH	1.000									
COL		1.000								
SPC		-0.577	1.000							
T	0.589	1.000	-0.577	1.000						
TUR		0.989	-0.694	0.989	1.000					
ALK	0.214	0.522	-0.302	-0.318	0.516	1.000				
FDO	-0.706	-0.556	0.562	-0.874	-0.668	0.309	1.000			
TBOD	0.293	0.333	-0.577	0.274	0.401	0.056	-0.523	1.000		
TCOD	-0.169	0.850	-0.921	-0.177	0.920	0.033	0.006	0.222	1.000	
TS	0.097	0.998	-0.605	-0.295	0.991	0.696	0.281	-0.204	0.894	1.000
TDS	0.006	-0.258	0.894	-0.524	-0.393	0.682	0.520	-0.305	0.027	0.933
TVS	0.219	0.117	-0.874	-0.230	0.265	0.064	0.477	0.043	-0.251	0.444
TSS	0.280	0.976	-0.741	0.512	0.998	0.132	-0.492	0.247	0.170	0.322

	TDS	TVS	TSS
TDS	1.000		
TVS	0.408	1.000	
TSS	-0.039	0.171	1.000

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
NH3N	32	0.2000	0.0000	0.0500	0.0052	0.0718
ORGN	32	1.1500	0.1000	0.5003	0.0617	0.2484
TKN	32	1.2900	0.1600	0.5641	0.0817	0.2859
NO3N	32	0.6900	0.0600	0.5025	0.0147	0.1212
OP	8	0.0800	0.0100	0.0400	0.0005	0.0220
TP	32	0.1600	0.0200	0.0734	0.0011	0.0338
PHL	32	0.0450	0.0000	0.0072	0.0001	0.0120
CL	37	21.0000	7.0000	13.1622	20.5285	4.5308
SO4	32	25.0000	11.0000	20.0313	10.0958	3.1774
CR	32	0.0550	0.0000	0.0031	0.0001	0.0105
ZN	32	0.2500	0.0100	0.0463	0.0023	0.0477

CORRELATION MATRIX FOLLOWS:

	NH3N	ORGN	TKN	NO3N	OP	TP	PHL	CL	SO4	CR
NH3N	1.000									
ORGN	0.361	1.000								
TKN	0.584	0.964	1.000							
NO3N	0.119	-0.110	-0.056	1.000						
OP	-0.146	0.230	0.173	0.467	1.000					
TP	0.379	0.265	0.363	0.156	0.967	1.000				
PHL	-0.257	0.271	0.164	-0.024	0.582	0.279	1.000			
CL	-0.404	-0.088	-0.207	-0.376	-0.141	-0.472	-0.107	1.000		
SO4	0.191	-0.111	-0.078	-0.157	-0.108	-0.380	-0.561	0.514	1.000	
CR	0.099	-0.072	-0.043	0.007	1.000	-0.063	-0.184	0.105	0.054	1.000
ZN	0.065	0.139	0.113	0.003	0.146		0.119	-0.185	0.069	-0.099

	ZN
ZN	1.000

MP 80.8
STATIONS ASDA 1 & 2
ALL DEPTHS
JUNE 11 THROUGH NOVEMBER 13, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
BE	28	0.0150	0.0000	0.0046	0.0000	0.0045
CD	28	0.0810	0.0000	0.0175	0.0006	0.0246
CA	24	45.0000	22.2000	27.1792	52.6965	7.2592
CR	28	0.0850	0.0000	0.0064	0.0003	0.0168
CU	24	0.1000	0.0030	0.0302	0.0008	0.0284
FE	28	3.3800	0.1700	0.7589	0.6840	0.8270
PB	34	0.0800	0.0000	0.0106	0.0006	0.0242
MG	8	5.4800	2.0700	2.9588	1.3872	1.1778
HG	8	0.0000	0.0000	0.0000	0.0000	0.0000
NI	33	0.0800	0.0000	0.0104	0.0004	0.0201
K	34	2.4300	1.0000	1.7706	0.0921	0.3034
SI	30	14.0000	0.0000	2.6667	16.5747	4.0712
NA	34	11.5000	4.5000	6.4644	4.5764	2.1392
V	26	0.0000	0.0000	0.0000	0.0000	0.0000
ZN	30	0.1270	0.0000	0.0192	0.0012	0.0348
AL	36	1.3000	0.0000	0.2756	0.0857	0.2928

CORRELATION MATRIX FOLLOWS:

	BE	CD	CA	CR	CU	FE	PB	MG	HG	NI
BE	1.000									
CD	-0.157	1.000								
CA	-0.111	-0.258	1.000							
CR	-0.213	-0.182	-0.170	1.000						
CU	0.029	-0.319	0.515	-0.164	1.000					
FE	0.169	-0.266	0.420	0.082	0.365	1.000				
PB	-0.058	-0.213	0.328	-0.121	0.161	0.398	1.000			
MG							0.152	1.000		
HG							1.000	1.000	1.000	
NI	-0.037	-0.042	-0.136	-0.027	0.236	-0.258	0.213	-0.020	1.000	1.000
K	0.137	-0.197	0.526	-0.060	0.498	0.478	-0.460	0.285	1.000	-0.305
SI	0.449	-0.288	0.530	-0.046	0.238	0.578	0.266	0.457	1.000	0.329
NA	0.025	0.017	-0.073	0.046	-0.082	-0.160	0.403	-0.071	1.000	-0.242
V	1.000	1.000	1.000	1.000	1.000	1.000	1.000			1.000
ZN	-0.233	-0.020	-0.032	0.633	-0.077	-0.079	0.404	-0.445	1.000	0.329
AL	0.133	-0.175	0.474	-0.097	0.131	0.416	-0.074	-0.764	1.000	-0.070

	K	SI	NA	V	ZN	AL
K	1.000					
SI	-0.230	1.000				
NA	-0.157	-0.211	1.000			

	K	SI	NA	V	ZN	AL
V	1.000	1.000	1.000	1.000		
ZN	-0.365	0.484	-0.203	1.000	1.000	
AL	0.277	0.398	-0.074	1.000	0.078	1.000

MP 80.8
STATIONS ASDA 1 & 2
ALL DEPTHS
JUNE 11 THROUGH NOV. 13, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
PH	37	7.9000	6.9000	7.5838	0.0558	0.2363
COL	31	35.0000	5.0000	15.9677	22.3656	4.7292
SPC	23	226.0000	180.0000	205.0435	86.4980	9.3004
T	11	75.0000	73.5000	74.0455	0.5727	0.7568
ALK	36	61.0000	42.0000	56.0278	25.6278	5.0624
TH	20	100.0000	80.0000	91.4000	27.8316	5.2756
FDO	11	8.0000	5.8000	7.2273	0.4462	0.6680
TBOD	34	9.0000	0.0000	2.9412	5.5116	2.3477
TCOD	37	370.0000	6.0000	26.1622	3841.7508	61.9819
TS	37	780.0000	120.0000	235.1351	20188.1757	142.0851
TDS	37	745.0000	115.0000	219.3243	15084.9474	122.8208
TVS	33	120.0000	40.0000	74.6667	353.7917	18.8094
TSS	37	175.0000	1.0000	15.2162	780.9520	27.9455
NH3N	37	0.3000	0.0000	0.0351	0.0079	0.0889
ORGN	37	2.5500	0.0000	0.5181	0.1866	0.4320
TKN	37	2.5500	0.0000	0.5608	0.2045	0.4522
NO3N	37	1.9800	0.0300	0.3489	0.1474	0.3839
OP	31	0.0800	0.0000	0.0274	0.0004	0.0211
TP	37	0.4200	0.0000	0.0970	0.0059	0.0770
PHL	33	0.0690	0.0000	0.0325	0.0004	0.0202
CL	37	18.0000	5.0000	11.7297	13.0916	3.6182
SO4	36	31.0000	14.0000	21.2500	17.1643	4.1430

CORRELATION MATRIX FOLLOWS:

	PH	COL	SPC	T	ALK	TH	FDO	TBOD	TCOD	TS
PH	1.000									
COL	0.077	1.000								
SPC	-0.378	-0.354	1.000							
T		0.418	-0.433	1.000						
ALK	0.331	0.183	0.734	-0.450	1.000					
TH	0.106	0.325	0.322	-0.078	0.325	1.000				
FDO	0.097	-0.709	0.103	-0.626	0.683	-0.025	1.000			
TBOD	0.359	-0.249	-0.111	0.720	-0.136	-0.009	-0.269	1.000		
TCOD	0.049	0.706	-0.223	0.481	-0.203	0.361	-0.420	-0.035	1.000	
TS	-0.472	0.235	-0.201	0.088	0.113	0.036	-0.528	-0.235	0.016	1.000
TDS	-0.428	0.227	-0.245	0.115	0.114	0.026	-0.462	-0.232	0.027	0.988
TVS	0.304	0.072	-0.235	-0.011	0.046	-0.237	-0.334	-0.093	0.092	0.376
TSS	-0.523	0.173	0.369	0.134	0.070	0.107	-0.555	-0.171	-0.035	0.746
NH3N	0.226	0.097	0.096	1.000	0.114	0.028	1.000	-0.149	-0.076	-0.138
ORGN	-0.552	0.158	0.033	0.235	-0.187	-0.156	-0.238	-0.126	-0.069	0.139
TKN	-0.478	0.151	0.075	0.158	-0.155	-0.108	-0.163	-0.160	-0.086	0.101
NO3N	-0.804	-0.240	0.591	-0.142	-0.272	0.108	-0.464	-0.225	-0.117	0.706

	PH	COL	SPC	T	ALK	TH	FDO	TBOD	TCOD	TS
OP	-0.487	-0.341	-0.001	-0.786	-0.450	-0.385	0.682	-0.437	-0.170	-0.457
TP	-0.285	-0.074	0.042	-0.262	-0.384	-0.140	-0.008	-0.049	-0.012	0.241
PHL	0.402	0.238	0.227	0.797	0.470	0.265	-0.355	0.363	0.119	-0.436
CL	-0.515	0.046	0.693	-0.571	0.496	0.233	0.383	-0.404	-0.018	0.580
SO4	0.239	0.117	-0.124	-0.621	0.603	0.189	0.673	-0.006	0.178	0.171

	TDS	TVS	TSS	NH3N	ORGN	TKN	NO3N	OP	TP	PHL
TDS	1.000									
TVS	0.418	1.000								
TSS	0.637	-0.230	1.000							
NH3N	-0.136	0.045	-0.096	1.000						
ORGN	0.111	0.289	0.216	0.126	1.000					
TKN	0.074	0.265	0.184	0.327	0.978	1.000				
NO3N	0.641	-0.097	0.781	-0.136	0.471	0.418	1.000			
OP	-0.464	-0.056	-0.499	-0.050	-0.191	-0.177	0.252	1.000		
TP	0.163	-0.185	0.513	-0.179	-0.049	-0.087	0.408	0.386	1.000	
PHL	-0.440	-0.127	-0.285	-0.233	-0.387	-0.421	-0.556	-0.400	-0.217	1.000
CL	0.562	-0.217	0.470	-0.237	0.163	0.143	0.479	-0.139	-0.110	-0.582
SO4	0.168	-0.139	0.139	-0.207	0.203	0.212	0.195	-0.291	-0.200	0.354

	CL	SO4
CL	1.000	
SO4	0.338	1.000

MP 37 AND 42
STATIONS OR-1, -2 & -3
ALL DEPTHS
MAY 2 THROUGH DECEMBER 13, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
OP	35	0.1500	0.0000	0.0577	0.0009	0.0294
TP	65	0.4400	0.0200	0.1052	0.0037	0.0610
PHL	65	0.8000	0.0090	0.0463	0.0137	0.1172
CL	65	3500.0000	5.0000	958.6923	1096478.1851	1047.1262
SO4	64	415.0000	5.0000	118.6563	16069.5942	126.7659
CA	2	56.6000	46.9000	51.7500	47.0450	6.8589
CU	2	0.1000	0.1000	0.1000	0.0000	0.0000
CD	30	0.0990	0.0000	0.0163	0.0005	0.0226
CR	58	0.1900	0.0000	0.0206	0.0014	0.0379
FE	44	2.7700	0.0000	0.8960	0.5666	0.7541
MN	30	0.4500	0.0100	0.1073	0.0103	0.1014
PB	43	0.0000	0.0000	0.0000	0.0000	0.0000
NA	2	1038.0000	845.0000	941.5000	18624.5000	136.4716
NI	37	0.7100	0.0000	0.0476	0.0136	0.1175
AG	41	0.6000	0.0000	0.0420	0.0156	0.1249
ZN	37	0.2450	0.0000	0.0482	0.0027	0.0516

CORRELATION MATRIX FOLLOWS:

	OP	TP	PHL	CL	SO4	CA	CU	CD	CR	FE
OP	1.000									
TP	0.299	1.000								
PHL	-0.073	0.027	1.000							
CL	0.125	0.121	0.010	1.000						
SO4	-0.016	0.018	-0.114	0.778	1.000					
CA	1.000	1.000	1.000	1.000	1.000	1.000				
CU	1.000	1.000	1.000	1.000	1.000	1.000	1.000			
CD	-0.309	0.391	0.078	-0.027	-0.224	-1.000	1.000	1.000		
CR	0.153	0.032	-0.001	-0.009	-0.112	1.000	1.000	0.128	-1.000	
FE	0.212	0.508	0.164	-0.036	-0.368	-1.000	1.000	0.411	-0.154	1.000
MN	-0.178	0.118	0.441	-0.197	-0.257	-1.000	1.000	0.533	-0.094	0.501
PB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-1.000
NA	1.000	1.000	-1.000	1.000	-1.000	1.000	1.000	-1.000	1.000	-1.000
NI	0.116	0.197	-0.008	0.012	-0.042	1.000	1.000	-0.067	0.178	-0.111
AG	0.123	0.027	-0.169	0.192	0.288			-0.136	0.125	-0.223
ZN	0.055	0.266	0.050	0.041	0.116	1.000	1.000	0.246	0.129	0.115

	MN	PB	NA	NI	AG	ZN
MN	1.000					
PB	-1.000	1.000				
NA	1.000	-1.000	1.000			
NI	0.175	-1.000	-1.000	1.000		
AG	-0.231	-1.000		-0.266	1.000	
ZN	0.114	-1.000	1.000	-0.249	0.152	1.000

MP 37 AND 42
STATIONS OR-1, -2 & -3
ALL DEPTHS
MAY 2 THROUGH DEC. 13, 1973

PARAMETER	NO. OF SAMP	MAX	MIN	MEAN	VARIANCE	STD. DEV.
PH	65	7.9000	7.1000	7.5800	0.0448	0.2115
T	58	87.9000	42.8000	61.8552	189.4046	13.7624
SPC	16	6345.0000	260.0000	3211.3750	6338681.5833	2517.6738
COL	2	20.0000	20.0000	20.0000	0.0000	0.0000
TUR	2	35.0000	19.0000	27.5000	144.5000	12.0208
ALK	65	67.0000	39.0000	54.8769	49.9534	7.0678
FDO	16	12.7000	6.9000	8.4188	2.9456	1.7163
TBOD	65	11.0000	0.0000	2.0308	2.4053	1.5509
TCOD	65	34.0000	4.0000	14.6615	32.5087	5.7016
TS	65	7480.0000	110.0000	2365.6154	5606487.8966	2355.2246
TDS	64	7300.0000	95.0000	2360.5469	5565450.8867	2359.1208
TVS	65	1600.0000	25.0000	490.6154	232660.5841	482.3490
TSS	65	270.0000	5.0000	37.3538	2393.5447	48.9239
NH3N	65	0.9000	0.0000	0.1385	0.0430	0.2074
ORGN	65	1.5000	0.0000	0.5974	0.1124	0.3352
TKN	65	1.7000	0.0000	0.7646	0.1607	0.4008
NO3N	65	1.6900	0.1200	0.7122	0.0654	0.2557
TCOL	44	27700.0000	260.0000	5772.0455	46772585.2537	6839.0486
FCOL	45	6900.0000	140.0000	1236.5556	2536429.3434	1592.6171

CORRELATION MATRIX FOLLOWS:

	PH	T	SPC	COL	TUR	ALK	FDO	TBOD	TCOD	TS
PH	1.000									
T	0.169	1.000								
SPC	-0.813	-0.955	1.000							
COL	1.000	1.000	1.000	1.000						
TUR	1.000	-1.000	1.000	1.000	1.000					
ALK	-0.568	-0.464	0.899	1.000	1.000	1.000				
FDO	-0.241	-0.584	0.956	1.000	-1.000	0.542	1.000			
TBOD	0.445	0.022	-0.466	1.000	1.000	-0.360	-0.255	1.000		
TCOD	-0.196	-0.215	-0.057	1.000	1.000	0.175	-0.199	0.168	1.000	
TS	-0.648	-0.110	0.972	1.000	1.000	0.751	0.925	-0.480	0.179	1.000
TDS	-0.653	-0.099	0.969	1.000	1.000	0.753	0.930	-0.477	0.170	1.000
TVS	-0.610	-0.006	0.937	1.000	1.000	0.673	0.933	-0.453	0.175	0.957
TSS	-0.072	-0.050	0.912	1.000	1.000	0.191	0.399	-0.073	0.439	0.265
NH3N	0.180	-0.271	0.137	1.000	1.000	-0.053	0.440	-0.023	0.270	-0.041
ORGN	0.350	-0.328	-0.425	1.000	1.000	-0.122	0.565	0.306	0.066	-0.410
TKN	0.397	-0.394	-0.302	1.000	1.000	-0.174	0.717	0.256	0.197	-0.392
NO3N	0.109	0.386	-0.177	1.000	1.000	-0.117	-0.033	0.067	0.060	-0.053
TCOL	0.420	0.338	-0.145			-0.411	-0.249	0.142	-0.168	-0.511
FCOL	0.178	0.261	0.673			-0.228	-0.182	-0.030	-0.111	-0.247

	TDS	TVS	TSS	NH3N	ORGN	TKN	NO3N	TCOL	FCOL
	TDS	TVS	TSS	NH3N	ORGN	TKN	NO3N	TCOL	FCOL
TDS	1.000								
TVS	0.957	1.000							
TSS	0.240	0.215	1.000						
NH3N	-0.058	-0.076	0.252	1.000					
ORGN	-0.439	-0.513	0.063	0.039	1.000				
TKN	-0.420	-0.484	0.162	0.543	0.856	1.000			
NO3N	-0.060	0.007	0.277	-0.308	0.139	-0.027	1.000		
TCOL	-0.529	-0.481	0.172	-0.018	0.230	0.211	0.631	1.000	
FCOL	-0.264	-0.151	0.184	-0.052	-0.056	-0.064	0.503	0.781	1.000

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APPLICATION OF THE NICHE ANALYSIS TO FOUR BIOTIC COMMUNITIES AT THE ROSETON-DANSKAMMER POWER GENERATING STATIONS, HUDSON RIVER, IN 1973

(RESEARCH GRANT #1200-400-010)

A Final Report to: Lawler, Matusky and Skelly Engineers
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VOLUME I

Abstract

Four groups of Hudson River organisms (phytoplankton, rotifers, fish larvae and adult fish) were analyzed. Phytoplankton were subdivided into green, blue-green, diatom, large, medium and small sized communities, while fish were subdivided into pelagic and inshore-benthic communities. All of the analyzed data were collected in 1973 at Roseton/Danskammer Point. Using Levins' niche equations, several measures of community structure and stability were calculated. The data for each community was stratified in as many ways as possible including station, date, depth and time of day stratifications. Of special interest was the effect of the Danskammer power-generating station on the four communities. The effects of the power plant in regard to heated effluents or mechanical damage enter the ecological network through natural pre-existing pathways, namely, temperature fluctuation and predation respectively. These effects were mainly illustrated through the station stratifications while the seasonal stratifications aid perspective in comparing the effects of heated effluents with natural temperature variation.

The study includes a lengthy discussion of the literature both past and present, of niche analysis as well as a detailed description of the mathematical methodology. Several new community indices were created for this study and the resultant data were subjected to a variety of statistical analyses. Since niche analysis is described in detail, this report serves as a technical manual, however, the reader is warned of the many problems involved in generating an appropriate data set for niche analysis. The study concludes with a general summary of results and comparisons of all thirteen communities. Sources of error and needed developments, both biological and theoretical, are also outlined.

Forward

This report represents the culmination of a twenty month (4/75 - 12/76) research effort by Dalhousie University, Halifax, Nova Scotia (Grant #1200-400-010). The project was funded by Lawler, Matusky and Skelly, Environmental Science and Engineering Consultants (LMS), Tappan, New York in conjunction with their studies of the effects of power generating stations on the Hudson River ecosystem. The basic objectives of the Dalhousie research effort were:

1. to assess the past and present data collection efforts of LMS.

2. to determine which data are applicable for the niche analysis described in the following report.

3. to apply this analysis to a subset of LMS data and thus evaluate the feasibility and appropriateness of this community approach for these data.

4. to develop the ecological theory both in a general way, for example, statistical evaluation of the niche measures, as well as in specific cases, for example, when the Hudson River data exhibited unique properties that required special treatment.

5. to develop the necessary computer programs and expertise to handle the new theoretical developments as well as the large LMS data sets.

6. to continue expanding the data base on several aquatic environments including Gull Lake, Michigan and Bedford Basin, Nova Scotia in order to facilitate the testing of ecological theory in different types of aquatic environments.

The present report represents the realization of objective number 3 and to varying degrees the fulfillment of the other objectives.

In the first year of the research program, we concentrated on obtaining an overview of the Hudson River ecosystem and familiarized ourselves with the general problems of thermal pollution and related governmental regulations and guidelines. During this period we also assessed the current status of available data for several power-generating stations on the lower part of the river, expanded the ecological theory including the development of several new niche and stability measures as well as the associated computer methodology, This initial effort at least partially fulfilled objectives #1, 2, 4 and 5. During the last eight months of the project we have undertaken an extensive application of niche analysis on a local (one study site) level at the Roseton-Danskammer power generating stations (MP66-67) of Central Hudson Gas and Electric Company (CHG&E). This study is discussed in the following report and it is undoubtedly the most exhaustive application of the analyses to a set of ecological data that has been attempted to this date. The data reported herein were exclusively collected by LMS.

We would also like to stress that whereas much of the application and development of the community analysis to global situations is presently possible we were unable to pursue this portion of the research project because funding was not available. By global we would normally mean the analysis of several study sites along the river simultaneously or the analysis of several years of data at the same site or set of sites. After analyzing the enclosed data it became apparent that there are some aspects of global dynamics that are elucidated by the present evaluation of several stations at one study site. Thus, we reserve the right to modify our definition of global until a later time when more Hudson River sites as well as stations have been studied. It also was not possible to develop the statistical tests to the degree we had anticipated because of the large amount of data that was analyzed

and because of some unexpected theoretical difficulties. Likewise we could not implement the closely-related loop analysis which eventually must be used with niche analysis for complete ecosystem evaluation.

In addition to the enclosed report, the study has generated a set of 85-90 enclosures that related to the research objectives in a variety of ways. The subjects of the enclosures vary as do the purposes of the study to include: discussions of computer methodology, sample printouts, computer programs, data analysis, reference materials, recommendations on data collection and analysis, information requests, work plans, progress reports, theoretical developments, budget and grant administration topics. The enclosures are on file at Dalhousie University and LMS. In addition there have been numerous two-way written and verbal communications between LMS and Dalhousie University personnel during the last 20 months. These forms of communication have been especially fruitful for all concerned and an important component in a project in which the data collection and data analysis are conducted by disjunct groups.

It is always difficult to work with someone else's data and although the results we obtained would have been substantially improved if we had also designed the sampling schedule, we feel the merits of the analysis are demonstrated in the report which was based on available 1973 Central Hudson data for Roseton-Danskammer Point. Even this problem has not been without its benefits since treating specific characteristics of the Central Hudson data set have enabled us to develop the associated theory in several directions. In addition, it has been educational for us to work with data collected outside our group and for the data reported herein, we have been forced to deal with both too little and too much data for particular functional groups of organisms.

In summary, while these data are not "the best possible" neither is the present state of the theoretical analysis. Several badly-needed theoretical developments are discussed in the later section of the

report. We prefer to think of the completion of this project as a first-step feasibility or pilot project. As such, it has many shortcomings. On the other hand, the enclosed report probably represents one of the most comprehensive applications of community analysis of any kind to a thermal perturbation situation that has been attempted. It is our hope in submitting this report that our results and conclusions will be regarded (at the very most) as tentative and that the merit of the report is not so much in its results but in the approach itself. Perhaps more important is what it could become with more research and development of the ecological theory, with improved coordination of data collection and data analysis and with enhanced understanding of the biology of natural communities.[1]

---

[1] The computer programs and print-outs used to generate this report are on file at LMS and Dalhousie University.

Acknowledgments

Many individuals have contributed to the overall research project. Dr. John P. Lawler, partner of Lawler, Matusky & Skelly (LMS), has been instrumental in bringing about the success of the project from initiating the beginning research contract to overseeing the development of the various stages of research through the completion of the enclosed report. Throughout the study period, he has continually served as wise counsel, source of inspiration and overall director of the research. It is basically because of his foresight in realizing 1) the applicability of the community analysis to thermal pollution studies as well as 2) the importance of supporting basic research to integrate ecological theory with applied problems, that has made this research project possible.

Early in the study Dr. Robert Keegan served as project manager and he was later succeeded by Dr. Joseph O'Connor. During the later portion of the study Mr. Robert Norris was the project manager and he has provided an effective liaison between LMS and Dalhousie University especially in regard to computer activities. Dr. Thomas Englert has also contributed significantly in regard to the development of computer methodology. Dr. Terry Cosper has been of invaluable assistance in supplying needed biological and environmental data as well as discussing the biology of the system. Ms. Susan O'Connor has also assisted in data retrieval and collection activities as well as introducing us to the general nature of thermal pollution studies. Dr. George Schumacher, Professor of Biology, SUNY at Binghamton, was on sabbatical leave during 1974-75 at LMS. During this period he contributed to our understanding of the Hudson River algal taxonomy and ecology. Besides the individuals named above, several others greatly enhanced the study including: Hugh Mulligan, Julian Hillegas and Hank Baslow.

No research project runs on science alone and this project was no exception. Mrs. Avis McCammon worked at Dalhousie as the administrative coordinator. For this role, she was responsible for report preparation, correspondence, budget and payroll work and a variety of other office and administrative duties. Her overall efficiency and enthusiasm undoubtedly contributed substantially to the smooth operation of the project both in terms of inter- and intra-department relations at Dalhousie as well as LMS-Dalhousie coordination. Likewise, Mrs. Barbara McKenna, senior executive secretary to Dr. John P. Lawler, served a similar role at LMS. She was instrumental in developing successful communication pathways between LMS and Dalhousie University. She was also responsible for preparing the present report in final form which was no small task. In the early stages of the project, Mrs. Sally Huns, secretary to Dr. Robert Keegan, also contributed much valuable secretarial assistance.

Last, but surely not least, have been our own dedicated group of graduate students and technicians who have borne much of the actual work load of the project. This group includes:

Anna Atherton
Bill Atherton
Alastair Barber
Pamela Brant
Terry Collins
Roanne Conover
Alan Downe
Goldie Gibson
Diane Gifford
Susan Hall
William Hart
Samuel Jackman
Gordon Laing
Kenneth Lee
Janet McCleave
David MacDonald
Luna O'Brien
Janet O'Dor
Roger Ovink
Lacy Pennington
Paul Phinney
Suzanne Phinney
Yolunde Rhude
Joseph Salter
John Skiver
Tova Tabacoff
Anna Taylor
Lynn Travers

As a group of people they have been outstanding and they serve as an inspiration to anyone contemplating group research. To all of

these individuals we are extremely grateful, each person has contributed to the success of the project and the role of each individual has been important. Special thanks are due Lynn Travers, Gordon Laing, and Anna Taylor who facilitated the preparation of this final report.

The data analyzed in this report was collected exclusively by LMS. Appendix Tables B-3, C-3, C-D and E-3 were developed by LMS and some other information in the background tables and figures was summarized by the 1973 LMS report to CHG&E, entitled 1973 Aquatic Studies of the Hudson River at Roseton-Danskammer Point

APPLICATION OF NICHE ANALYSIS TO FOUR BIOTIC COMMUNITIES AT THE ROSETON/DANSKAMMER POINT GENERATING STATIONS, HUDSON RIVER, IN 1973. Dennis T. Logan and Sidney L. Weiss.

REVIEWERS' COMMENTS

This manuscript represents one of the few efforts in investigating the effects of power plant operation on a community of organisms. Most studies to date have addressed effects on the population level, and many are data reports without analysis of effects. This treatise, a result of much hard and demanding work, presents a thorough treatment of the subject and represents a relatively new area of investigation.

This document is chiefly the work of Dr. Lane and Mr. Wright and was reviewed at LMS primarily by Mr. Sidney Weiss and Dr. Dennis Logan. Review comments will be limited to the general methods and specific techniques applied. The present comments principally pertain to those methods which we (DTL, SLW) think should not be used in future investigations exactly as presented here.

The principal objective of the report was to demonstrate the use of presently developed niche measures (as of 1976) in impact evaluation and to develop new measures.

Other objectives were: 1) the presentation of background and historical information on the origins and purposes of niche analysis; 2) the recommendation of modifications in LMS sampling techniques and data analysis necessary to permit the use of niche analysis,

and 3) the presentation of a detailed example demonstrating the use and interpretation of niche analysis to be employed in learning the techniques. In addition, several possible measures of stability were tested, and an argument was made to justify the use of some of these.

Because all of these objects were addressed in this single report it is necessarily lengthy. In order to facilitate its use, the report has been divided into several volumes. These are:

Volume I	Introduction Description of Study Site Mathematical Modeling and Data Analysis
Volume II	Results
Volume III	Discussion Bibliography
Volume IV	Appendices

Volume I contains a complete description of methods and is also a self-contained unit. Volume II, however, relies heavily on Volume IV.

REVIEW OF BIOLOGICAL MATERIAL

Sampling Design. Dr. Lane mentions in several places the shortcomings of the sampling design used with regard to niche analysis. However, it should be noted that the sampling design was not directed at niche analysis. In some 1973 programs there were many more samples through time than through space, so that seasonal

patterns were more easily (and more appropriately) detectable than spatial patterns. As a result, time is the resource which is being partitioned in many analyses. In many other analyses, both time and space are partitioned. The former use makes sense, especially for groups with fast turnover, but the latter may provide confusing results. In perusing these analyses, the reader should be careful to understand what is meant by "environment" or "habitat" in any particular analysis, so that he may properly judge the correctness of the given interpretation.

Structure. The concept of community structure is used throughout this report. It is important to realize that this term is used in the sense of heterogeneity of species among resource states and not in the sense of interactions among species. For example, when resource states (habitats, environments) are mostly samples at different times, a large amount of temporal heterogeneity or seasonal succession may be interpreted as having more structure than a less heterogeneous or less seasonal community.

Stability. Stability in this report is linked conceptually to the variability of niche measures. Strata which exhibit less variability are in terpreted as having more stability. The link between this interpretation and the more usual one (stability being the ability of a system to rebound from a perturbation) is somewhat intuitive. Those groups or strata with low variability are assumed not to be changed as greatly by everyday perturbations.

"Within" and "Among" Diversity. Dr. Lane calculates total diversity and diversity within each stratum in many of her analyses, pointing out that total diversity has two components: the first, the average

diversity within classifications and the second a measure of heterogeneity between environments, which can be likened to the "among" classification in analysis of variance. To do this, the average diversity within each environment must be weighted by the proportion of total species found in that stratum (e.g., see Reza, 1961; Chapter 3). Since this was not done, the "among" diversity component is correct only in those situations where all strata have equal weighting. Most, but not all, references to "among" diversity components have been deleted from this report, and the remaining references should be used with this discussion in mind. This effect probably results in the observation that "among diversity is frequently found to have no pattern" (p.IV-156).

Partitioning diversity. Dr. Lane calculates species diversity for the whole environment, where the number of individuals in each species is calculated by summing over all strata. This is termed total diversity (H). Diversity is then calculated for each environment under the stratification of time, depths, or time and depth and then averaged to calculate $\bar{H}_t$, $\bar{H}_d$, and $\bar{H}_{t,d}$ respectively. There are no subdivisions of the samples for H, generally two to three for $\bar{H}_d$, and many for $\bar{H}_t$, since LMS generally sampled more times than depths.

Diversity is the product of two components, the evenness of distribution and the number of species. Subdivision of the categories would be expected to result in fewer than the total number of species in each category. Then the relationship $H > \bar{H}_d > \bar{H}_t > \bar{H}_{t,d}$, would be expected to be found based only on the number of samples analyzed. This is what was found (e.g., p.IV-148). It may be advisable in future studies to use evenness instead of diversity for comparing strata, thus eliminating the confounding effect of chance captures of species occurring in low densities.

If stability is measured as the magnitude of |A| we would come to the following conclusions:

1) Stability is greatest when species 1 and 2 share no environments (h) in common. Then |A| achieves its maximum value of +1.

2) If the temporal or spatial distribution of species 1 and 2 are identical through environments (h), the system is unstable since |A|=0. This result would be obvious since A would be singular.

3) In general, the more heterogeneously 1 and 2 are dispersed with regard to one another, the greater would be the value of |A| and therefore the greater the stability.

4) If the numbers of species 2 in environments h are multiples of the numbers of species 1, A will be singular and |A| will be zero, causing the system to be judged unstable.

It may be shown that conclusions of this type may be drawn for a matrix A of any order, yet it is not obvious why these properties should relate to stability. Using |A| and Levins' formula for result in a measure of heterogeneity of distribution rather than a measure of stability. The problem lies with Levins' (1968) statements about this measure rather than with Lane's application of them.

STATISTICAL COMMENTS

Instead of the analyses described on page III-30 (third paragraph), a unified, multiway factorial analysis of variance should be used

in future investigations, especially if unequal sample sizes are present.

The ad hoc ANOVA techniques described on pages III-30 to III-31 may result in biased comparisons and are not recommended for use. Conclusions based on ANOVA results as calculated on pages III-30 and III-31 should be regarded with caution.

Dennis T. Logan
Sidney L. Weiss

Dr. Lane's Reply to Comments

Dr. Lane has replied to the review comments and the substance of her reply is reproduced here. In interpreting community structure, she emphasizes that the underlying assumption is that a "group of species are interacting and alleviate overlap with habitat selection." The use of variability and heterogeneity in interpreting structure and stability is included in the matrix calculations and the reader should look there for the usage.

Regarding our comments on diversity, Dr. Lane noted:

> "The measures, diversity and evenness, are related but different measures. Diversity reflects both on the evenness and number of species sampled and the effect of the number of species may or may not be desirable to have depending on what your [sic] studying and how meaningful the numbers are. On the big tables, I think we probably have both printed. If the same species occur in all environments then subdividing the categories would not necessarily reduce the # of species. Thus, the relationship to be expected is $H \geq H_d \geq H_t \geq H_{td}$ and there should be no problem comparing them especially if correct among and within components are compared."

She indicated the desirability of using both species richness and equitability in interpreting diversity.

Replying to our comments on missing samples, she observed:

> "The Shannon index used as niche breadth was labeled H' and not discussed in the text. Clearly, any measure of niche breadth will be related to the number

of environments sampled and thus be sensitive to missing samples. This is corrected for in measures such as $\bar{B}/E$ and $\bar{B}/\hat{B}$ but uneven distributions of missing samples will still introduce bias. Acutally, the stability measures are the most directly affected by missing samples."

The only point upon which we and Dr. Lane do not agree is on the use of eigenvalues to evaluate <u>stability</u>. Dr. Lane's comments on our review of this aspect were:

"The statements made about stability are not true. <u>Any</u> measure of stability based on eigenvalue analysis of <u>any</u> matrix of coefficients relating to a multivariate system is going to reflect the degree of linear dependence or independence (i.e. homogeneity or heterogeneity) among the variables. That a more heterogeneous system will be able to absorb more perturbations than a homogeneous system is an intrinsic and underlying concept of classical stability analysis. Levins clearly states this in regard to the community matrix approach. The 'problem' they talk about must be with accepting the determinant of the coefficient matrix as a stability measure and that came before Levins. What constitues stability in a two-variable system is obvious not going to be generally applicable in a more complex situation and it hardly seems relevent to point out that the determinant of a two-variable community matrix reduces to an inverse measure of their correlation which is all they've said here."

The mechanisms of stability in ecological communities are largely unresolved and so the validity of this approach cannot finally be judged here.

D. Logan

TABLE OF CONTENTS

VOLUME I

ABSTRACT
FORWARD
ACKNOWLEDGEMENTS

		Page
	TABLE OF CONTENTS	i
	LIST OF FIGURES	v
	LIST OF TABLES	vi
I.	INTRODUCTION	
A.	Natural Communities and Their Analysis	I-1
1.	Ecological Patterns	I-1
2.	Niche Analysis - Theoretical Development	I-2
3.	Niche Analysis - Biological Development	I-6
4.	Ecological Stability	I-8
B.	Purpose of Present Study	I-9
C.	Significance of the Study	I-11
1.	Roseton and Danskammer Point Generating Stations	I-11
2.	The Hudson River Environment	I-12
3.	General Applicability of the Analysis to Other Aquatic Environments	I-13
II.	THE STUDY SITE: THE HUDSON RIVER	
A.	Morphometry and Tidal Factors	II-1
B.	Physical and Chemical Parameters	II-2
C.	Study Area	II-4
D.	Power Plants	II-7
E.	Reference and Experimental Stations	II-8
III.	MATHEMATICAL METHODOLOGY AND DATA ANALYSES	
A.	Basic Community Structure and Stability Measures	III-1
1.	N-Dimensional Hypervolume Concept of the Niche	III-1
2.	Niche Analysis	III-2

TABLE OF CONTENTS
(Continued)

		Page
B.	Statistical Analysis	III-22
1.	Means and Coefficients of Variation	III-25
2.	t-tests	III-29
3.	Analysis of Variance (ANOVA)	III-30
4.	Data Handling and Analysis	III-31

VOLUME II

IV.	RESULTS	
A.	Introduction - Organization of Subsequent Discussion for Each Community	IV-1
B.	Phytoplankton Community	IV-6
1.	The Sampling Program and Selection of Stations (B-1 and B-2)	IV-6
2.	The Species and Their Trophic Characterization (B-3 to B-4)	IV-9
3.	Stratification of Data for Niche Analysis (B-5 to B-7)	IV-11
4.	Results by Density and Functional Group	IV-13
5.	Results by Biovolume (Size Category)	IV-66
C.	Rotifer Community	IV-90
1.	The Sampling Program and Selection of the Stations (Tables C-1 and C-2)	IV-90
2.	The Species and Their Trophic Characterization (Tables C-3 and C-4)	IV-91
3.	Stratifications of the Data for Niche Analysis (Tables C-5 and C-7)	IV-91
4.	Results by Density	IV-92
D.	Fish Larvae Community	IV-111
1.	Sampling Program (Tables D-1 and D-2)	IV-111
2.	The Species and Their Trophic Characterization (Tables D-3 and D-4)	IV-114
3.	Stratifications of the Data for Niche Analysis (Tables D-5 and D-7)	IV-114
4.	Results by Density	IV-115

TABLE OF CONTENTS
(Continued)

		Page
E.	Adult Fish Community	IV-137
	1. Sampling Program and Selection of Stations (Tables E-1 and E-2)	IV-137
	2. The Species and Their Trophic Characterization (Tables E-3 and E-4)	IV-141
	3. Stratifications of the Data for Niche Analysis (Tables E-5 and E-7)	IV-143
	4. Results by Density	IV-145

VOLUME III

V.	DISCUSSION	
A.	General Summary of Results	V-1
	1. Introduction	V-1
	2. Some General Remarks	V-4
	3. The Plant Community	V-7
	4. The Animal Communities	V-11
	5. A Comparison of All Communities	V-13
B.	Evaluation of the Effects of the Roseton and Danskammer Power Stations on the Four Functional Groups of Organisms	V-16
	1. Introduction	V-16
	2. Community Structure and Thermal Perturbation	V-18
C.	Some Paradoxes and Speculations	V-30
	1. Ecological Versus Mathematical Artifacts	V-30
	2. What is Ecological Success?	V-31
	3. To Be or Not to Be Stable	V-32
	4. Perturbations and the Ecological Network	V-37
D.	Sources of Error and Bases for Guarded Conclusions	V-38
	1. Sampling	V-39
	2. Data Analysis	V-49
E.	Recommendations for Applying the Analysis to Aquatic Data Sets	V-58

TABLE OF CONTENTS
(Continued)

		Page
F.	Research and Development Needed for Niche Analysis	V-60
	1. Computer Technology	V-61
	2. Methodology Associated with Ecological Theory and System Biology	V-64
VI.	BIBLIOGRAPHY	
VOLUME IV		
VII.	APPENDIX A	
A.	Format of the Tables of Niche Measures	VI-1
B.	Table Format for Means and Coefficients of Variation	VI-5
C.	Table Formats for T-Tests	VI-7
D.	Table Formats Displaying Analysis of Variance	VI-8
VIII.	APPENDIX B	
	Data analysis and community tables for the Hudson River phytoplankton community (Tables B-1 - B-36)	
IV.	APPENDIX C	
	Data analysis and community structure tables for the Hudson River rotifer community (Tables C-1 - C-20)	
X.	APPENDIX D	
	Data analysis and community structure tables for the Hudson River fish larvae community (Tables D-1 - D-23)	
XI.	APPENDIX E	
	Data analysis and community structure tables for the Hudson River adult fish community (Tables E-1 - E-32)	
XII.	APPENDIX F	
	Miscellaneous Undiscussed Data (Tables F-1 - F-11)	

LIST OF FIGURES

Figure No.	Title	Following Page
1	Schematic representation of the ongoing development of community structure and niche theory	I-3
2	Map of Hudson River at Roseton-Danskammer power generating stations illustrating the location of the thermal plume and water quality sampling stations	II-4
3	Map of Hudson River in south central area (Newburgh Bay) illustrating the location of the sampling stations and bottom types in a cross-sectional diagram	II-4
4	Diagram of Shelford's (1911) tolerance curve	III-1
5	Diagram of a hypothetical community of phytoplankton competitors in a two-dimensional ecological space	III-1
6	Diagram of a hypothetical community of phytoplankton competitors in a two-dimensional ecological space	III-13
7	Map of Hudson River at Roseton-Danskammer Point illustrating plankton sampling stations in 1973	IV-17
8	Map of Hudson River at Roseton-Danskammer Point illustrating fish larvae sampling stations in 1973	IV-111
9	Map of Hudson River at Roseton-Danskammer Point illustrating adult fish sampling stations (trawl only) in 1973	IV-137
10	Hypothetical (and over-simplified) loop diagram of effect of Danskammer power plant on Hudson River ecosystem	V-17
11	Diagram illustrating sources of error involved in sampling at extremes of species ranges	V-45

LIST OF TABLES

Table No.	Title	Following Page
1	Summary of major characteristics of the Hudson River at the study site Part A: Physical parameters Part B: Chemical parameters	II-1
2	Summary of water quality characteristics of the sampling stations	II-6
3	Equations, terminology and symbols used in Niche analysis Part A: Equations Part B: Terminology and Symbols	III-3
4	Stability criteria and their variation with increased stability	III-17
5	Organization of the results section and the data tables	IV-1
6	Summary comparison of important niche measures for the phytoplankton community by density, functional group and station	IV-47
7	Summary comparison of important niche measures for the phytoplankton community by density, functional group and date	IV-48
8	Summary comparison of statistical results for the phytoplankton community by density and functional group	IV-51
9	Summary comparison of important niche measures for the phytoplankton community by biovolume and date	IV-80
10	Summary table for phytoplankton by biovolume	IV-83
11	Summary comparison of important niche measures for the rotifer community	IV-107
12	Summary comparison of statistical results for the rotifer community	IV-108

LIST OF TABLES
(Continued)

Table No.	Title	Following Page
13	Summary comparison of important niche measures for the fish larvae community by station and date	IV-132
14	Summary comparison of statistical results for the fish larvae community	IV-134
15	Summary comparison of important niche measures for the adult fish community	IV-190
16	Summary comparison of statistical results for the adult fish community	IV-199
17	Summary comparison of the phytoplankton functional groups	V-8
18	Summary comparison of all functional groups of organisms	V-13
19	Summary comparison of community structure and stability values by stations using median values	V-20
20	Qualitative summary of community structure by station for all functional groups	V-24
21	Qualitative summary of community stability by station for all functional groups	V-28

SECTION I

INTRODUCTION

I. INTRODUCTION

A. NATURAL COMMUNITIES AND THEIR ANALYSIS

1. Ecological Patterns

Many branches of science have developed in a similar way: large-scale description, identification of pattern, elucidation of underlying (and casual) mechanisms, formulation of laws and predictive statements. Ecology has not reached this latter stage and, at present, it is at a lower stage of development. Ecological systems are formidably complex, with many variables and parameters dynamically interacting with each other. MacArthur (1972) has stated, "much of ecology is a search for patterns." On the community level, Levins (1975a) has termed this a search for the macroscopic (We later define the macroscopic as a set of consistent properties). Most ecosystem descriptions are pitifully incomplete and unrealistic. Many variables are impossible to measure simulteneously, let alone describe with appropriate mathematical constructs. Often variables are difficult to identify. As Slobodkin (1968) aptly noted, the sister science of ecology, namely evolution, has as its theoretical backbone the law of natural selection. This imposes an overall theoretical framework on the understanding of evolution. Ecology does not have this framework. With all the ecological impetus of the last two decades, largely related to the pressing problems of ecosystem perturbation, the development of such a predictive theory is imperative and may eventually be possible. Prediction is obviously the ecologist's goal because we not only want to describe and understand a given ecosystem but also be able to foretell what will happen as humans encroach more and more upon it.

There have been several papers concerning pattern in ecology: notable are Hutchinson's (1953) classic paper "The Concept of Pattern in Ecology," and MacArthur's (1972) book, which is full of discussions of ecological patterns, as is Whittaker's (1962) discussion. Lane et al. (1975) have used niche analysis as well as the delineation of consistent properties to identify pattern within zooplankton communities. Certain ecosystem properties remain constant in relation to many kinds of fluctuations in the environment and the species, and this study emphasizes the fact that natural communities do have recognizable integrity which can be quantified with field data. While perhaps the communities are not as highly structured as Clements (1916) described them (superorganism concept), they certainly are more structured than Gleason's (1926) individualistic concept would lead us to believe.

Heatwole and Levins (1972), in analyzing the data of Simberloff and Wilson (1970), have also developed the concept of consistent properties. The former authors demonstrated that after defaunation and recolonization of a given island, the trophic structure was quickly re-established even though the species list after refaunation included different organisms from those that originally inhabited the island. Thus, there is both a growing emphasis on the discovery of pattern and its theoretical basis in ecological systems, as well as an enhanced data base which links the theory to real world situations.

2. Niche Analysis - Theoretical Development

One way to delineate ecological patterns at the community level is the use of niche analysis. A set of species (zooplankton) occupying a single trophic level is considered a community. The major emphasis is on competitive coexistence and overlap of these species and

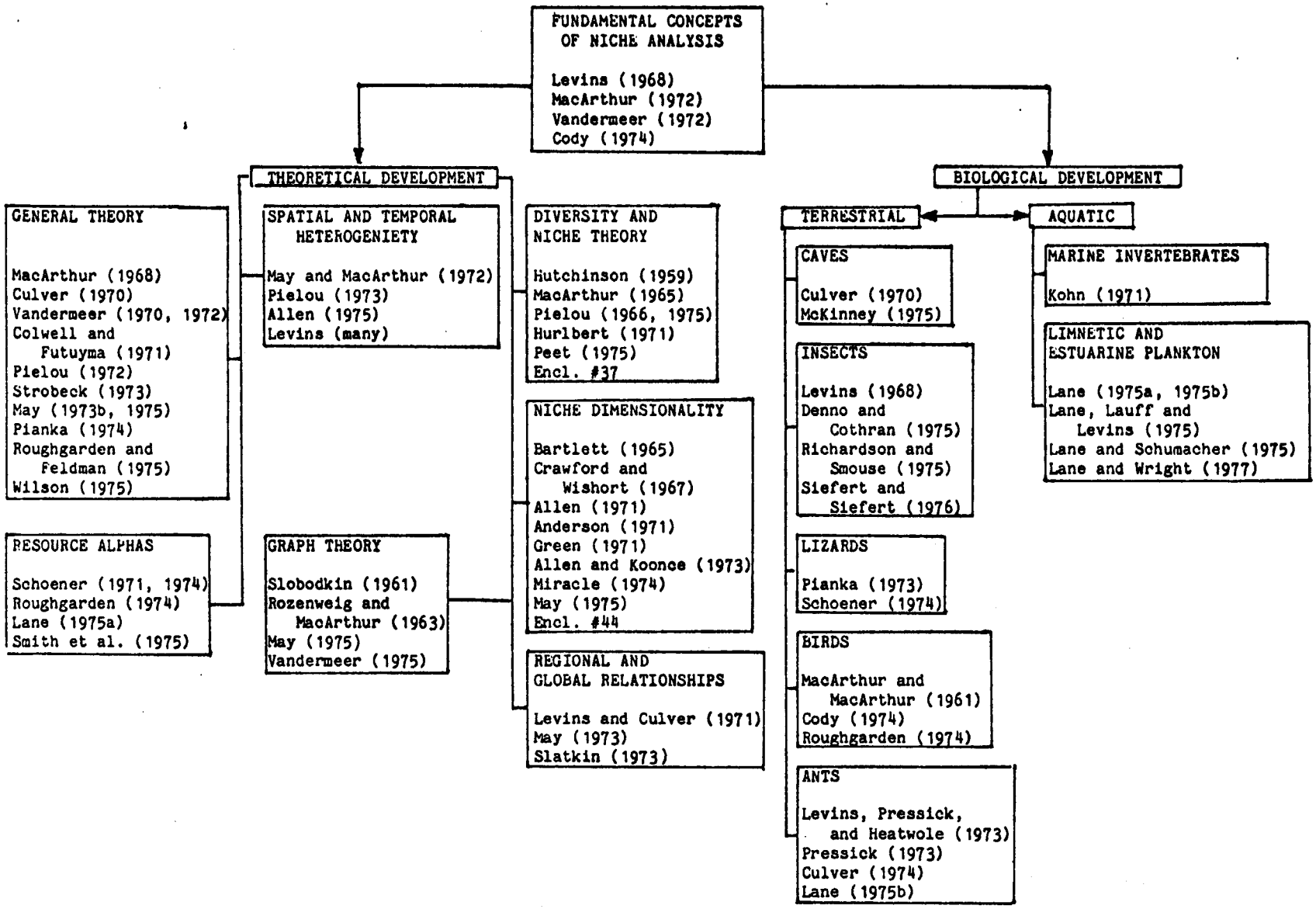
in the evaluation of their Lotka-Volterra competition coefficients (alphas) or some approximation thereof. Thus, in niche analysis, the aim is to place values on these interactions and to produce a community matrix. We have been developing several formulae which measure biotic interactions of natural populations; use of each formula produces a new matrix of species interactions. Comparison of (community) matrices generated by different formulae not only facilitates identification of key competitive interactions, but also helps distinguish the validity and usefulness of the different formulae and their associated variables. For example, filtering rates and variance in temperature fluctuations may be critical to understanding competitive coexistence for two zooplankton species, while algal/detrital turnover rates may be more important in delineating the competition between two phytoplankton species. With Levins, we are also developing predation alphas to expand the community matrix approach to two or three trophic levels.

After niche analysis is applied to a set of field data, various patterns in the niche measures are often identifiable. Particular niche measures exhibit regularity in their values over particular data stratification and can be termed consistent properties of natural communities. Lane (1978) has defined consistent properties as measures that: (1) vary less than the original variables, (2) are characteristics of a type of community, (3) vary among different types of communities so that their consistency is not a mathematical artifact, and (4) have some intuitive meaning for the investigator.

At present, several people are working on niche analysis (Figure 1) in terms of its application to the biology of real systems, although proportionally more effort is presently being expended on mathematical and theoretical developments. Three works represent

FIGURE 1

SCHEMATIC REPRESENTATION OF SOME ONGOING DEVELOPMENT OF COMMUNITY STRUCTURE AND NICHE THEORY



rather substantial contributions to niche analysis: MacArthur's Geographical Ecology (1972), Levins' (1968) - Evolution in Changing Environments, and Cody's (1974) book on bird communities. Some of these studies have been summarized by Vandermeer (1972a).

Vandermeer (1970, 1972b) has also written papers on the covariance of the alpha matrix and the determination of the number of species in a community. Culver (1970) advanced some measures of interference competition. Pielou (1972) has attempted to develop alternative measures for ecological overlap and niche breadth. Strobeck (1973) has discussed N-species competition, Colwell and Futuy-ma (1971) have presented weighted measures of niche breadth, and May (1973a, 1973b, 1975) has written papers concerning how to calculate competition matrix elements as well as some of the stability aspects of the alpha matrix. MacArthur (1968) summarized some of the theoretical considerations for measuring niches in nature, and Pianka (1974) has summarized current niche theory, especially in regard to his work on lizard communities.

Continuing with the development of alpha, there is no reason to believe that the approximation alpha originally created by Levins (1968) (the probability of co-occurrence alpha) is necessarily the best one to use. Lane working with Levins (1975a, 1973b), Schoener in 1974, and Smith et al. (1975) have developed other measures of alpha based on resource availability and turnover. Habitats are weighted not simply by the density of organisms occurring there but also by some measure of the resource dynamics. Since much of the theory has been developed around resource competition, this adds more reality to the general theoretical models. Roughgarden (1974) has also made considerable progress in the development of resource competition theory.

Two measures, niche dimensionality and diversity, have been treated only superficially by Levins. Diversity is one of the most popular measures of community structure and it has been a subject of several hundred papers. Hutchinson's (1959) classic paper entitled "Homage to Santa Rosalia, or Why are there so many species of animals" summarized much of that contemporary thinking on species diversity in the animal kingdom. He emphasized that diversity arrives through dynamic interactions of many types of factors that both increase and decrease species diversity. MacArthur in 1965 wrote another classic paper on the patterns of species diversity and Pielou, in 1966, discussed much of the mathematics of diversity measurement, especially the diversity measures coming from information theory. Pielou (1975) has recently written an up-to-date account of the present thinking on the nature of species diversity, the mechanisms underlying diversity patterns, and how to measure them. Also, much of the work on diversity has not been without critics. Peet (1975) and Hurlbert (1971), as well as some of the sources listed in Enclosure #47, dealt with the problems of applying species diversity indices to certain types of ecological data.

Dimensionality is essentially a measure of how many factors are used by a set of competing species to divide up their environment. To obtain a measure of dimensionality, a multivariate statistical analysis is necessary. Some of the recent papers on this subject are listed in Enclosure #44 and some pertinent applications to the analysis of aquatic populations include Green (1971), Allen (1971), Allen and Koonce (1973), and Miracle (1974). The concept of using multivariate approaches is not really a new one in the sense that plant ecologists for several decades have used these techniques to study succession gradients in time or in space for several decades. The theoretical linking of niche dimensionality to the niche equations, however, is recent, and the relationships are still in their

embryonic form. Other papers in this area would include Anderson (1971), Bartlett (1965), Crawford and Wishort (1967), and May (1975). Essentially, when multivariate analysis can be applied routinely to aquatic data, it will be possible to obtain measures of the number of ways species divide up their available habitat according to the factors needed for survival. Then it will be easier to develop, for example, some of the specialized alphas such as resource alphas, and diurnal time displacement alphas which account for critical coexistence factors as well as spatial and temporal heterogeneity.

3. Niche Analysis - Biological Development

The actual application of niche analysis to natural communities has understandably lagged behind the theoretical development. More new formulations (which we could not begin to include in one report) are available than the actual documentation of the validity and usefulness of these measures with natural communities. There is, however, a growing literature on different types of natural communities that have been analyzed with some sort of niche theory. Hopefully in the future this application will increase and improve as did the application of diversity measures.

a. Terrestrial Communities

Levins (1968) applied niche equations to *Drosophila* populations. Culver (1970) has worked on simple cave communities, especially with amphipods and applied niche equations by treating caves as islands. MacArthur studied bird communities (MacArthur and MacArthur 1961), and since that date has published a variety of papers, which are summarized in his most recent book (MacArthur 1972). Tropical ants have been studied by Levins and his collaborators (Levins et al. 1963; Pressick 1973; Culver 1974;

Lane 1975b [using some of Pressick's data]). Pianka (1973) and Schoener (1971, 1974) have worked with lizards, especially in terms of resource competition theory. These papers all include values of alpha and other niche measures for terrestrial organisms.

b. Aquatic Communities

Among applications of niche theory to aquatic communities, Kohn (1971) has evaluated marine invertebrate community structure, plankton communities have been analyzed by Lane (1975, 1978), Lane et al. (1975), Lane and Schumacher (1975), and Lane and Wright (1976, 1977). While many of our results are not in published form, some have indicated that despite certain basic differences between marine and freshwater plankton communities, consistent properties of community structure were identified. For zooplankton, many of these properties are based on vertical migration patterns, while consistent niche values for phytoplankton were based on functional group differences. For ants, zooplankton, and phytoplankton, consistent properties have been demonstrated over a wide variety of dynamic and heterogeneous conditions. We believe that these results provide at least partial evidence for much of the pattern and regularity in natural communities, despite the superficial chaos natural communities sometime exhibit.

In some of the work (for example, Lane 1975b), many similarities are apparent in natural communities regardless of whether they are aquatic or terrestrial, a finding which is somewhat encouraging. In additon, stability measures developed on the properties of the zooplankton community matrix exhibited seasonal instability which was associated with blue-green algal blooms and the hypolimnetic oxygen deficit (Lane et al. 1975).

Lane and Wright (unpubl.) have given an abbreviated account of the results of their present study on the Hudson River ecosystem. These papers essentially illustrate that niche analysis is useful to delineate community structure and stability for aquatic communities undergoing perturbation, such as for example, eutrophication or thermal pollution.

Siefert and Siefert (1976) evaluated niche analysis with Heliconia communities. These are plants that hold minature aquatic communities composed of diverse taxa whose existence is often transitory and subject to dynamic (and often dramatic) extinction-migration phenomena. Siefert and Siefert (1976) concluded that niche analysis did not apply to these communities because many of the species interactions were mutualistic and non-equilibrium interactions.

4. Ecological Stability

The development of ecological stability theory has been associated with both the work in community structure and ecosystem analysis. Stability is a critical ecological concept, especially to anyone contemplating the evaluation of perturbations to ecosystems, because stability is the measure of the system's ability to resist the perturbation or to return to normal or equilibrium after the perturbation has occurred. Most of the papers that have appeared so far have dealt with the mathematics of stability theory which was largely produced in a different subject area, physics. Loop analysis (Levins 1973, 1975a, 1975b; Lane and Levins 1977), like niche analysis, includes a mechanism for measuring stability of natural ecosystems. To date, there has been limited application of stability theory to natural communities. Most other references are only theoretical discussions of stability theory and give little or no biological application, let alone interpretation, to real world situations.

Some of the formal mathematics are included in Searle's (1966) book on matrix algebra, Gantmacher's (1960) "The Theory of Matrices", Rosen's (1970) work on the mathematics of dynamical systems, Shannon (1948), and Shannon and Weaver's (1949) development of information theory, which is related to diversity measures.

May's (1973a) book is probably the best summary statement of the current status of ecological stability theory. Lewontin (1969) described some of the early definitions of stability theory, Holling (1973) has added to Lewontin's definitions of stability, May (1973a) also discussed qualitative stability, and MacArthur (1955) discussed some of the early measures of stability with natural systems.

In addition, there has been a series of papers on ecological stability, including a limited number of considerations of global stability, including Gilpin's (1975b) recent paper on limit cycles, Sutherland's (1974) discussion of multiple stable points, and papers by and Laddle and Siljaks' (1975), Gardner and Ashby (1970), Somorjai and Goswami (1972), May (1972), Roberts (1974), Siljak (1974), Daniels and MacKay (1974), Gilpin (1975a), and Saunders and Bazin (1975), McMurtrie (1975) and Siljak (1975).

B. PURPOSE OF PRESENT STUDY

The purpose of the present study is to apply Levins (1968) niche equations to four functional groups of organisms inhabiting the Hudson River in the vicinity of the Central Hudson Gas & Electric Corporation's (CHG&E) Roseton and Danskammer Point Generating Stations in 1973. These groups included: 1) phytoplankton, which were subdivided into blue-green and green algae and diatoms, 2) rotifers, 3) fish larvae, and 4) adult fish, which were subdivided into pelagic and benthic-inshore fish. Thus, thirteen subcommunities

were analyzed in all. (Unfortunately the taxonomy was not adequate for the remaining microzooplankton, benthos and macrozooplankton groups and these animals had to be excluded from present consideration. It would be possible to analyze them in the future if the samples were recounted.)

Application of niche analysis to the CHG&E data set involved a number of theoretical and biological activities. First, we attempted to delineate the basic patterns of community structure and stability for each of the functional groups. Second, it was necessary to familiarize ourselves with the biology of individual species and their respective communities in order to better interpret the observed patterns. Also in several instances, it was not obvious how to group the species into a given community. Third, in order to evaluate possible influences of the thermal plume on the communities, it was necessary to distinguish the characteristics of the sampling stations and the extent of the thermal plume. Whenever possible we stratified the data to facilitate comparisons of supposedly thermally influenced samples from those not supposedly influenced by thermal effluents. Fourth, in order to determine the effects of natural variability on community structure and stability, as distinguishable from other types of variability such as that due to thermal perturbations, it was necessary to stratify the available data in as many ways as possible: by functional group, or subgroup, by station, by date, by depth and by time of day. (Phytoplankton were further stratified by size as well as density.)

This intensive data stratification may appear superfluous to the reader. However, the central problem to be solved in this study was an experimental one since: 1) the Hudson River ecosystem had never been formally treated by this type of analysis, 2) ecologists have only very vague notions on how environmental heterogeneity

affects community structure and stability, and 3) the way to differentiate between effects of natural environmental variation and those resulting from thermal perturbation was not obvious. Thus, we attempted to solve the problem by conducting an exhaustive data stratification to the extent the data would allow. For this reason, the following comprehensive format used for data analysis does not represent what would be termed a routine data work-up for assessing thermal impact on an aquatic ecosystem. However, we hope that after the limits of the system and the degree of natural variation are determined, further researchers will be able to be more selective in data stratification than we have been.

Finally, in order to evaluate the effects of thermal effluents on the thirteen subcommunities, it was necessary to create new niche measures, stability criteria, and to find statistical tests appropriate for the results we generated. Also some peculiarities in these particular data necessitated the design of special theoretical constructs. Thus, this portion of the study involved considerable biological, mathematical and theoretical effort.

C. SIGNIFICANCE OF THE STUDY

1. Roseton and Danskammer Point Generating Stations

The study has generated some interesting results of a general ecological nature as well as some specifically related to thermal pollution at the Roseton and Danskammer Point power plants. These specific results are especially noteworthy since only one station was on line in 1973 and it was relatively smaller than many in presently existing locations or in various planning stages. This study also set the baseline for the application of the community analysis at this site because data collected before 1973 are probably

not adequate for the analysis. This study presented the first example of niche analysis of a point-source perturbation in a complex heterogeneous system also undergoing various diffuse source perturbations.

2. The Hudson River Environment

This study also marks the first time a large river environment, and specifically the Hudson River ecosystem, has been studied with this type of analysis. The results obtained in this study, and more importantly, the overall approach are directly applicable to several sites in the river simultaneously as well as to temporal variation over years at one site. In fact, expanding the present local analyses to a global situation is a necessary next step toward a more complete understanding of the Hudson River ecosystem.

The generation of global community structure and stability values is especially important for the Hudson River ecosystem because the river is receiving many other types of perturbation which must be distinguished from the influence of a thermal effluent, and because of the inherent complexity of an essentially flow-through ecosystem with tidal dynamics superimposed on it. Much of the effort needed to expand the local analysis to a global one involves intensive coordination of data collection activities and some new theoretical advances, particularly community structure and stability measures. In terms of theoretical requirements, special mathematical constructs would have to be developed in regard to 1) niche statistics and sampling theory, including new measures incorporating among-site stratifications to be superimposed on existing types of data stratification, 2) multivariate statistical procedures such as ordination and factor analysis, and 3) global stability analysis.

3. General Applicability of the Analysis to Other Aquatic Environments

To date, we have successfully applied the analysis extensively to a lake (Gull Lake, Michigan) and to a marine basin (Bedford Basin). On a smaller scale, niche analysis has been completed on Lake Michigan, Cranberry Lake, Lake George, and the Delaware River (Lane 1975; Lane and Schumacher [unpubl.]) These six environments represent a variety of aquatic ecosystems (a marl eutrophic lake, a marine basin, a large oligotrophic lake, a dystrophic lake, a medium sized mestrophic lake, and river.) Whenever an ecological analysis purports to measure community structure and stability to any degree, the theory must be tested on as wide a variety of habitats as possible, and this analysis is no exception. It has been our experience to date that there are no apparent problems with the choice of habitat per se but only in regard to whether the data collection has been adequate or not. Thus, the analysis and general ecological approach discussed in this report should be applicable to most if not all habitats which are large enough to support natural communities of organisms. This report is, in one sense, a "how-to-do-it manual" for this type of ecosystem analysis, and as such, has applicability to many types of environment and perturbations. Thus, its significance is greater than the immediate results reported.

There is always a danger with how-to-do-it manuals, however, if they attempt to illustrate the general with examples from the specific, as does this present report (the specific being the Hudson River ecosystem). Thus, while we are hopeful that this report will facilitate the analysis of other ecosystems, the reader should be cautioned against following our methodology so closely as to exclude special considerations needed for particular ecosystems and their respective perturbations.

In conclusion, niche analysis is firmly based in ecological theory and is probably the most promising and comprehensive descriptive analysis of natural community structure and stability presently applicable to real world data sets. The theoretical basis of the analysis is still not complete nor can the theory be considered to be rigorously tested. Undoubtedly, its usefulness must be more completely documented in the next few years. It will also be necessary to incorporate many of the more recent developments in the field of ecosystem analysis into niche analysis so that the continually evolving theoretical framework will be the best that is permitted by the contemporary level of ecological understanding. At its present stage of development, however, enough worthwhile results have been generated to document the significance and increasing importance of this method for ecosystem analysis.

SECTION II

THE STUDY SITE: THE HUDSON RIVER

II. THE STUDY SITE: THE HUDSON RIVER

A. MORPHOMETRY AND TIDAL FACTORS

The Hudson River flows from its source, Henderson Lake in the Adirondack Mountains, 315 river miles south into the New York Bight. Battery Point in New York City is defined as mile point 0. Table 1* gives the typical values of general physical (Part A) and chemical (Part B) characteristics of the Hudson River as they vary at different sites along the river as well as seasonally.

The river's drainage area is about 12,700 square miles and there is one major tributary, the Mohawk River, which enters the Hudson River just above Troy, at mile point 154, the site of a Federal dam. The lower river is a fairly deep, straight channel, although there are numerous shallow bays and shoals. The width of the river ranges from one mile at the Battery out to three miles at Haverstraw Bay (mile point 40) and 0.5 miles beyond Newburgh Bay (mile point 60). The mean depth, averaged across the entire width of the river near the outlet, is about 35 ft, increasing to 90 ft at West Point (mile point 50) and decreasing to about 15 ft at Troy. Because of erratic local variations in width and depth, the cross-sectional area changes abruptly along the length of the river, ranging from 60,000 square ft to 250,000 square ft. The total drop in water level from Troy to the sea is about 2 ft. The bottom is sandy loam or silt and is not very rocky. Relative proportions of sand, silt and clay vary locally and the content of organic material in the substratum decreases regularly upstream in this locality.

*These data and the information for this brief description of the river dynamics come from the report to CHG&E entitled, "Hudson River Aquatic Ecology Studies at Roseton and Danskammer Point," Volume IV and VII, Appendix B (LMS 1974).

TABLE 1

SUMMARY OF MAJOR CHARACTERISTICS
OF THE HUDSON RIVER AT THE STUDY SITE[1]

Part A. Physical Parameters of the Hudson River

Freshwater Flow (long term monthly average; from Figure VII-7)

January	19,000 cfs
April	43,000 cfs
July	8,000 cfs
October	10,000 cfs

Tidal Flow (for summer seasonal maximum ebb/flood peak; from Figure VII-3)

Average from	mile point 0- 40	230,000 cfs
	mile point 40-110	100,000 cfs
	mile point 110-150	50,000 cfs

Typical Location for Salt Front (based on flow data; from Figure VII-22) in 1973.

January	Mile point 30-40
April	Mile point 20-25
July	Mile point 35-50
October	Mile point 60-80

Temperature (from Figure VII-25) in 1973.

January	32 F
April	40-60 F
July	75-85 F
October	55-70 F

New York State Department of Environmental Conservation Water Quality Classifications:

Up To	Mile Point	Classification
New Jersey State Line	0-22	Special Class I (.....)
Bear Mountain Bridge	22-46.7	Class SB (.....)
Chelsea	46.7-66	Class B (recreational but drinking, etc.)
South of Albany	66-125	Class A (any purpose including drinking, cooking and washing)
Troy Dam	125-153.7	Class C (.....)

[1] Representative ranges estimated from tables and graphs in Chapter VII, LMS 1973 report to CHG&E.

TABLE 1

SUMMARY OF MAJOR CHARACTERISTICS
OF THE HUDSON RIVER AT THE STUDY SITE[1]

Part B. Chemical Parameters of the Hudson River

Parameter (mg/l where applicable)	Saltwater Typical of Mile Points 0-40	Freshwater Typical Above Mile Point 40	Proposed EPA Criteria For Freshwater To Protect Wildlife	For Class A & B
pH	7.1-7.9	6.9-7.8	5-9	6.5-8.5
salinity	100-20,000	0-100		
alkalinity		40-70	30-130	
hardness		50-200		
turbidity		5-75		
DO	5-15	5-15	≥5	≥5
COD	4-400	2-50		
BOD	0-10	0-10		
NH_3-N	1-2	0-1	≤.5	
NO_3-N	.02-2	.02-1.5	≤10	
SO_4	50-600	5-50	≤250	
Total Phosphates	0-1	0-.2	≤.1	≤.1
Phenols	0-.8	0-.1	≤.001	≤.005
TDS	1,000-100,000	10-1,000	≤500	≤500
TVS	100-1500	1-150		
TSS	0-300	0-100		
Cl	40-10,000	0-40		
F	.3-.6	0-.2		
Zn	0-1	0-.25	≤5	≤.3
Cr	0-.2	0-.06	≤.05	
Cu	0-1	0-.04	≤1	≤.2
FR	0-.03	0-.2	≤.3	
Mg	200-10,000	0-200		
Na	200-10,000	0-200		

[1]Representative ranges estimated from tables and graphs in Chapter VII, LMS 1973 report to CHG&E. All data and criteria are relevant to 1973 and are not updated and do not refer to subsequent years.

Because there are measurable tidal effects in the river as far as the Federal Dam at Troy (mile point 153.7), the lower part of the river is properly termed an estuary and it receives varying influxes of fresh and saltwater. The freshwater flow is estimated (based on long-term observations at Green Island, just north of Troy, between 1918 and 1970) to have a yearly average of 18,200 cubic ft per second [cfs] with a spring runoff maximum of 43,000 cfs in April and a summer minimum of 6,000 cfs in August. Flow increases from Green Island to the lower Hudson because of inflow from the tributaries by a factor of up to 1.5, in the spring.

Because of the erratic channel geometry, the tidal influence from the ocean is damped and reflected (completely at Troy) and its amplitude and velocity vary with channel dimension. There are many factors, from local perturbations to seasonal variation in weather conditions, that influence tidal dynamics. The average tidal amplitude between low and high tides ranges from approximately 4.5 ft at both the Battery and Troy down to 2.5 ft at West Point. These ranges vary by $\pm$.5 ft for spring and neap tides. Mean sectional velocity is about 1 ft per second (fps) with peaks to 2 fps at the Battery and at Hudson (mile point 117). This is averaged over ebb and flood strengths, although the ebb flow is usually stronger by virtue of being in the same direction as the freshwater flow. The mean tidal flow drops sharply in August from about 425,000 cfs at the Battery to about 125,000 cfs at West Point (mile point 50) and then gradually decreases to zero at Troy. This again, is dependent on both freshwater flow and seasonal tidal strength.

B. PHYSICAL AND CHEMICAL PARAMETERS

The salt front or extent of salt intrusion may be defined as the location where the water salinity exceeds 100 ppm over freshwater

salinity. Although there are many other influencing factors, the salt concentrations in the Hudson River are affected primarily by freshwater flow. At the Battery, salt content varies throughout the year from 17 to 25 °/oo (parts per thousand) and at West Point (mile point 50) from negligible to 1.2 °/oo. Under steady-state conditions, the salt front is located as far downstream as the George Washington Bridge (mile point 12) during spring runoff and as far north as Hyde Park (mile point 80) in late summer. In general, the salt front moves at the rate of 2 miles per week, although actual chloride concentrations vary considerably, both vertically and horizontally, with other factors, particularly tidal phases and proximity to the salt front.

Chemical parameters which appear to be primarily correlated with the salt front, and, in general, tidal versus freshwater flow effects, are concentrations of chlorides, sulphates, most metals, total dissolved solids, total volatile solids, and water hardness. Thus, the effects of ocean salt on water quality usually drop off sharply upstream to mile point 40, with almost no effect observed beyond mile point 60. Marine effects also exhibit a seasonal peak in late October.

Parameters associated with municipal sewage and other chemical sources also show variations along the river. These parameters include nitrogen, phosphate, and fluoride concentrations; chemical oxygen demand, and amount of suspended solids. They all vary with depth and velocity and magnitude of river flow. This information is summarized in Table 1B.

Temperature does not vary significantly with respect to location in the river. Although there are diurnal and vertical variations, the ambient temperature increases from 0 C (32 F) or just above it between December and early February to a summer value of 21-26 C

(70-79 F) throughout July and August. Temperature affects the river's dissolved oxygen concentration, which varies seasonally and inversely with temperature, from about 15 mg/l in the winter to about 5 mg/l in the summer. Alkalinity, pH, and dissolved metals are also slightly influenced by temperature fluctuation.

The New York State Department of Environmental Conservation (NYSDEC) has defined water quality standards for various sections of the Hudson River based on a system of classifications, which are given on the bottom of Table 1A (Adopted from NYSDEC, Title 6, Part 660).

C. STUDY AREA

This study involves an area of the river near CHG&E is Danskammer Point Generating Station and the new Roseton power plant, from the Newburgh-Beacon Bridge (mile point 62.3) extending north of New Hamburg to mile point 69 (Figure 2). The Roseton plant is situated on the west bank at mile point 66 (in class A waters). To the south in Newburgh Bay, the river is about 2,000 yards wide, while at Danskammer Point, in the plant area, the river width is only about 1,000 yards. The point forms Danskammer Cove to the north and on the east bank at mile point 67.6 there is a small tributary, Wappingers Creek.

A fairly straight and deep (about 50 ft) channel runs down the length of the river, usually west of center where the bottom is sandy loam. A shelf on either side, at a depth of 30-35 ft, expands into a shallow, silt-bottomed bay, in several areas primarily the east bank south of mile point 66 (Newburgh Bay), north and south of the New Hamburg Point, and at Danskammer Cove on the west bank. The substrate composition in sandy bottom areas is around 50% sand, 30% silt, 5% clay, and 15% organic material, while the silt-bottom porportions are about 30% sand, 60% silt, 5% clay, and 5% organic material (see Figure 3).

Figure 2. Map of Hudson River at Roseton-Danskammer power generating stations illustrating the location of the thermal plume and water quality sampling stations.

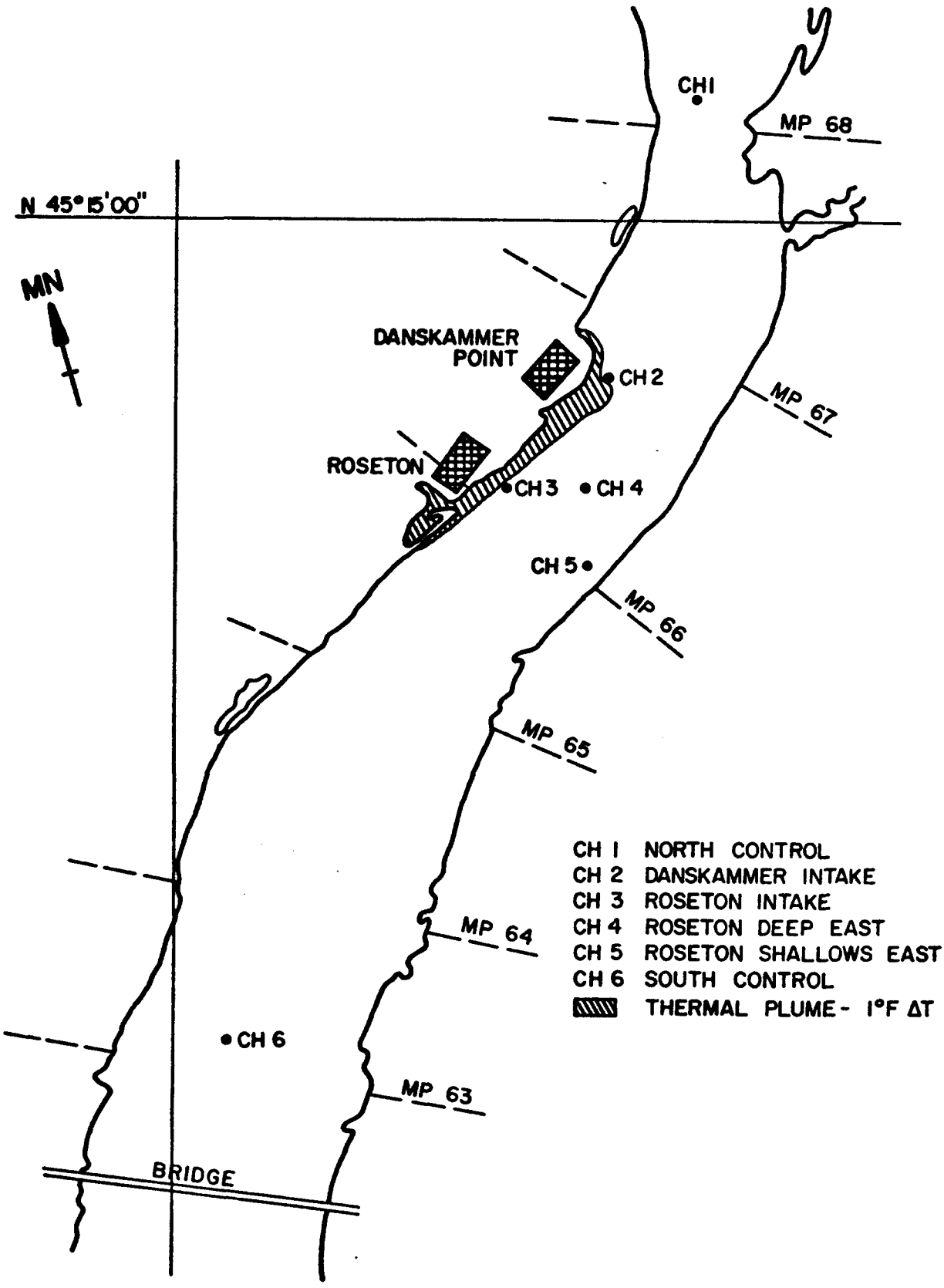
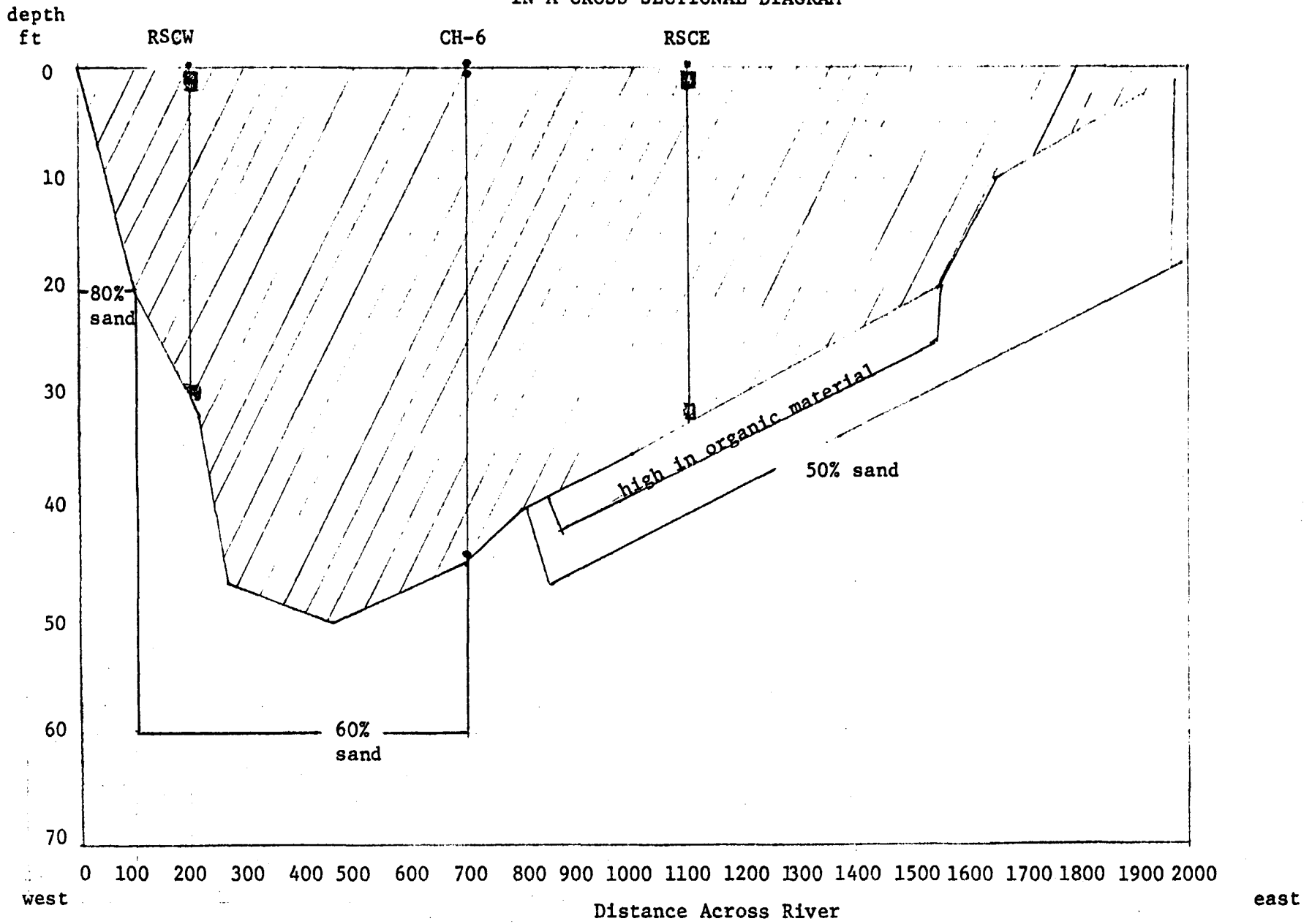


FIGURE 3

MAP OF HUDSON RIVER IN SOUTH CENTRAL AREA (NEWBURG BAY)
ILLUSTRATING THE LOCATION OF THE SAMPLING STATIONS
IN A CROSS-SECTIONAL DIAGRAM



Tidal effects on this stretch of the river produce maximum ebb or flood flows on the order of 230,000 cfs, while the mean yearly stage variation is about 2.8 ft from low to high water. This area is transitional between freshwater and estuarine, in that the salt front seasonally reaches upstream. It is estimated (LMS 1973: p. VII-21) that a freshwater flow of 6,000-7,000 cfs will place the salt front in the Roseton-Danskammer Point area. Long term measurement shows that the freshwater flow in the lower Hudson reaches a low of 4,000-6,000 cfs from mid-July to mid-October. Accordingly, during this time, the water of the Roseton-Danskammer Point area becomes brackish, showing dramatic increases in chloride, concentrations of sulphates and dissolved solids.

A sampling program for various chemical and physical parameters relating to water quality was carried out in the Roseton-Danskammer study area from the end of May 1973 through the end of the year (The last sampling date was actually in January 1974). A map of the sampling stations is given in Figure 2 and the results are presented in Table 2. Six locations, denoted as stations CH-1 to CH-6, were sampled at surface and bottom. CH-1, in the north control area, was sampled in the deepest part of the channel off the railroad trestle, CH-2 off the Danskammer plant intake in front of the bar racks, CH-3 off the Roseton plant intake also in front of the bar racks, CH-4, on the east side of the river, across from the Roseton intake at the deepest point in the channel (a mid-depth sample was taken here in addition to the regular surface and bottom samples), CH-5, also on the east side, across from the Roseton intake in shallow water, and CH-6, the south control, north of the Newburgh-Beacon bridge in the deepest point in the channel.

Sampling was conducted once a month starting in May and always during the day. Although no collections were missed, the total of 104 samples collected were probably too few to adequately evaluate

TABLE 2

SUMMARY OF WATER QUALITY CHARACTERISTICS OF SAMPLING STATIONS

Station	MP	Depth Feet ±5	Distance From Danskammer Intake (yards) ±100	Distance From Shore (yards) ±25	ΔT^1 (°F)	Sampled		ΔT (°F)	ΔT (°C)	pH	Salinity (mg/l)	Alkalinity $CaCO_3$ (mg/l)	NO_3-N Nitrogen (NO_3-N) (mg/l)	Total Phosphorus (mg/l)	Total Dissolved Solids (mg/l)
CH-1 North Control	68.2	55	2500	400	0°	S	Sp	54-71	12-21	7.6-7.7	6	43-46	.38-.96	.03-.08	100-125
							Su			7.8	6-11	55-61	.27-.47	.08-.09	140-160
							F	46-52	8-22	6.9-7.6	16-50	56-60	.37-.73	.02-.08	155-210
							W			7.4	11	44	.70	.07	75
						B	Sp	54-71	12-21	7.5-7.6	6-7	43-47	.50-.79	.11-.14	110-130
							Su			7.8	10-11	52-58	.31-.56	.17-.22	145-175
							F	47-72	9-22	6.9-7.6	15-69	58-61	.38-.82	.05-.09	165-275
							W			7.5	10	40	.83	.18	75
CH-2 Danskammer Intake	66.7	25	100	150	1°	S	Sp	54-71	12-21	7.4-7.8	4-6	43-46	.43-.76	.06-.11	95-110
							Su			7.8	8-10	53-58	.34-.48	.12	170-185
							F	48-72	9-22	6.9-7.6	16-47	54-57	.41-.77	.03-.08	150-210
							W			7.5	11	40	.75	.10	135
						B	Sp	54-71	12-21	7.4-7.8	7-8	45-54	.48-1.58	.08-1.43	120-310
							Su			7.7-7.8	7-10	54-58	.27-.52	.15	185-230
							F	47-72	9-22	6.9-7.6	16-73	56-60	.38-.50	.08-.27	125-270
							W			7.3	12	43	.73	13	170
CH-3 Roseton Intake	66.2	25	100	150	1°	S	Sp	55-70	13-21	7.4	7	46	.41-.79	.06-.11	110-115
							Su			7.7-7.8	5-9	54-61	.29-.56	.09	195-200
							F	48-72	9-22	6.9-7.6	14-93	56-59	.37-.73	.05-.07	190-285
							W			7.5	12	43	.54	.08	80
						B	Sp	55-69	13-20	7.5-7.7	6-7	43-48	.50-1.50	.14-.60	110-130
							Su			7.8-7.9	9-16	55-59	.37-.56	.15-.18	165-200
							F	48-72	9-22	6.9-7.6	13-150	57-59	.39-.77	.06-.47	240-425
							W			7.5	11	43	.77	.26	30

[1] Rise in temperature because of heated effluents from power plants

S = Surface

B = Bottom

M = Middle

Sp = Spring (73/V/29 - 73/VI/19)

Su = Summer (73/VII/30 - 73/VIII/22

F = Fall (73/X/3 - 73/XI/27)

W = Winter (74/I/3)

TABLE 2 (continued)

SUMMARY OF WATER QUALITY CHARACTERISTICS OF SAMPLING STATIONS

Station	MP	Depth Feet ±5	Distance From Danskammer Intake (yards) ±100	Distance From Shore (yards) ±25	ΔT^1 (°F)	Sampled		ΔT (°F)	ΔT (°C)	pH	Salinity (mg/l)	Alkalinity $CaCO_3$ (mg/l)	NO_3-N Nitrogen (NO_3-N) (mg/l)	Total Phosphorus (mg/l)	Total Dissolved Solids (mg/l)
CH-4 Roseton															
East Deep	66.5	80	750	450	0°	S	Sp	55-72	13-22	7.5-7.8	4-7	43-47	.41	.08-.09	98-110
							Su			7.9	9-10	56-61	.27-.45	.08-.13	150-195
							F	47-72	9-22	6.9-7.6	15-114	57-58	.40-.69	.05-.81	245-350
							W			7.5	10	44	.69	.09	90
						M	Sp	71	21	7.5	6	47	.76	.10	125
							Su			7.8-7.9	7-10	56-58	.29-.51	.10-.12	175-180
							F	47-72	9-23	6.9-7.7	14-119	56-60	.38-.74	.04-.09	245-350
							W			7.4	12	44	.84	.25	60
						B	Sp	55-70	13-21	7.1-7.6	6-7	43-48	.45-.79	.10-.12	105
							Su			7.7-7.8	0-9	57-62	.21-.55	.15-.19	175-185
							F	47-73	9-23	6.9-7.7	17-130	55-59	.40-.75	.03-.15	154-430
							W			7.6	10	44	.84	.14	185
CH-5 Roseton East Shallows	66.5	25	1300	150	0°	S	Sp	55-72	13-22	7.4-7.8	5-6	43-46	.30-.74	.04-.09	105-125
							Su			7.8	10	43-46	.19-.52	.09-.11	190-200
							F	47-73	9-23	6.9-7.8	22-114	49-58	.39-.76	.07-.24	170-610
							W			7.8	12	45	.55	.08	70
						B	Sp	55-71	13-21	7.4-7.8	5-6	46-47	.45-.76	.08-.10	110-120
							Su			7.8-7.9	10-19	55-59	.33-.51	.08-.12	170-200
							F	48-73	9-23	6.9-7.9	16-161	58-62	.40-.71	.07-.11	235-395
							W			7.8	12	44	.77	.12	80
CH-6 South															
Control	62.7	45	6500	700	0°	S	Sp	55-71	13-21	7.2-7.4	4-6	39-45	.41-.84	.02-.10	115-120
							Su			7.8-7.9	8-11	55-59	.47-.48	.10-.11	150-185
							F	48-73	9-23	6.9-7.6	20-166	58-62	.40-.75	.06-.09	150-410
							W			7.4	10	43	.73	.09	150
						B	Sp	54-70	11-21	6.9-7.5	5-7	43-46	.45-.76	.08-.11	105-130
							Su			7.8-7.9	10	55-61	.48-.56	.07-.15	160-180
							F	48-73	9-23	6.9-7.7	18-275	57-59	.41-.78	.07-.37	130-670
							W			7.7	13	44	.70	.05	95

the water quality of the study site, especially with respect to seasonal variation. The samples do not indicate natural variations or important diurnal variations, and unfortunately, the dates of water quality samples do not correspond with any of the biological sampling programs. Therefore, while major trends may be evident from these data, they do not justify any statistical analysis or even quasi-statistical treatment in relation to the biological results. Quoting the analysis (LMS 1973) of these data: "Substantial differences in mean values exist for several parameters but these differences are not statistically significant...."

In Table 2, each station is listed with information on its location, mile point, depth, etc. The ΔT column lists the average increase above normal ambient temperature in the river for stations within the thermal plumes, and indicates those stations outside the range of thermal effects. Other parameters shown are: temperature (F, with conversion to C); pH, a measure of hydrogen ion concentration, and thus an indicator of acidity; chloride concentration (Cl), an indicator of salinity; alkalinity, a measure of hydroxyl ion concentration expressed as mg/l of $CaCO_3$; nitrate and phosphates, two important phytoplankton nutrients; and total dissolved solids, which is a measure of the residue after evaporation of filtered samples. The samples were also analysed for chemical and biological oxygen demand, suspended and volatile solids, ammonia and total Kjeldahl nitrogen, sulphate, chromium, zinc, and phenols. (For these results LMS 1974: Chapter VII-D).

Unfortunately, the temperature data were incomplete and dissolved oxygen concentrations were not included, although these are perhaps the most important data of all. Temperature exhibits an obvious seasonal behavior and the near-plant and south stations seem to have had a higher minimum fall temperature than the north control,

although there is no depth difference whatsoever among stations. The summer maximum ambient temperature was a slightly high 81 F.

Because of a wet winter and spring, followed by a dry summer, the year 1973 had a relatively high freshwater flow, with a yearly average of 17,670 cfs as opposed to the long-term average of 13,070 cfs. According to daily chloride measurements the salt front was in the study area or upstream from mid-September to mid-December. The chloride concentrations on the 24/X/73 date place the salt front inside the study area, in fact, right at the Roseton plant. The salt concentration increases with depth. The normally steady pH value also dropped on this date because of the buffering action of the salt water. At all other times the pH was about 7.7 and the chlorides 5-20 mg/l.

Changes in alkalinity were small, and values of this parameter were generally low except for a slight rise in summer. The nitrates and phosphates exhibited similar behavior, concentrations of both being quite low and more variable, although they apparently decreased in the summer and increased with depth. This may represent the effects of temperature on their solubility, or varying pollution levels. The total dissolved solids were also fairly low and constant except during the October salt front conditions when concentrations doubled.

Thus, these data suggest that the river's chemical dynamics are controlled primarily by tidal effects and secondarily by temperature. The plant appears to have had no measurable effects, although it is possible that more effects would have been observable had the sampling design been different.

D. POWER PLANTS

The Danskammer Point Generating Station, a 511 MW fossil fuel plant located on Danskammer Points produces about 4 billion BTU/day

and drawn cooling water from the Hudson River at the rate of 308,000 gallons/minute (gpm). The average rise in temperature of the water in the cooling system is 14.5 F, and heated water is discharged at the surface. The Roseton plant, one half mile south of the Danskammer Point plant, was not scheduled to go into operation until after 1973, and the project was in fact a preoperational study of the plant's ecological effects under full operation. It was expected that at full capacity the plant would dissipate 120 billion BTU/day and use 656,000 gpm of cooling water, heating it 15.4 F. The heated effluent is released through a submerged diffuser.

Although other studies were conducted in 1973 on the effects of entrainment and impingement of fauna in the intake system, the analysis discussed in this report concentrates on the effects of the thermal plume. The plume is the river area affected thermally by the influx of heated water from the plant, the quantity of hear being measured as ΔT, or the rise over ambient river temperature. Because the Roseton plant was not operational during the study, the thermal plume was solely that of the Danskammer plant. With the perimeter of the plume defined as a ΔT of 1 F, it extended along the surface 250 yards out into the river and about a mile along the river bank from Danskammer Cove to below the Roseton discharge (Figure 2). On the other side the outflow of Wappinger Creek constitutes a natural plume which can extend down past the plant area. The shape of the plume is, however, greatly affected by seasonal and tidal flow, as well as by seasonal and diurnal variations in ambient temperature, and these estimates are based on the average of data collected from July through October of 1969.

E. REFERENCE AND EXPERIMENTAL STATIONS

One of the purposes of this study is to compare the ecological communities of portions of the river which may be affected by

thermal effluents from the Danskammer Point Generating Station with those of unaffected portions, and thereby to evaluate the ecological impact of the Roseton plant. For this purpose, the sampling locations of each collection program were divided into a reference or "control" group and an experimental group, the controls being stations representative of "normal" river conditions and the experimental stations being those under the influence of the plant, that is, in or close to the thermal plume area.

Clearly, the stations to the north and south of the plant area will be the least affected by the plant and should be termed control stations. Similarly, stations on the west bank in the plant area in or near the plume were considered experimental stations. However, there were some ambiguities and difficulties in delineating control and experimental stations. For example, a fish trawl had ended in the plume and proceeded away from the area of plant influence. The niche results indicate that the choice of this staion as experimental was well founded but this choice was not initially obvious from the sampling design. In fact, stations near that area might be more affected by the plant than the 1969 average plume data indicates. This problem could be resolved in the future by measuring temperature concurrently with biological sample collections.

A more complicated problem was posed by those stations outside the above definition; that is, neither representative of normal river conditions nor affected in any way by the generating plants. Such a station was located off the eastern bank across from the plant in an area apparently influenced by the inflow from Wappinger's Creek to the east (Figure 2). The LMS personnel consulted agreed with us that this station was not representative of the plant-affected community and should not be defined as an experimental station; however, including it as a control station seems, in retrospect, to

have been a poor decision because it clearly is not representative of the "normal" river conditions as indicated by the other control stations. Statistically, the control group should be homogeneous, at least with respect to the effect being tested (that is, natural thermal variation versus the thermal effects of the power plant). By including the odd station as a control we are increasing the range of 'normal' variations and thus decreasing the significance of any differences between control and experimental stations. Therefore, instead of examining the question of whether the experimental stations were significantly different from control stations (that is, by virtue of plant effects) relative to the variation in "normal" (control) river communities, we in fact considered whether the plant effects were more significant relative to any other measured effect on the river environment. From this point of view, it probably would have been better to group this section with the experimental stations, consider it independently, or not to consider it at all.

SECTION III

MATHEMATICAL METHODOLOGY AND DATA ANALYSES

III. MATHEMATICAL METHODOLOGY AND DATA ANALYSES

A. BASIC COMMUNITY STRUCTURE AND STABILITY MEASURES

1. N-Dimensional Hypervolume Concept of the Niche

When Shelford (1911) introduced the Law of Tolerance, he represented the tolerance curve of a population as shown in Figure 4. Hutchinson (1957, 1965) extended this law of tolerance to the n-dimensional hypervolume concept which can be used to include all the species in a community of competitors and their tolerance ranges in regard to the smallest number of factors (axes or dimensions) that serve to separate the species' niches.

Figure 5 is a diagram representing the Hutchinsonian concept of a niche of a hypothetical phytoplankton community in a two-dimensional ecological space. In this community, two factors serve to separate the species: light intensity and concentration of phosphorus, and there are six species in the community: A-F. Levins (1968) attempted to formulate measures (niche analysis) to quantify the niche patterns of such a group of coexisting species.

Niche analysis centers on a biological community as a complex, dynamical system composed of competing species, each with its own function or niche in the community. The niche of each species is the abstraction of the complex phenotypic interaction between the species and its environment. In theory, as well as in nature, there can be no separation of the two. In evaluating niches, there is also an associated criterion of fitness, even though it is impractical to measure this parameter in the field. The population of a given phenotype in a stable system will be limited by its competitors in regard to various environmental factors and levels of

FIGURE 4. Diagram of Shelford's (1911) tolerance curve.

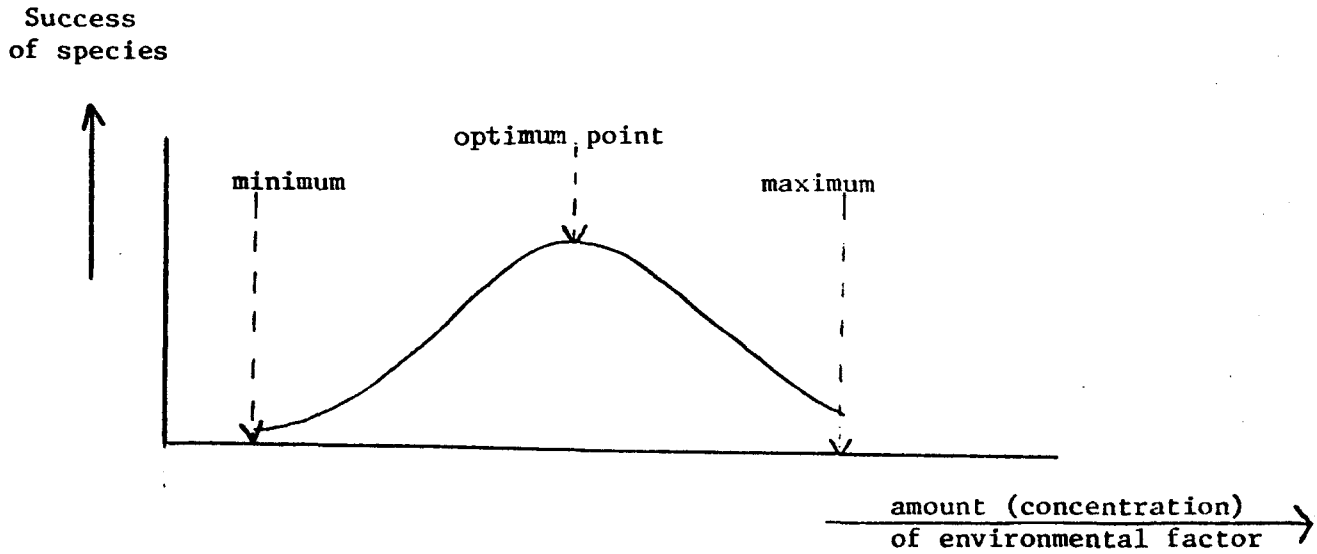
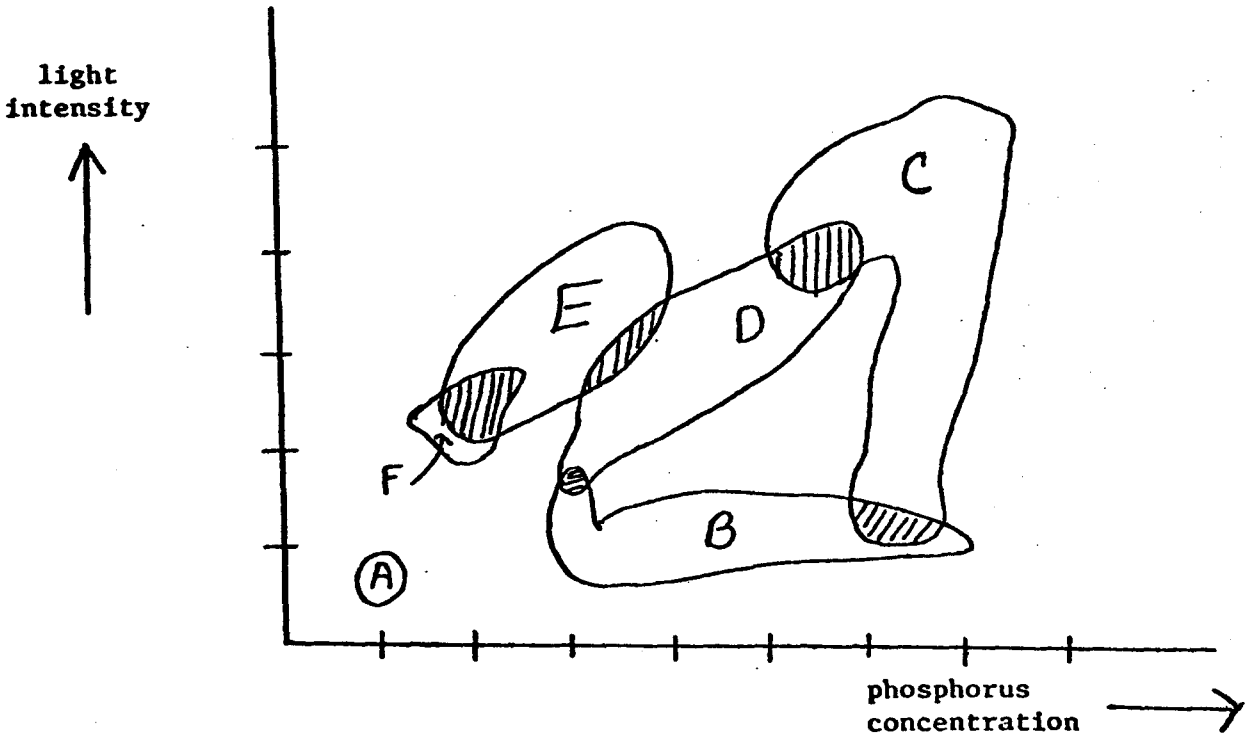


Figure 5. Diagram of a hypothetical community of phytoplankton competitors in a two-dimensional ecological space.



resources. This limited ecological space was termed the actual or realized niche, by Hutchinson (1967), in contrast to the potential or fundamental niche which is the ecological space the population could occupy with no competitors present. Thus, the realized niche will be determined by the species' success in competition with the other species in the community.

Levins (1968) developed several sufficient parameters for evaluating community structure, i.e., a set of niche measures for a group of competitors. He defined a sufficient parameter as a measure that integrates many pieces of information from lower levels of biological organization. Community stability, for example, is a sufficient parameter which involves in part, the relative abundances, amplitudes of fluctuations, rates of these fluctuations, responses rates, and magnitudes of external forces acting upon the total community. A list of the number of individuals in each population, or even a successive list through time, is not by itself a complete measure of community stability. First, we will discuss the basic set of niche measures or sufficient parameters that Levins (1968) developed; and then compare them to Figure 5.

2. Niche Analysis

a. Niche Measures

This analysis includes four main parameters used to characterize the niche patterns of a community of competitors: species diversity, niche breadth, niche overlap and niche dimension. Species diversity measures the number of species in the community, also taking into account their relative abundances or frequencies. Niche breadth is the length of a niche axis covered by the fitness curve, or in a complete ecological space, the hypervolume representing the conditions where the species has a

fitness (density) >0. It can be applied on a per species or a community basis. Niche overlap measures the region of hypervolume in which the niches of two species overlap. Niche dimension is the theoretical number of niche axes; that is, the number of factors separating the species in the community. Table 3 contains a comprehensive listing of the equations, terminology and symbols used in this study. The niche measures are also discussed in Appendix A-3.

(i) Species Diversity

Species diversity (H) is a measure of the number of species and their distribution in the environment. Thus, the measure takes into account both the actual number of species and the 'evenness' or 'equitability' (Lloyd and Ghelardi, 1964) of their densities. Table 3 lists the various diversity formulations in this study while the following discussion describes the theoretical development of the diversity concept. Diversity measures are by no means unique to niche analysis and it has been common ecological practice to use two formulae from information theory (Pielou, 1966). Since these measures were developed by communication engineers, the ecological interpretations of diversity measures have often been clouded with metaphor. Thus, it is best to avoid drawing parallels too closely between areas of ecology and communication theory.

Essentially, H measures the uncertainty with respect to species of the next random encounter of an individual of the community. Note that this is not the probability that the next encounter will be of any given species but rather it is a relative measure of the uncertainty of making any such prediction. Diversity can be interpreted as the number of

TABLE 3: Equations, Terminology and Symbols Used in Niche Analysis

Part A. EQUATIONS

(1) $$p_{ih} = d_{ih} \Big/ \sum_{h=1}^{E} d_{ih}$$

(2) $$P_h = \sum_{i=1}^{N} d_{ih} \Big/ \sum_{i=1}^{N} \sum_{h=1}^{E} d_{ih}$$

(3) $$q_{ih} = d_{ih} \Big/ \sum_{i=1}^{N} d_{ih}$$

(4) $$Q_i = \sum_{h=1}^{E} d_{ih} \Big/ \sum_{i=1}^{N} \sum_{h=1}^{E} d_{ih}$$

(5) $$Q_{it} = \frac{\sum_{d=1}^{\#depths} d_{itd}}{\sum_{i=1}^{N} \sum_{d=1}^{\#depths} d_{itd}}$$

(6) $$Q_{id} = \frac{\sum_{t=1}^{\#times} d_{itd}}{\sum_{i=1}^{N} \sum_{t=1}^{\#times} d_{itd}}$$

continue .....

Table 3
(continued)

Part A. EQUATIONS (Continued)

(7) $$H_h = -\sum_{i=1}^{N} q_{ih} \log_2 q_{ih}$$

(8) $$H = -\sum_{i=1}^{N} Q_i \log_2 Q_i$$

(9) $$H_t = -\sum_{i=1}^{N} Q_{it} \log_2 Q_{it}$$

(10) $$H_d = -\sum_{i=1}^{N} Q_{id} \log_2 Q_{id}$$

(11) $$H' = -\sum_{h=1}^{E} P_h \log_2 P_h$$

(12) $$\bar{H}_h = \sum_{h=1}^{E} H_h / E$$

(13) $$\bar{H}_t = \sum_{t=1}^{\#times} H_t / \#times$$

(14) $$\bar{H}_d = \sum_{d=1}^{\#depths} H_d / \#depths$$

continue .....

Table 3
(Continued)

Part A. EQUATIONS (continued)

$$(15)\quad B_i = \frac{1}{\sum_{h=1}^{E} p_{ih}^2}$$

$$(16)\quad \bar{B}_i = \sum_{i=1}^{N} B_i / N$$

$$(17)\quad \hat{B} = \frac{1}{\sum_{h=1}^{E} P_h^2}$$

$$(18)\quad B' = \frac{1}{\sum_{i=1}^{N} Q_i^2}$$

Niche Measures:

$$\hat{B} / E$$

$$\bar{B}_i / \hat{B}$$

$$\overline{B_i} / E$$

$$\overline{B_i / E_i}$$

$$E \cdot \overline{B_i / E_i}$$

$$B' / N$$

are also generated directly from these equations.

$$(19)\quad D_i = \frac{1}{E} \sum_{h=1}^{E} d_{ih}$$

$$(20)\quad D = \sum_{i=1}^{N} D_i$$

$$(21)\quad K_i = D_i + \sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_{ij} D_j = \sum_{j=1}^{N} \alpha_{ij} D_j$$

$$(22)\quad \%K_i = \frac{K_i}{D}$$

$$(23)\quad \overline{\%K_i} = \overline{K_i / D}$$

Niche Measures:

$$\frac{\overline{D_i / K_i}}{\%K_i / (B_i / \hat{B})}$$

$$\bar{\alpha}$$

are also generated from these equations

Table 3
(continued)

Part A. EQUATIONS (continued)

(24) $$\alpha_{ij} = \frac{\sum_{h=1}^{E} \left(p_{ih}\ p_{jh} \right)}{\sum_{h=1}^{E} \left(p_{ih}^{2} \right)}$$

(25) $$S_x = \frac{1}{n} \Sigma \left(\frac{X - \bar{X}}{\sigma_x} \right)^3 \quad \text{where } X = \alpha \text{ or } \lambda$$

(26) $$K_x = \frac{1}{n} \Sigma \left(\frac{X - \bar{X}}{\sigma_x} \right)^4 \quad \text{where } X = \alpha \text{ or } \lambda$$

(27) $$\bar{\alpha} = \frac{1}{N(N-1)} \cdot \sum_{i \neq j}^{N} \alpha_{ij}$$

(28) $$\text{cov } \alpha_{ij}\ \alpha_{ji} = [\ \overline{\text{cov } \alpha_{i\cdot}\ \alpha_{\cdot i}} + \text{cov } \bar{\alpha}_{i\cdot}\ \bar{\alpha}_{\cdot i}\ ] \quad \text{where}$$

$$\overline{\text{cov } \alpha_{i\cdot}\ \alpha_{\cdot i}} = \sum_{i=1}^{M} \left[\frac{\sum_{j \neq 1} \alpha_{ij}\ \alpha_{ji} - \sum_{j \neq 1} \alpha_{ji} \sum_{j \neq i} \alpha_{ij} \ /\ N-1}{N(N-2)} \right]$$

and

$$\text{cov } \bar{\alpha}_{i\cdot} \bar{\alpha}_{\cdot i} = \frac{\sum_{i=1}^{N} \bar{\alpha}_{i\cdot}\ \bar{\alpha}_{\cdot i} \ -\ \left(\sum_{i=1}^{N} \bar{\alpha}_{i\cdot} \sum_{i=1}^{N} \bar{\alpha}_{\cdot i} \right) / N}{N-1}$$

where $\bar{\alpha}_{i\cdot} = \sum_{j \neq i} \bar{\alpha}_{ij} \ /\ N-1$

and $\bar{\alpha}_{\cdot i} = \sum_{j \neq i} \alpha_{ji} \ /\ N-1$.

continue .....

Table 3
(continued)

Part A. EQUATIONS (continued)

(29) $|\underline{A}|$ = det of matrix $\underline{A}$ or $\{\alpha_{ij}\}$

$$\det \{\alpha_{ij}\} = \sum_{i=1}^{N} (-1)^{i+k} \alpha_{ik} |m_{ik}|,$$

where $|m_{ik}|$ is the determinent of the minor of α_{ik}.

(30) λ = N eigenvalues of matrix $\underline{A}$: Solutions of

$\det (\underline{A} - \lambda_i \underline{I}) = 0$ where $\underline{I}$ = the identity matrix

(31)* $$s_\lambda^2 = \frac{\Sigma (X-\bar{X})^2}{N-1}$$

(32)* $$\text{H.M.}_\lambda = \frac{N}{\sum_{i=1}^{N} 1/\lambda_i}$$

(33)* $$\overline{(1/\lambda)} = \frac{\sum_{i=1}^{N} 1/\lambda_i}{N}$$

---

* assuming all λ_i are positive. If any are zero, then N becomes the number of non-zero eigenvalues and the sums are only taken over them.

Table 3

(continued)

Part B. TERMINOLOGY AND SYMBOLS

i	- species designation (used as a subscript)
i=1, ..., N	- species designation, community has N species
h	- environment designation, time and location where one sample is collected (used as a subscript)
h=1, ..., E	- habitat designation, community inhabits E environments; at least one individual of the community is found in each environment h
E_i	- total number of environments species i was found in (i.e. where D_{ih} was non zero)
d_{ih}	- data matrix element representing the density of the ith species in the h environment
t	- time (diurnal or seasonal) designation, used as a subscript
d	- location (depth or station) designation, used as a subscript
d_{itd}	- data matrix element representing the density of the ith species in the t time (day-time) and depth (depth-station)
P_{ih}	- percentage of species i occurring in habitat h of total of species i occurring in all E habitats
P_h	- percentage of all species occurring in habitat h of total of all species occurring in all E habitats

continue .....

Table 3
(continued)

Part B. TERMINOLOGY AND SYMBOLS (continued)

q_{ih} - percentage of all species i occurring in habitat h of all species occurring in habitat h

Q_i - percentage of species i occurring in all habitats of all species occurring in all habitats

Q_{it} - percentage of species i occurring in all depths at time t of all species occurring in all times at time t

Q_{id} - percentage of species i occurring in all times at depth d of all species occurring in all times at depth d

H_h - within environment diversity for each sample

H - total community diversity

H_t - within temporal community diversity calculated for each time and/or date over all species

H_d - within spatial community diversity calculated for each station and/or depth over all times

H' - community habitat diversity

$\bar{H}_h$ - mean within environment diversity

$\bar{H}_t$ - mean within temporal diversity

$\bar{H}_d$ - mean within spatial diversity

continue .....

Table 3
(continued)

Part B. TERMINOLOGY AND SYMBOLS (continued)

$H\text{-}\bar{H}_d$ - among community diversity with respect to time

$H\text{-}\bar{H}_t$ - among community diversity with respect to space

$H\text{-}\bar{H}_h$ - total among community diversity

B_i - niche breadth of species i

$\bar{B}_i$ - mean niche breadth over all species

$\hat{B}$ - community niche breadth

$\hat{B}/E$ - relative community niche breadth

B_i' - species breadth, spread of species in environments sampled, relative species breadth is this measure divided by N

$\bar{B}_i/\hat{B}$ - mean relative niche breadth of all species, a measure of how much ecological space the average species uses as compared to the community use of the environment

$\bar{B}_i/E$ - mean species niche breadth over maximum value, mean species use of environment over maximum possible use of environment

$\overline{B_i/E_i}$ - mean values of ratios of species niche breadth over number of environments species i is found in (measure of how equally distributed the average species i is over the environments it is found in)

$E \cdot \overline{B_i/E_i}$ - mean values of ratios of species niche breadth over number of environments species i is found in times number of environments (measure of what value $\bar{B}_i$ would attain if $E_i=E$ for all species

continue .....

Table 3
(continued)

Part B. TERMINOLOGY AND SYMBOLS (continued)

$\bar{D}_i$ - average density of species i per habitat h

D - average density of community (total of all species) per habitat h

$\bar{K}_i$ - average carrying capacity of species i per habitat h, carrying capacity is the theoretical density a species would attain if there are no competitors

$\bar{K}$ - average community carrying capacity per habitat

$\% K_i$ - percent carrying capacity of species i of community density

$\% \overline{K_i}$ - mean percent carrying capacity

α_{ij} - measure of interspecific overlap of the effect of species j on species i based on the probability of co-occurrence of the two species

D_i/K_i - competitive success ratio for species i, it measures how well species i has reached its carrying capacity in regard to competitors represented in the matrix

$K_i/(B_i/\hat{B})$ - measures how well the species could theoretically fill (K_i) the proportion of ecological space ($B_i/\hat{B}$) it possesses, since K_i depends on the amount of food in each environment, the general suitability of each environment for species i and the safety from predators in each environment; this ratio measures the relationship of species i to factors and species in the ecosystem which are not represented in the matrix of competitors

continue .....

Table 3
(continued)

Part B. TERMINOLOGY AND SYMBOLS (continued)

S_α
S_λ - skewness is a standard statistical measure of the distribution of a set of variables in regard to their deviation from the mean on the right and left-hand sides of the curve and thus, it is proportional to the ratio of areas on each side of the curve. In this study, it is used for both alpha value and eigenvalue distributions

K_α
K_λ - Kurtosis is a standard statistical measure of the distribution of a set of variables in regard to their clustering about the mean. In this study it is used for both alpha value and eigenvalue distributions

σ_x
σ_λ - the standard deviation (or square root of the variance) of the alpha values or eigenvalues, is also a standard statistical measure and it is used in calculating skewness(S) and Kurtosis (K)

$\text{cov } \alpha_{ij} \alpha_{ji}$ - the covariance of the alpha matrix in relation to pairs of symmetric terms

$|A|$ - the determinant of the alpha matrix, A

λ - the eigenvalues or roots of the characteristic equation of the alpha matrix, A

S_λ^2 - the variance of the eigenvalues of the alpha matrix

$H.M._\lambda$ - the harmonic mean of the eigenvalues of the alpha matrix

$\overline{(1/\lambda)}$ - the arithmetic mean of the reciprocals of the eigenvalues of the alpha matrix

species with which the individual's next encounter is likely to be. This can be termed the 'effective' number of species in the community, thus, correcting for those species which are relatively infrequent.

Diversity is measured as follows:

$$H = - \int_A q(t) \cdot \log_2 q(t) dt \qquad \text{(III-1)}$$

where

$$q(t) = x(t) / \int_A x(t)\, dt \qquad \text{(III-2)}$$

H is calculated in units (termed bits) of the function x(t) over the set A. In this case where there are N random samples from an infinite population, then there is a sequence of continuous random variables $x_1, x_2, \ldots x_n$ and the following form of the equation is used:

$$H = - \sum_{i=1}^{n} Q_i \log_2 Q_i \qquad \text{(III-3)}$$

where

$$X = \sum_{i=1}^{n} x_i \qquad \text{and} \qquad Q_i = x_i / X$$

thus

$$H = (X \log_2 X - \sum_{i=1}^{n} x_i \log_2 x_i) / X \qquad \text{(III-4)}$$

In computing diversity indices, ecologists have used logarithms to the bases e and 10 and the units are called nits and decits respectively. These units are different from the bit values by a factor of $\log_e 2$ or $\log_{10} 2$ respectively. In this study, all diversity values were calculated with Shannon's formula using base 2 logs.

In the case that an x_i is zero, we take the whole term $x_i \log_2 x_i$ to be zero because:

$$\lim_{x \to 0}: \quad x \cdot \log_2 x = 0 \qquad \text{(III-5)}$$

Thus, as x becomes smaller so does $x \cdot \log_2 x$. This also means that H is extremely robust to sampling errors and spurious observations since their proportions will be relatively low. H varies from 0 in the case that only one species is found in an environment, to $\log_2 N$, in the case that N species were found in equal numbers.

Diversity, like variance, can be partitioned into components and an analysis of components of diversity can be used to examine diversity at several levels in stratified data (Levins, 1968; Pielou, 1971; Colwell and Futuyma, 1971). We have included an analysis of diversity components following the usage of Levins as follows:

$$H_{(\text{total})} = H_{(\text{among})} + H_{(\text{within})} \qquad \text{(III-6)}$$

This tells us that, of the total species diversity measured across a set of environments (H_{total}), how much is due to the number of proportions of species in the environments

sampled (H_{within}) and how much is due to the differences in species content among the environments (H_{among}). The total diversity (H_t) was calculated acording to equation 8, Table 3, from the species proportions over all stations and/or dates etc., while the within diversity ($\overline{H_h}$) was calculated according to equation 12, Table 3 as the mean of the diversities for each environment (equation 7, Table 3). The among environment diversity ($H-\overline{H_h}$) was calculated as the difference of total and within diversity values. This quantity, which is similar to an interaction term in ANOVA and is called "mutual information" in information theory (Abramson, 1963). It should be noted that the computation of the mean $\overline{H_h}$ should have been weighted by the total density in each environment. Our erroneous use of unweighted means tended to drive within diversity values upwards and occasionally this leads to a negative among diversity value which is invalid ecologically and should be interpreted as zero.

Where appropriate, that is, where there were both temporal (time or date) factors and spatial (station or depth) factors in the same stratification, total diversity was also partitioned into mean within date and/or time diversity (H_t, equations 9 and 13, Table 3) and its corresponding among diversity ($H-H_t$) and into mean within station and/or depth diversity (H_d)(equations 10 and 14, Table 3) and among station/depth diversity ($H-H_d$). Remember that sample data was coded as a time factor and therefore both dates and times will be referred to in equations and on results tables by the subscript t, while sample stations were coded as depths for the computer program and thus, are represented along with depths by the subscript d (see Part 3 of this section on computer codes and runs).

Habitat diversity (H') is the uncertainty with respect to environment of a species or community and is a measure of niche breadth (Pielou, 1971). As an alternate to $\hat{B}$, we have included a community H' (without a component stratification) as follows:

$$H' = \sum_{h=1}^{E} P_h \log_2 P_h \qquad \text{(III-7)}$$

This measure has a range of 0 to $\log_2 E$ and was found to be almost identical in its patterns to $\hat{B}$.

(ii) Niche Breadth

The second niche measure is niche breadth, B_i, which measures how much of a generalist, or inversely, a specialist, a given species i is in the community, over all environments (h) where the maximum h = E,

$$B_i = 1 \,/\, \sum_{h=1}^{E} P_{ih}^2 \qquad \text{(III-8)}$$

In this equation, the percentage of species i occurring in each environment h is squared and summed over all the environments, E. Thus, niche breadth measures the spread of a population over a set of environments and can be treated as an effective number of environments. In mathematical terminology, environments could be considered as elements in a set. If all elements of the set are zero but one, then the breadth will be one, and if all non-zero elements are equal, then the breadth will be the number of non-zero elements.

Values in between are obtained depending on the distribution of the set. If a species is found in all environments in equal numbers, then B_i obtains a maximum value that is equal to the value of E. Such a species is termed broad-niched. This index is sensitive to both the distribution of species i and the number of environments it inhabits.

The community niche breadth, $\hat{B}$, can be calculated by first summing all of the species' abundances in each environment h and then using these new percentages in the formula given above. Since B_i is sensitive to h, the number of environments sampled, it is better to compare species niche breadths by using the ratio $\overline{B}_i/\hat{B}$, called the mean relative species niche breadth, as this ratio provides a measure of the relative ecological specialization of the species in relation to their community. Likewise, communities can be compared by using the ratio $\hat{B}/E$, the relative community niche breadth, where E is the total number of environments h and therefore the maximum value of $\hat{B}$. Usually $\hat{B}$ is 50-70% of E. Some other niche breadth ratios used in this study are summarized in Table 3.

$\hat{B}$ is fairly stable throughout the study, however, $\overline{B}_i$ gives an average for the effective frequency of the species and therefore is extremely sensitive to the selection of species used to calculate it. A low $\overline{B}_i$ value relative to E does not indicate that the community is sparsely populated or patchy, or that the niche breadths are generally low, as would a low $\hat{B}$ or max $\overline{B}_i$ value. A low $\overline{B}_i$ value simply means that the majority of species considered were infrequent in the sampling effort. Considering only abundant species or a different taxonomic system could drastically increase $\overline{B}_i$, which is sensitive to sampling and taxonomic problems.

Equation 18, Table 3, was also used to calculate B', species breadth, which gives the effective number of species in the community. To compute B', Q_i becomes the proportion of all species abundances in a given habitat of the total community, over all habitats. The final summation is done over species and B' has a maximum value of N. This measure correlated highly (positively) with H_t. Essentially B' is a diversity measure and H' is a niche breadth measure. Both H' and B' measures evaluate the number of items and their evenness simultaneously.

(iii) Niche Overlap

The third measure is niche or ecological overlap, that is, how ecologically similar are particular species pairs? Ecological overlap has been traditionally approached as a measure of competition between two species. Levins (1968) presented the following equation to measure interspecific overlap:

$$\alpha_{ij} = \sum_{h=1}^{E} p_{ih}\, p_{jh} \;/\; \sum_{h=1}^{E} p_{ih}^{2} \qquad \text{(III-9)}$$

where α_{ij} is the effect of species j on species i. This is approximately equal to the regression coefficient of p_i on p_j, or

$$r_{ij} = \left(\sum_{h=1}^{E} p_{ih}\, p_{jh} - 1/E \right) / \left(\sum_{h=1}^{E} p_{ih}^{2} - 1/E \right) \qquad \text{(III-10)}$$

The absence of the 1/E terms in equation III-9 makes α_{ij} equivalent to a regression of p_i on p_j where the line is forced through the origin.

For each species pair, i and j, there are two interaction coefficients α_{ij} and α_{ji}. This formula (Equation III-9) called the probability of co-occurrence alpha, can most validly be applied to species that are habitat selectors, that is, species that coexist by occupying different spatial-temporal positions. Thus, large values for α_{ij} and α_{ji} indicate that species i and j occupy many of the same habitats to a similar degree. For species that are resource allocators, that is, species that coexist by eating different foods, this is not a good measure of interspecific competition because the species may occur together yet not compete. By calculating a mean value for α, it is possible to evaluate the average amount of overlap in a particular community.

The total set of alphas of the species pairs can be arranged in to form a community matrix $\underline{A}$, where:

$$\underline{A} = \begin{bmatrix} | & \alpha_{12} & \alpha_{13} \cdots \alpha_{1n} \\ \alpha_{21} & | & \alpha_{23} \cdots \alpha_{2n} \\ \alpha_{31} & \alpha_{32} & | \quad \cdots \alpha_{3n} \\ \alpha_{n1} & \alpha_{n2} & \alpha_{n3} \cdots \alpha_{nn} \end{bmatrix}$$

This matrix is used to generate all of the associated stability criteria that are discussed in the following section. Included in this study are also some statistical measures of the alpha matrix including the variance (S^2_α); the skewness of alpha (S_α) (equation 25, Table 3), and the kurtosis of alpha (K_α) (equation 26, Table 3) and the covariance of alpha. The covariance term measures the correlation between the niche breadths of competitors, that is, the symmetric elements of the matrix. This measure of matrix assymetry is calculated as the covariance between α_{ji} and its transpose, α_{ji}. We use Vandermeer's (1972b) formula for computational purposes:

$$\text{cov}\,(\alpha_{ij}\,\alpha_{ji}) = \frac{1}{N(N-1)} \cdot \sum_{\substack{i,j=1 \\ i\neq j}}^{N} \alpha_{ij}\,\alpha_{ji} - \alpha^2 \qquad \text{(III-12)}$$

A community can hold more species if its covariance is low, that is, the niche breadths are equal (Levins, 1968). In this study, we do not calculate the maximum number of species although some formulae are available for this purpose. The skewness and kurtosis measures are described in detail in Appendix A-3.

(iv) Niche Dimensionality and Other Measurements

Niche dimensionality is the effective number of factors that serve to separate the species. It was not calculated in this study since the theoretical formulation for it is still not complete. We indicated several of the scientists who are presently attempting to measure niche dimensionality in Part I and the need for this measure is discussed in Part V.

An additional measure of interest is carrying capacity (K_i) of the environment for each species i. This is the theoretical density a population would reach if no competitors were present. Obviously, this is a difficult and usually impossible parameter to measure in a natural community where competitors are always present. Actual density (D_i) of a species, however, can usually be determined. In the Lotka-Voterra formulation, K_i was found by experimentation and alpha was the unknown that was calculated. In niche analysis, it is possible to calculate K_i if the alpha values are known, as follows:

$$K_i = D_i + \sum_{\substack{j=1 \\ j\neq i}}^{N} \alpha_{ij}\,D_j \qquad \text{(III-13)}$$

Thus, the carrying capacity of the environment for species i is equal to the density of species i plus the sum of the densities of the competitors of species i times their interaction coefficients on species i in a community of N species. Thus, the K's can be calculated by multiplying the alpha matrix by the vector of densities.

$\overline{\%K_i/(B_i/\hat{B})}$ ratio expresses the relative usage by species i of the ecological space available to the community. The ratio, therefore, quantifies the theoretical number of organisms of species i per unit of ecological space if no competitors are present. This ratio reflects the effects of three factors: predation, food resources, and physical environment. Predation affects K through the following relationship:

$$K_i^* = K_i\ (1-S_i/r_i) \qquad \text{(III-14)}$$

where S_i is the predation rate on species i and r_i is the growth rate of species i. Thus, if a predator is preying on species i at a high rate, and if species i has a low growth rate, then the new carrying capacity of (K_i^*) will decrease. Likewise, low temperature and unfavorable food resources will decrease the value of $\overline{\%K_i/(B_i/\hat{B})}$. This ratio is calculated using K as a percentage, %K, which is the mean percentage of K_i over D, expressed as a simple ratio:

$$\overline{\%K_i} = \overline{K_i/D} \qquad \text{(III-15)}$$

The D_i/K_i ratio measures the effects of species included in the community, thus, it is termed the competitive success ratio. The $\%K_i/(B_i/\hat{B})$ ratio measures the effects of

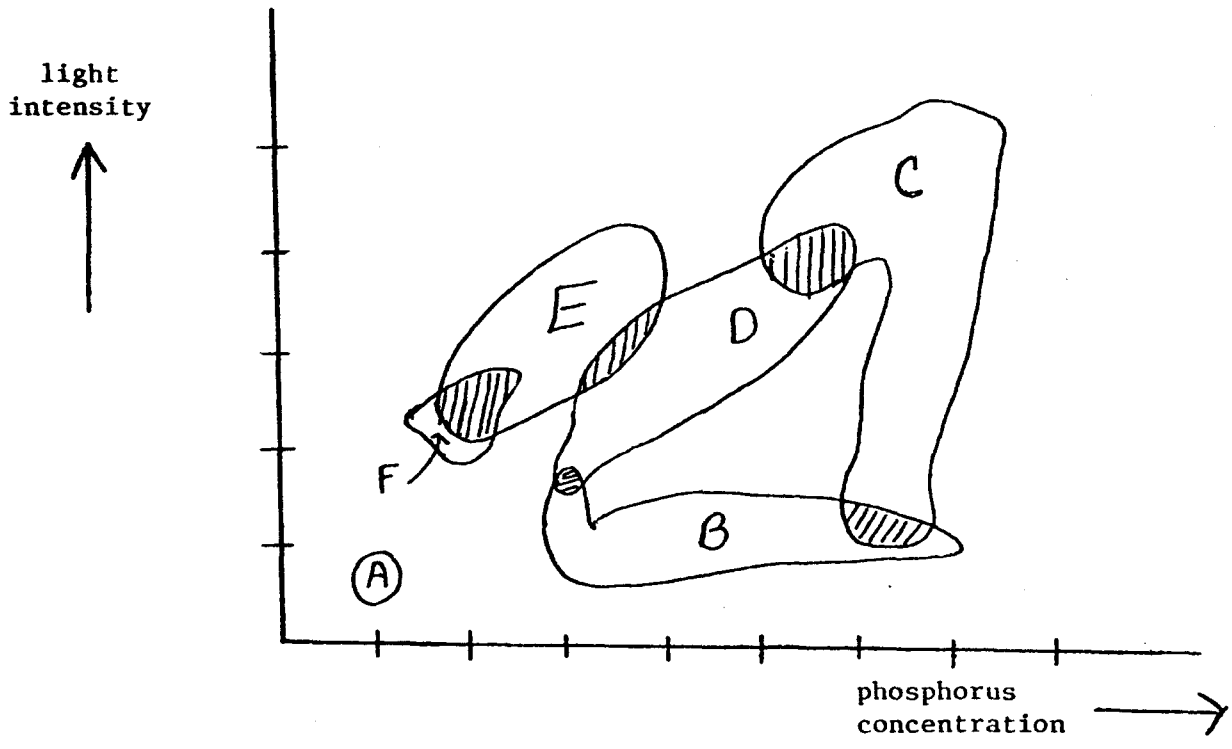
species outside the community, that is, noncompetitive factors. By evaluating the two ratios simultaneously, it is possible to assess whether competition, predation, food resources, or physical factors are involved in the response of a particular species or set of species. Thus, these ratios can provide a predictive tool.

(v) Levins' Measures as Related to the Hyperolume Concept

Using Figure 6, the major niche measures can be explained based on the pattern of species use of the ecological space in a given environment. In a real world situation, there would be many more axes than two. For example, phytoplankton niches are usually separated by temperature, light, a variety of macro- and micro-nutrients, vitamins and toxins, herbivores, as well as a variety of other factors. In this example, however, our hyperspace has only two dimensions and can be described by a plane. The term "hypervolume" is used to refer to a specific region in hyperspace. For two dimensions, this is an area.

There are six competing species in this community and several do not overlap directly. This means that the probability of co-occurrence alpha values for these species pairs are low. The two species that are overlapping the most are species E and F. Besides facilitating the evaluation of the probability of co-occurrence or the simultaneous use of the environment by competing species, this type of representation also makes it easy to picture what the niche breadths are like. For example, species B has a large niche

Figure 6. Diagram of a hypothetical community of phytoplankton competitors in a two-dimensional ecological space.



breadth in relation to phosphorus concentration, and a small niche breadth in regard to light intensity. In contrast to species B, species C has a large niche breadth in regard to light intensity and a small one in regard to phosphorus. Species A has a small niche breadth for both of the environmental factors, while species E and D are similar in regard to their use of both of these environmental factors.

The hypervolume or hyperspace concept as a graphical representation is helpful for looking at niche breadths and overlaps, however, it does not adequately treat other problems. For example, density and carrying capacity are not represented on this diagram except at the gross level where fitness is approximated by density. Diversity is represented only superficially in terms of the number of species, since relative abundances are not given on the diagram. Likewise, community stability is not treated in any way. As mentioned previously, niche dimensionality is directly relatable to the number of axes of the hypervolume. There are also the associated problems of the real world situation in which axes are discontinuous, nonlinear, dependent, as well as the pragmatic consideration that it is fairly impossible to measure fitness in the field. Like niche and competition, the term fitness defies exact definition. Thus, it is not feasible to measure hypervolumes in nature by quantifying the complete set of fitness functions for each species in a complex community over a range of habitats. It is possible, however, to approximate the gross patterns of community structure and to generate relative measures that facilitate comparisons of species, communities and habitats. This is essentially the approach of niche analysis.

b. Stability Measures

(i) Traditional Stability Theory

Niche analysis also includes an application of stability analysis to biological communities. In conventional stability analysis, (which is often applied in engineering to mechanical systems) the assumption is made that the motion of each part of a system is directly related in a linear fashion, at least as a gross approximation, to the motion of the other parts; or, that each part of a system is not related at all to the other parts and is therefore independent. By assigning values to the constants involved, using the theory of calculus and in particular, ordinary differential equations, we can delineate the component factors of motion in the whole system (besides standard textbooks see Gantmacher, 1960). These factors are separate and independent of each other, that is, perpendicular in an n-dimensional space, but linearly related, in various proportions, and thus, accounting in whole, for all of the individual parts or variables of the system. In particular, we can, by making further assumptions, predict the motion of the system through its various states and determine whether its motion will stay the same, decrease or increase, and whether its direction will stay the same or change, as in oscillatory phenomena. Essentially then, the system has been modelled as a set of differential equations.

Often the constants in the equations are unknown, and solved for using a posteriori knowledge of the system's behavior, either as observed or as experimentally determined. Our approach is to estimate the equation coefficients statistically from measurements of the system in its current state,

assuming equilibrium, and then, determine the consequent properties. Thus, we use the inter-species interaction coefficients given by the alpha matrix as the constants (partials) in our differential equations. This approach, although it is practical, leads to a severely limited model and produces several mathematical vagaries to be considered in interpreting the results. These points are discussed in the following sections (III A2 B2).

The eigenvalues, denoted λ_i, and corresponding eigenvectors of the alpha matrix, represent the independent trends or factors which are the components, or principal axes, of the total variation of the system. The eigenvalues are also termed the latent roots of the characteristic equation for the matrix. Each trend is moving toward an equilibrium, attained by the proportions of species densities, which in biological terms, are represented by an eigenvector. The corresponding eigenvalue is inversely proportional to the time taken for the return equilibrium from an initial perturbation from equilibrium. There, a small eigenvalue indicates a slow, gradual change (i.e., a perturbation will have a long-lasting effect), while the largest eigenvalue denotes the most rapid return, that is, the most stable factor. The larger the eigenvalue the shorter time needed for the system to return to its trajectory path, since we are calculating maximum time of return as the reciprocal of the smallest eigenvalue. Lane et al. (1975) calculated the half time of the system as a whole to return as a value somewhere between the reciprocal of the smallest eigenvalue and the harmonic mean of the eigenvalues.

Using a factor analytic approach, we can say, equivalently, that an eigenvector gives a linear function of the species

proportions, thus a factor accounts for (λ_i/n) of the total variance of the system, and the largest eigenvalue represents the most significant factor. The matrix determinant is the product of the eigenvalues and measures overall stability. The exact number of factors in a matrix is its rank, while the number of significantly large factors, that is, those not due to various types of random sampling errors, is referred to as the dimensionality of the system. Note, however, that there are not yet clear criteria for determining dimensionality.

Whenever the actual determinant is zero (i.e., linear dependencies present); a corrected determinant is calculated by taking the product of the non-zero eigenvalues. The measures for the eigenvalues we computed in this study include: the minimum and maximum, variance, harmonic mean, and skewness and kurtosis about the harmonic mean (which is always 1). They are listed in Table 3. The skewness and kurtosis help characterize the distribution of the eigenvalues which are in turn sensitive to the stability dynamics (Appendix A-3). Also, for the reciprocals of the eigenvalues, the range, variance, and arithmetic mean, or one over the harmonic mean of λ, are given (Table 3). Table 4 illustrates how these measures are related to stability. Since eigenvalues are critical in measuring the system's response to perturbation, we have included many types of measures of them in the stability formulations. For our particular set of formulations, the eigenvalues have all real parts and are always positive. It should be pointed out that because of the nature of the calculation it is impossible to obtain imaginary roots; this is in contrast to a matrix of first partials where imaginary parts would be common.

TABLE 4

STABILITY CRITERIA AND THEIR VARIATION WITH INCREASED STABILITY

CRITERION	SYMBOL	CHANGE IN CRITERION AS SYSTEM BECOMES MORE STABLE
determinant	$\|A\|$	larger
eigenvalues	λ	*
variance	S^2_λ	smaller
minimum	λ_{min}	larger
range	$\lambda_{min} - \lambda_{max}$	smaller
harmonic mean	H_λ	larger
skewness	S_λ	larger
kurtosis	K_λ	larger
reciprocal eigenvalues	$^1/_\lambda$	*
variance	$S^2_{^1/_\lambda}$	smaller
maximum	$^1/\lambda_{max}$	smaller
range	$^1/\lambda_{min} - {}^1/\lambda_{max}$	smaller
arithmetic mean	$\overline{^1/\lambda}$	smaller

*Not applicable

Note that there is an analog of these stability formulations given by loop analysis (Levins, 1973; Lane and Levins, 1977) which includes qualitative information of whether a given species affects each of the other species or variables in the community, positively or negatively. Using combinatorial methods it is possible to determine the overall effects of parameter change in the system, as well as its instability as feedback measures, and complexity as connectivity computations. Also, there is a statistical interpretation of the alpha matrix in which it is treated as a covariance matrix. Eigenvalues and eigenvectors are computed as variance rather than stability measures. This particular method is called factor analysis and it is associated with the evaluation of niche dimensionality.

(ii) Some Special Considerations

- The Alpha Matrix Versus a Matrix of First Partials

The approach toward the quantification of stability in this study departs in several ways from the more traditional theory of physicists. They begin with the Jacobian matrix of first partials. Excellent discussions of formal stability theory can be found in May (1973a) and Gantmacher (1960). In niche analysis, the functional forms of the competition equations are never known and the alphas are estimated from samples. Thus, the particular way that α_{ij} is calculated in this analysis leads to peculiarities in some of the mathematical results. The community matrix based on species overlap measured as the probability of co-occurrence, is not the same as the matrix of first partials which gives conditions for stability of a system of differential equations. To obtain the latter matrix, each

row i of the alpha matrix is multiplied by r_i (D_i/K_i), where r_i is the intrinsic rate of increase of species i; D_i is its abundance and K_i is the carrying capacity for the i species. We have found, however, that the ratios of the real parts of the eigenvalues of the matrix of first partials to those of the community matrix are distributed about one with a variance,

$$S^2 = \frac{1}{n} \text{ variance } r_i \frac{D_i}{K_i} \qquad \text{(III-16)}$$

We have also found that D_i/K_i varies relatively little so that unless the r_i's are extremely uneven, the eigenvalues of the two matrices are similar (Levins, p.c.).

- Conditions and Restrictions on Stability Measurement

The logistic model, assumes that any species interaction for competitors j and i has an essentially negative effect and therefore it approximates the partial differential, $(\partial d_j / \partial d_i)$ (-1), evaluated at equilibrium. It is also similar to the correlation matrix between the p's which is approximated by May's (1973a) alpha matrix which is positive and semi-definite. (A is similar to B if $A=QBA^{-1}$ for some matrix Q, and if so, then they have the same eigenvalues. Positive semi-definite means that the eigenvalues of the matrix and its determinant are all non-negative). Vandermeer (1970, 1972b) has formulated some of the general theory of the community matrix for a community of different types of species interactions.

In the community matrix, only positive alpha values as well as positive eigenvalues are generated, since a minus one is factored from each alpha value. Because only competing species pairs are considered; the determinant can only be positive. It is a necessary but not sufficient condition that the determinant of the matrix be positive for stability. When Vandermeer (1970, 1972b) described his general results for the alpha matrices he was not aware that it was impossible to generate alpha and eigenvalues of the opposite sign using the probability of concurrence alpha. Consequently, while his theoretical developments are completely compatible with mixed predator-prey and competitor based ecosystems, his results are not as applicable to similar communities of competing species. This was later pointed out by May (1975).

In addition, no complex roots can be generated and thus no oscillatory values can be determined in these particular sets of formulations. This is not to say that oscillations do not exist in natural systems but that given this type of calculation, complex values cannot be generated. Thus, because of many of the mathematical peculiarities of the particular model being used, we cannot completely analyze the stability of a system such as one would do with a system of first partials. Nevertheless, many relative statements can be made which may be as useful and informative as those a more formal treatment would yield. Consequently, stability in our analysis must be evaluated by 1) the relative size of the determinant, (a larger determinant indicating a higher relative degree of stability than a lower value) and 2) the patterns of the eigenvalues, not by different types of roots, that is, real, complex, imaginary, positive and negative.

- Linear Dependencies

Usually, if n independent variables are used, n independent factors or trends are represented. When one variable is proportional to another or some linear combination of the other, however, it is said to be dependent. Thus, there will be fewer than n separate factors and the dependencies or redundancies that appear in the matrix will be represented by zero eigenvalues and eigenvectors so that the resultant determinant is zero. This problem severely limits our stability evaluation.

The alpha measures and the resultant stability measures generated from the alpha matrix are sensitive to instability in the data as well as the system itself. It can be shown that the number of non-zero eigenvalues, or rank, of a covariance matrix is limited not only by the number of variables (species) which is the order of the matrix, but by the number of cases (environments) for which the covariances were compared. Information is simply not available to describe more than N or more than E independent factors. Therefore, the cardinal rule of multivariate statistics is that the number of cases must be greater than, or equal to, the number of variables. Otherwise, the solution becomes a mathematical artifact, that is, dimensionality becomes a function of the number of samples rather than the number of observed variables. Also, the computations assume that E is relatively large so that 1/E vanishes. If this is not so, it cannot be corrected mathematically. In order to fully characterize the system of n variables, there must be a certain number of observations, and to characterize these observations properly, there must be a certain number of samples. The mathematics can model only the system as

observed and thus, its accuracy depends on the quality of the sampling program.

Also, because our matrix is calculated where rows and columns essentially have the same denominator and pairs of symmetric terms have the same numerator, the rows and columns are not independent. See Appendix A-3 (Enclosure 57)[1] for a discussion of the problem of linear dependencies. Some of our other alpha derivations yield independent alphas in the matrix and thus do not present the same computational difficulties that this particular type of alpha matrix exhibits.

B. STATISTICAL ANALYSIS

Statistical methods are used for hypothesis testing and for data reduction.

A statistical procedure starts with a mathematical representation for the system in question, a model, and formulates the question as an assumption, which may or may not be true, concerning the values of some parameter of the model. The hypothesis that the assumption is true is termed the null hypothese H_o and that it is not true, the alternative hypothesis H_1. There may be several alternatives. Observations of model variables from the data set and a function of the data, a statistic, is generated which estimates the parameter in question. Using assumptions about the nature of the population on which the model was based and the assumption that the data sample was randomly selected from the populations, an expected frequency

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[1]Enclosure 57. The problem of linear dependencies in the niche calculations.

distribution is derived for the statistic, given that the null hypothesis is true. The test statistic is compared with this distribution to determine the probability, called the significance level (alpha), that value of the statistic could have been found given that the null hypothesis is true (i.e., the probability of randomly drawing the given data or even more deviant data, from the population for which the null hypothesis holds). The researcher can then decide to accept or reject the null hypothesis depending on whether the calculated significance level is greater or less than predetermined cut-off value. Thus, should he reject the null hypothesis, alpha is the probability that he will reject a true hypothesis (a type I error) while if he accepts H_o, he risks accepting a false premise (type II error) with probability β which depends on the definition of the alternate hypothesis (see Sokal and Rohlf, Section 7.8).

In this report the results of a significance test are reported as the significance alpha (α_t for a t-test, α_F for an ANOVA). It is common usage to reject the null hypothesis if the significance alpha is less that or equal to 0.05 and thus, conclude that the sample was significantly different from the hypothetical population. If alpha is greater than 0.05, then the test is considered insufficient evidence to reject H_o and therefore the null hypothesis is accepted (regardless of the probability F, given that it is false).

Thus, a statistical test provides us with a probability measure of how consistent our assumptions were with the data as sampled and enables us to detect patterns and identify trends of the data in an objective manner. It cannot be taken as proof or disproof of anything about the original population nor can identify the causal mechanisms in the system which produced those trends. The worth of

the statistical test generally depends on the accuracy and lack of bias in the data and on the number of samples which are used to represent the population. Also many tests require that assumptions be made concerning the underlying probability distribution of the population sampled. When the number of a sample is small, these assumptions may not even hold approximately and particularly if the sampling was biased in any way, the statistical results can be incorrect and quite misleading.

In our study, it must be pointed out that the number of cases on which our tests were based was small and the sampling distributions of most of the niche measures are unknown. As well, most biological population data have a (inherently) high variability and are notoriously prone to bias. Therefore, it is unlikely that the probabilities computed are exact. However, it is felt that the tests still provide a valuable measure of the relative strength of certain trends and patterns in our results.

The statistical tables described herein appear in the appendices. They are presented in greater detail in regard to the intermediate calculations involved, and are provided for the convenience of the reader for further reference. Most of the important information in these tables has been summarized in tables which appear in the text for each functional group.

To analyze the community structure and stability patterns we have used a variety of statistical techniques including:

1. Coefficients of variation. This statistic evaluates the relative degree of variation in a set of numbers. This simple measure of variation was used extensively in a variety of ways throughout the study. Cut off criteria were

employed to assess the relative degree of variation but no significance levels can be attached to these results.

2. t-tests. These were used to compare the means of sets of values for the niche values calculated from by stations stratifications. Significance levels were used in conjunction with these tests.

3. ANOVA or the analysis of variance. This is another standard statistical test that was used in evaluating the sources of variation in two way data stratifications. Significance levels were used with these tests.

The following subsections will include a discussion of the statistical analyses listed above, including the purpose of the test, the equations used, significance criteria, and format and explanation of the results tables.

1. Means and Coefficients of Variation

In order to compare the consistency of niche values over a set of categories like stations or dates, the means and coefficients of variation for selected values have been calculated over all runs for a given stratification, as well as over sub-groups of runs which we wished to compare. Lane and Wright (1976, 1977) and Lane et al. (1975) discuss the need for identifying consistent patterns in community structure. The coefficient of variation is defined as the standard deviation of a set of numbers divided by the absolute value of their arithmetic mean. Given x_1, x_2,.....x_n, are n numbers, their simple or raw mean is:

$$\bar{x} = \sum_{i=1}^{n} x_i/n \qquad \text{(III-17)}$$

and their raw coefficient of variation is:

$$c_x = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}/|\bar{x}| = s_x/|\bar{x}| \qquad \text{(III-18)}$$

where s_x is the standard deviation of x. c_x is a dimensionless quantity indicating the degree of variation in a set of numbers (Sokal and Rohlf, 1969).

Niche values such as diversity, H; the community niche breadth, $\hat{B}$; or the alpha matrix determinant, $|A|$, are 'pure' numbers and only the simple or raw mean and coefficient of variation as described above were calculated. Niche values such as $\bar{B}_i$ and $\bar{D}_i$ and measures derived from them, however, are means over species within the given category and, thus, these means have an associated coefficient of variation over species. For these measures, mean coefficient of variation, and its coefficient of variation are calculated. Given x_1, x_2, ... x_n are n means, for example, $\bar{B}_i$ for n stations or n dates, each over n_1, n_2 ...n_n elements, (in this case, the number of species for each of the n stations or n dates), and also given that c_1, c_2, ... c_n are coefficients of variation for each x_i, the mean value of coefficients of variation is:

$$\bar{C} = \sum_{i=1}^{n} c_i/n \qquad \text{(III-19)}$$

where

$$c_i = s_{x_i}/|\bar{x}_i| \qquad \text{(III-20)}$$

and s_{x_i} is the standard deviation of each $\bar{X}_1$, again with a Gaussian correction. The coefficient of variation of the mean of the coefficients of variation is:

$$C_c = \frac{1}{n-1} \sum_{i=1}^{n} (c_i - c)^2 / \bar{c} \qquad \text{(III-21)}$$

Also given for these measures is the pooled mean and coefficient of variation. This is the mean of means, that is, the mean over species and categories without regard to grouping, and it is calculated by weighting the simple mean by the number of species in each category. Similarly, the pooled coefficient of variation is calculated over all the values within all of the categories as though there were no categories. For the same numbers as in equations III-14, III-20 and III-21 the weighted or pooled mean is:

$$\bar{\bar{X}} = \sum_{i=1}^{n} n_i \bar{x}_i / N \qquad \text{(III-22)}$$

where,

$$N = \sum_{i=1}^{n} n_i \qquad \text{(III-23)}$$

and the pooled coefficient of variation is,

$$C = \frac{N}{N-n} \left(\sum_{i=1}^{n} [N_i (\sigma_{x_i}^2 + \bar{x}_i^2)/N - \bar{\bar{x}}^2] / \bar{\bar{x}} \right) \qquad \text{(III-24)}$$

where

$$\sigma_{x_i}^2 = (c_i \mid \bar{x}_i \mid)^2 \quad \frac{n_i - 1}{n_i} \qquad \text{(III-25)}$$

Therefore, in summary, the raw coefficient of variation measures the variation because of the category factor, for example, differences in stations, while the mean coefficient of variation indicates the average variation within a category among species. The pooled coefficient of variation indicates the total variation because of both the within and among category factors.

There is no one best criterion that can be applied to evaluate the values of the coefficients of variation. For practical purposes, in the present report, we have usually chosen a 0.5 cut-off point as separating essentially non-varying from varying parameters with values greater than 1.0 indicating highly variable results. Occasionally for sets of values that do not vary much, we have selected a cut-off point of 0.3. In the 1973 LMS report on Roseton-Danskammer, the criterion of the coefficient of variation being greater than one was also used to determine highly variable parameters. While this is a purely-arbitrary cut-off and cannot be associated with any statistical levels of confidence, it illustrates how the coefficient of variation can be used to compare variation among different parameters which would otherwise have different scales of measurement.

2. t-tests

a. Explanation of the t-tests

The t-test is commonly used to test the null hypothesis, among others, that two population means are equal versus the alternative (for the two-tailed test), that they are unequal (Sokal and Rohlf, 1969). The significance alpha is the probability that a difference as large or larger than that oberved would occur, given that there was no difference in the means. Thus, a low α_t is an indication of a difference between the two, based on their sample variances. The version used here was an approximate test for two means from small samples whose variances are unequal (Satterthwaite, 1946). It assumes only that the samples were drawn randomly and that parent populations were distributed close enough to normality, or that the sample sizes were large enough so that the distribution of the sample means is normal (Sokal and Rohlf, 1969). Also used was a version to test a mean against a single observation (the observation is treated as having a sample variance equal to that of the mean and a sample size of one) giving the probability that the observation was drawn from a population with the given mean (Sokal and Rohlf, 1969).

We have used these two t-tests to compare, for each niche measure, the mean of the control station values with that of the experimental group and also with each individual experimental station value. The control stations, then, can be taken to represent ambient river conditions whose variation is accepted as within natural limits. The tests point out where the experimental stations as a group or individually, deviate from the control station values.

3. Analysis of Variance (ANOVA)

The principle of the t-test can be generalized to testing several groups of values for equality of their means. For instance, if we have several values for each of a given set of dates, we can use the variance of the values from each date as an estimate of the natural variability of sample values, and with this, test the differences between date means to see if they are all approximately equal, that is, from the same population.

The null hypothesis is, then, that the means of the populations from which our groups were sampled are equal, versus the alternative that at least one is not. The test statistic, F, is the ratio of the variation among the sample means, to the weighted average of the sample variances within the groups. This is compared with the F distribution for the appropriate degrees of freedom in a one-tailed test. The resulting alpha has the same interpretation as in the t-test.

We have applied the ANOVA test to two way stratifications, such as a set of values for each of several depths on each of several dates. The variance over depth can be used as an error variance to test the means over date or vice versa. Thus, we have taken one factor (say depth) as replication in a one-way ANOVA over the other factor (say date) and then reversed the procedure doing a one-way ANOVA over the first factor using the second as replicates. Since these are not really replicates (not having been taken under the same conditions) this test must be conservative as both interaction and the other factor are included in the error variance.

Because there are only a small number of cells, each with no replications (so that the error variance cannot be calculated directly) and since the two factors involved are likely to interact, it was

felt that the two-way ANOVA procedures would not give useful results. However, in the event that the replicate factor in a one-way ANOVA shows significant variation, the resulting F will be non-centrally distributed and the probability calculation will be incorrect. Therefore, the second ANOVA should be used to check the validity of the first and vice versa. The column alpha should be taken literally only if the row alpha is not significant and so on. If both alphas are significant then neither procedure would be valid since it is unlikely that there are any consistent patterns to be found.

4. Data Handling and Analysis

In this study, the four communities: phytoplankton, rotifers, fish larvae and adult fish were sampled within the period of May to December, 1973. The sampling programs were generally different for the various communities, however, they were most similar in terms of sampling stations and dates for the two plankton communities. Because these data were not originally collected for niche analysis, much preliminary work was needed to prepare the data. Several data points were not usable for a variety of reasons and in many instances we wished more data were available for particular stratifications. For a complete discussion of the data collection program refer to LMS Report to CHG&E (1974). We include a brief discussion of the sampling plan for each subcommunity in the introductions to their respective results sections (A, B,=phytoplankton, C=rotifers, D= fish larvae and E = adult fish). In section, IV A. we give a more detailed discussion of how this information is to be presented in this report.

The foregoing represents an overview of how the raw data was taken, organized, selected and prepared for the computer. This was accomplished by preparation of seven tables for each of the four functional groups (B-1-7, C-1-7, D-1-7 and E-1-7). The appropriate table number is given where it applies in the discussion below.

a. Sampling Program Description

In order to prepare the data for analysis, it is necessary to have a complete and detailed description of the design of the sampling program. The description of the sampling program includes an enumeration of all the parameters which define all of the available data. These parameters include: 1) a list of the sampling locations used (given as Table 1 in each appendix results section) along with the associated geographical-physical-chemical information; 2) a list of all the dates on which sampling was carried out, (on Table 2), 3) a list of all the species that occur in the data with information on size, trophic class as well as any other relevant ecological information (Table 3) and 4) any other factors which can be used to classify these data. The next requirement is a description of the results of the sampling program, that is, a listing of every sample that was taken indicating where and when each was collected. Any other identifying information (day or night, sampling device used, etc.) and any pertinent comments on the success of the sampling (sample empty or decayed, etc.) are recorded. Note this is not a complete listing of the data with the results of each sample, but merely an indication of which samples were taken, how many good samples there are, and how many missing cases there are. This is also given on the second table in each appendix section.

Preliminary analysis of the data should include a table showing the number of samples in which each species was found, that is, the frequency of occurrence, preferably subdivided according to each of the classifying criteria used (Table 4 of each appendix). This will show which species were dominant and which were capricious as well as giving a vague idea of the content of the data. It may be useful, in fact, to perform statistical tests

such as ANOVA or χ^2 on the raw densities to point out interesting trends which may be followed up in niche analysis. This was done at Dalhousie for rotifers and phytoplankton, using a computer statistical package (although the results are not directly presented) and by LMS for all functional groups. This analysis constituted the bulk of the result generation effort in the report on the 1973 Roseton-Danskammer data.

b. Stratification of the Data

The sampling program has been designed, ostensibly, so that the locations sampled are representative of the effects of several factors of interest in regard to the biological communities. Samples can be taken and classified according to these factors or criteria in order to demonstrate their relationship to the community patterns existing in the data. These factors are termed the parameters of the sampling design and become the criteria of the analysis. For instance, in order to investigate seasonal patterns, samples are taken at various times throughout the year and date becomes the criterion. In order to test the effect of the thermal plume produced by the Danskammer power plant, there were several sampling stations both in and out of the plume. For each criterion, the data have two or more classifications or treatments which were samples, and these are termed categories, for example, each sampling date for the date criterion, or each sampling location for the station criterion.

In order to analyze the differences in community structure associated with a given criterion the data are stratified by that criterion. For each category, the niche values are calculated individually for the data falling under that classification with all values from the other criteria. These niche values are compared with each other and with the niche values

using all of the data together, as well as for any desired groupings of categories. For stratification by stations, the analysis would be run on the data for each category (that is each station) to describe the community structure separately at each station over all sampling dates, etc. Additional runs are made using data from groups of categories for the overall community structure patterns, for example, over all of the control stations out of the plume area and overall of the experimental stations in the plume. Each of these evaluations of niche values on a different data subset is termed a run. All of the runs make a stratification by criterion, and there is a run for each separate category in the data as well as for grouping of categories. The 'all categories' group is run in all cases and sometimes with other groupings for comparison.

For station stratifications, local and global communities are differentiated based only on the available data used in this study. For the purposes of this study local community stratifications involve only one station while global communities are based on data stratifications involving two or more stations. See May (1975) for the theoretical basis of this distinction. The available data set did not permit us to define these terms more rigorously.

With the information from part C-1 on sampling program, it is possible to consider the structure of the data as a whole and decide on a set of criteria of interest to be used in stratifying the data, for example, station, date, time, depth and species. It is necessary to insure that there is enough data for each category or cell of the stratification to adequately characterize it. Also, to avoid problems involving sampling theory which is not yet completely formulated for niche analysis, one should try to make the number of environments or cases in

each category approximately the same and as unbiased as possible. This also applies to the number of species. Therefore, it is necessary to select a subset of the available data points enumerated in Table 2 of the Appendices which is as regular as possible, according to the stratifying (including species) criteria. Because the 1973 Roseton-Danskammer sampling program was not designed with this analysis in mind, many of the data are irregular and the selection of a usable data set discards a large proportion of the data that was orginally available.

(i) Selection of the Environments Sampled[1]

The classification structure of our working set of data is called the statistical "frame" and is presented in Table 5 of each appendix section, and summarized in Table 7 (appendix). Table 5 indicates the criteria that we have decided are of interest for stratification, and the number of samples in each category; as well as whether the sample is present and usable or missing and unusable for each cell of the design.

(ii) Selection of the Species and Species Ranking[1]

The species are selected or ranked for two reasons. Not only is it necessary to omit rare species to obtain a relatively regular data set, but the number of species must be decreased to a number which can be adequately described and differentiated by the set of working data. This involves selecting the dominant species of a community through ranking of species by ecological importance. Niche analysis cannot be effective with data included on species which

[1] See also sources or error, section V C.

occurred too infrequently or too erratically for the sampling performed to give an accurate idea of their distribution. It is important to insure that, first, what is labeled as a different species, taxonomically or by any other criterion, is really ecologically different from the other community members, and second, that there is enough data to characterize these differences. Mathematically there must be at least as many environments sampled as species considered. Environments are termed cases and species are termed variables in statistical terminology (see Appendix A-3, enclosure #57[2]). Thus, not all species that are sampled for a given community are used in the analysis and the ranking criteria that are used will vary with the community and environment under consideration, as well as the overall sampling design.

The level of taxonomic expertise applied to the samples is of great importance in determining how finely they are to be subdivided. The phytoplankton species in this study were enumerated to a relatively high degree of taxonomic expertise and thus 115 species were identified. Some of these species were very closely related, and others were seen only once. Therefore, this data set was plagued by both complex linear dependencies or near dependencies and by spurious data to the extent that for the runs using all species (unranked) any meaningful patterns were obscured by the noise.

Therefore, for some data sets, in order to obtain a good environment to species ratio, the dominant species in each competing group must be selected. A dominant species,

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[2]Enclosure 57. The problem of linear dependencies in the niche calculations.

however, is not easily defined. By dominant species we mean most prevalant, or common species, and unfortunately there is more than one possible criteria for being the most prevalant. The two criteria we used are:

1) comparing the frequency of occurrence, or the number of environments in which a given species occurred at least once, or by

2) comparing total densities or relative abundances, that is, the total density of a species over all species expressed as a percentage.

This duality in criteria is necessary because the appearance in samples of a zero value or a non-occurrence can be ecologically equivalent to a low density value. Since zero densities, which are in a sense, missing data, are detrimental to the analysis, and since they are rare, in the sense that sparse or low density species can be quite important to the structure of the community, frequency is probably the more important determinant in ordering the species by importance. Frequency can be influenced by many aspects of a species' biology, such as habitat preference, seasonality, etc., which generally affect relative abundance patterns less, although both factors should be considered simultaneously along with any biological peculiarities that are known to exist. Frequencies can also be easily calculated with various groupings of environments, such as number of dates or stations, to study particular patterns in the data.

Since frequency of occurrence is the best single indicator of species dominance; it is computed for each species in

each community; for all the available data and not just the working subset. In this report, we have subdivided the frequency results into as many substratifications (that is station, date) as possible in order to improve our decision making ability on species selection. The selected species are given, in order of frequency, along with percent relative abundance or density of each species in the working data (Appendices Table 6).

c. Computer Codes and Runs

The last step in the data processing is to formulate a coding scheme for the data to put them in a form suitable for computer analysis, and to determine the various computer runs required for the desired stratifications. This is outlined in Table 7 of every appendix section. The first page (of Table 7) lists the computer codes used for all the included categories. The computer program for niche analysis requires that the density of each species in each environment be placed on a separate input record along with the information identifying the species and environment. This information is in the form of code numbers, each representing a particular species, station, or date. The species code is generally a letter indicating functional group with two digits for species. This corresponds exactly to the actual species name which is also given to the program. The environment codes are frame numbers; that is, since a sampling profile can take several hours to collect, any sampling time in a several hour range will be considered to be in one time frame. Depth may have been sampled in approximate intervals such as 0, 10, 20 ft, and so on, for which sequential numbers must be assigned respectively, as 1, 2, 3. In most cases, the time frames and depth frames were very broad: day/night, surface/bottom. The actual values corresponding to the codes were usually put on the end of the card for visual identification.

At most, four environmental criteria were used; station, date, time frame and depth frame. Code numbers are listed for those stations, data, etc., that were used in the analysis. The current niche program only recognizes two stratifying parameters, time and depth, so, when necessary, the digit for time of day is followed by the digit for data. This is read as one time code. The digit for depth followed by the digit for station is read as a location code referred to in the outputs as depth. This also affects the interpretation of the diversity values $\bar{H}_t$ and $\bar{H}_d$. The list of codes is given in this report and it constitutes a final summary of the structure of the data set, that is, all the stratifying criteria on each category of a given criterion. On the bottom half of page 1 of each appendix Table 7 there is a list of the data card columns used for each piece of information, for use with the raw data listing in the outputs.

The remaining pages of each Table 7 list the stratification run and cross-reference these to the niche tables. For each stratification, for instance by station, a line is given for each category which corresponds to a separate subset of the data as a run of the niche program, and a column on a niche table. In some case, where a functional group is stratified over a trophic group, all are placed on the same line for that set of environments. Thus, for a stratification by station, there would be a listing for each station, and each group of stations that we wish to compare, including one for all stations run together. Note that all stations cover the same data as all dates, all depths, etc; so that these columns on the niche values tables are identical. Each line gives the category or group of categories to which it applies, and the number of environments that were selected, that is, the number of cases in the data subset over which the analysis was run, along with the location in the

niche tables of the results of this run. For example, a location given in the following format: Table B8-2. corresponds to phytoplankton stratified by stations, run over all stations and all taxonomic groups. The niche values for the subset of data can be found in Appendix B, Table 8, column 2; the latter designation refers to the small column numbers printed across the top of the page. In the case of a two page table, a subscript is used, so $C17_2$-10 refers to Appendix C, Table 17, page 2, column 10.

After the niche stratification information is a listing of the means and coefficients of variation that were run. In general, there is a set of coefficients calculated over each group of categories that niche values were computed for, including over all categories. For instance, phytoplankton by station were summed over control station, 1 to 5; over experimental stations, 6 and 7; and then over all station together, 1 to 7. For each set of runs analyzed, the number of runs or categories over which the mean was summed is given as well as the table and column where it is to be found.

The last stratification in each functional group is two-way, over two criteria at once, such as over time and depth for all dates and stations. This allows an ANOVA to be performed which indicates interaction effects from both time and depth. A table is presented giving the number of categories falling under both classifications, with its niche table location. Also for each combination of categories or cell, for example, each time-depth, as well as for groupings of one, or the other, or both criteria, that is, each depth for all times, each time for all depths, all times and depths are listed. Note these groups are usually presented as simple categories on other tables but are repeated here for comparison. Beside each of these in the table there is

generally an entry indicating means and coefficients of variation calculated over the categories included by the group. Thus, a row of the table might read: niche values for depth 1 (over all times), niche values for depth 1 and time 1, niche values for depth 1 and time 2, and, niche values for depth 1 and time n, and on the end, means and coefficients of variation over the n times for depth 1. There are also coefficients of variation calculated over all cells, for both factors.

SECTION IV

RESULTS

IV. RESULTS

A. INTRODUCTION - Organization of Subsequent Discussion for Each Community

The discussions of the results for all four functional groups or natural communities are organized by the same format to facilitate the reader's understanding of a rather large number of tables and results (Table 5). The general pattern of discussion of the results contains three sections for each community. The first section consists of an introduction which includes three subsections:

1. the sampling program and selection of stations,
2. the species and their trophic characterization,
3. stratification of the data for niche analysis by station, season (date), time of day, depth, and species.

In the second section, the data is discussed in the order it was stratified, that is, by station, season (date), time of day, depth and species group. The number and type of data stratifications that were conducted is a function of the community type, as well as the amount and design of the available data set. Thus, some of the functional groups were represented by more data points and consequently it was possible to stratify their data sets in more ways than for some of the other groups. As we have repeatedly emphasized in this report, these data were not orginally collected for this analysis and this, has resulted in many inconsistencies and difficulties in the report.

Appendix Table 1 through 7 of each section for each functional group are of the same form throughout and are explained in detail in an

Table 5: Organization of the results and the appendix data tables.

I. Appendix VII Subdivisions

B. Phytoplankton Community
C. Rotifer Community
D. Fish Larvae Community
E. Adult Fish Community

II. Organization of Appendix Tables

(Introductory Section for VII B, C, D or E)

Topic discussed	Table #	Table Title
Total Data Available		
1. the sampling program and selection of stations	#1	Station characteristics
	#2	Sampling schedule
2. the species, their trophic-characterization and frequency	#3	List of species and trophic preferences
	#4	Species frequency table
Data Used in Analysis		
3. stratification of the data for niche analysis	#5	Data frame
	#6	Summary of species frequencies
	#7	Summary of computer runs, coding and data stratifications

(Middle Section for VII B, C, D or E)

4-5. results by data stratification (description of community pattern, partial critique of sampling design and resultant data stratification, species dominants)	#8-X	Table of niche values alternating with their associated table of coefficients of variation followed by species dominants tables by functional groups

(Final Section for VII B, C, D or E)

4-5. summary of results and comparison of niche values	X-X+2	Summary results-tables of statistical tests (summary of coefficients of variation, t-tests, and ANOVA.

introduction to those tables, and where they first occur (for phytoplankton, in Section IV B.). The rest of the tables are particular in form to the group and sampling program they refer to and are explained as they occur in each section.

The niche tables are difficult to summarize in a few words because of the sheer number of values each table possesses. Thus, we have chosen to briefly discuss each table with its associated coefficients of the variation when they occur. The purposes of this portion of the results section are:

1. to describe the patterns of community structure and stability that can be demonstrated for the particular data stratification
2. to test the regularity of the values
3. to point out interesting and/or aberrant values, and
4. to make some general observations about the particular data stratifications that were used. For example, often a given control or experimental station was not wisely chosen in the original sampling plan.

The middle section contains a description of the individual trends for species in regard to some of the more important niche values.

The final or third portion of the results section for each community consists of a discussion of some statistical tests of the observed community patterns, especially in regard to the comparison of niche values from various data stratifications. This section has been difficult to generate and does not represent the best possible results that we feel we could accomplish if we had more time to develop the sampling theory of niche analysis and the related significance tests.

For each functional group, the discussion of the results follows the ordering of the tables which is also similar for all communities. Any difference in the ordering which do appear are a result of either unique ecological attributes of a given functional group or because of peculiarities in the sampling design of the data collection program.

The data tables for each functional group are contained in a set of appendices:

Appendix B includes phytoplankton results,

Appendix C includes rotifer results,

Appendix D includes fish larvae results, and

Appendix E includes adult fish results.

At the beginning of appendices B, C, D, and E, Tables 1-7 contain the information that is discussed in the introductory section. As shown in Table 9, and discussed in Section III C, the first two appendix tables illustrate the stations and overall sampling schedule. Thus, this section describes the initial data set. For a variety of reasons, such as irregularity of sampling or lost samples, certain data could not be used from a given data set. In the next subsection, the species and their frequencies are described in terms of station and date. This information was compiled not only to determine which species should be considered as community members, but also to determine which data should be used and how they were to be stratified.

In the last section of the first portion of results, the data frame or table of data used is described. Based on this reduced data set,

the final list of species was chosen and their frequencies and relative abundances were determined (Tables B-6, C-6, D-6, and E-6). The computer codes and array of data stratifications actually employed are summarized in Tables B-7, C-7, D-7, and E-7.

Thus, the reader should remember that for each functional group, sections 1 and 2 discuss the total data and species available and section 3 illustrates the actual data and species used in generating the community structure and stability values. The step 2 to 3 is not an easy one and there are few precedents or guidelines for many of our choices. We were continually plagued by too much or too little data since the samples were not collected and analyzed for this type of community analysis. Obviously, we want to select the portions of ecological space and time that are meaningful for each species group. What these are and how they can be rigorously defined is a problem that does not have an obvious solution; it has troubled ecologists for several decades. Arriving at step 3 actually took more effort, than did the generation of the niche tables. We consider our data stratifications to represent an experimental procedure and not to represent firm rules or even a pattern for applying niche analysis to aquatic ecosystems. The best guideline we can offer at the present time is a pragmatic one. If a given data stratification tells us anything new or interesting about a natural community that enhances our understanding of the system under study, then its' creation has been worthwhile.

The data tables which follow the introductory Tables 1-7 are straightforward. The niche tables include the values of community structure and stability and their format was discussed in Section III. Each niche table is followed by a table of coefficients of variation for selected niche measures which facilitate the indentification of regularity and hence, pattern in community structure.

The data stratifications are grouped (for convenience) in the following order: by station, season, time of day, and depth. In a few cases, there was enough data to run a two-way stratification, for example, by depth and time of day. Following the community niche tables are tables of the niche values of dominant species using a reduced number of niche measures. These tables are followed by a set of statistical tables that were designed to measure, compare and test the patterns. The statistical tables were generated in the following order: 1) ANOVA, 2) t-tests, and 3) summary of means and coefficients of variation.

This general outline of results is repeated for each of the four major functional groups that have been analyzed in this study. The four groups have been further subdivided into these subcommunities:

Group designation		
B. Phytoplankton	- 1.	all common species
	- 2.	common blue-green species
	- 3.	common green species
	- 4.	common diatom species
	- 5.	all common species by size
	- 6.	all common large species
	- 7.	all common medium species
	- 8.	all common small species
C. Rotifers	- 9.	all species
D. Fish larvae	- 10.	all species
E. Adult fish	- 11.	all species
	- 12.	pelagic species
	- 13.	benthic-inshore species

The presentation of the results and the data tables follow the ordering of the subcommunities. Tables 1-7 are generated only for the major groups B, C, D, and E with the exception that additional information on data preparation is given for the phytoplankton by biovolume (Table B-27).

B. PHYTOPLANKTON COMMUNITY

1. The Sampling Program and Selection of Stations (B-1 and B-2)

The phytoplankton and zooplankton sampling programs for Roseton/ Danskammer area for 1973 were carried out concurrently between May and December. Plankton dynamics were discussed in Chapter III of the 1973 CHG&E Report and the data are listed in Appendices III-A and B of that report for phytoplankton and microzooplankton respectively.

The phytoplankton (algae) were sampled from the surface at a depth of 12 to 18 inches. The collections were performed using a 900 milliliter Van Dorn bottle. Two samples were taken, preserved with 2-4% formalin and (unfortunately) mixed together. In addition, a net sample was taken by passing 18.9 liters (5 gallons) of surface water through and 18μ Wisconsin-type plankton net. A filtrate sample of 900 milliliters of water from the net was collected for nannoplankton (QLM 1973). Our analysis did not use either of these last two sets of samples, only the first described whole-water samples.

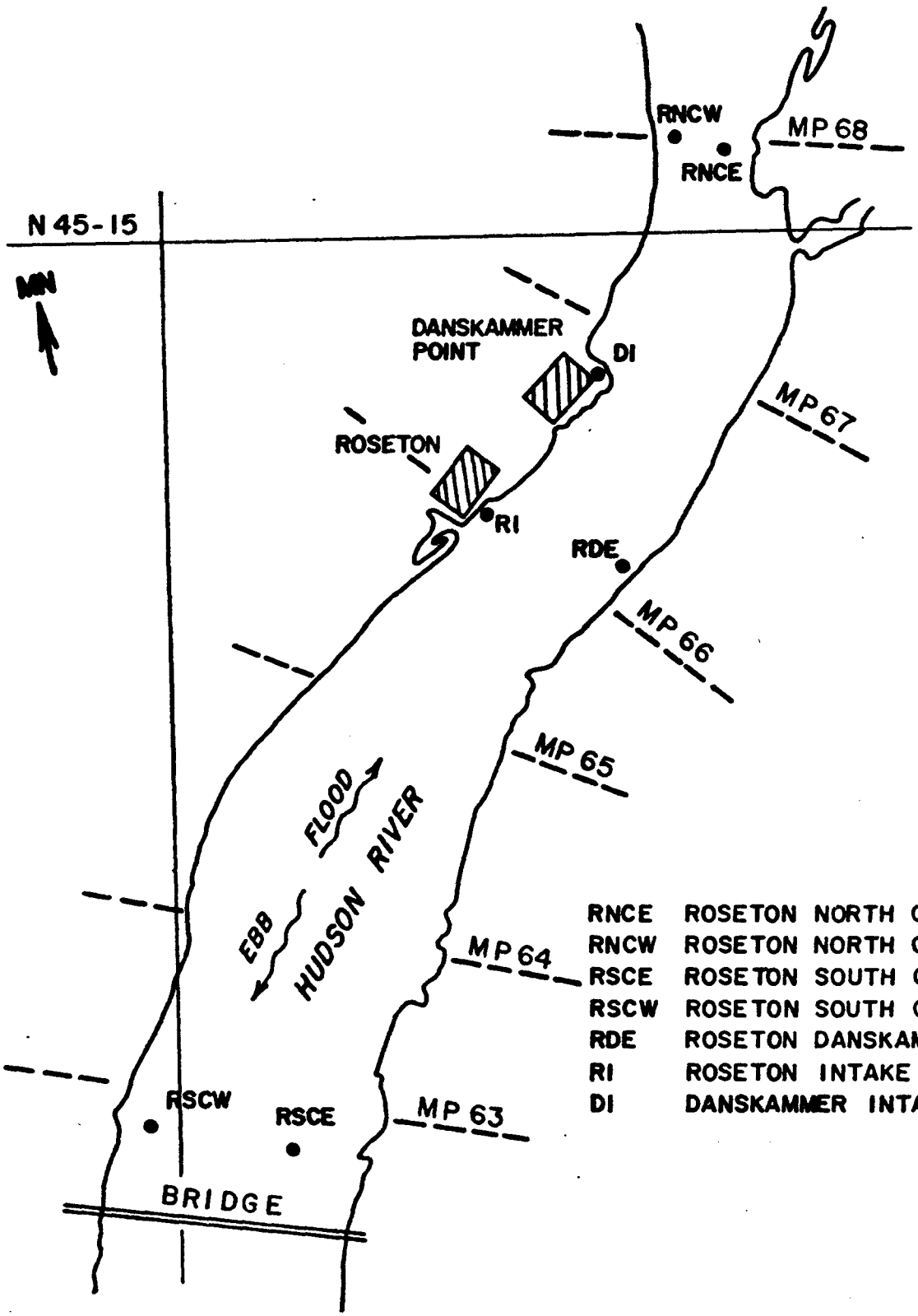
The algae were counted in a Palmer cell at 200 x magnification, using three aliquots of the concentrated field sample. Each count was duplicated (QLM 1973). Counts were done by both cell and 'clump' (colonies, filaments, or any other aggregates) and converted

to cells/liter and organisms/liter. Only the counts in cells/liter and estimates of the number of cells/organism for each species were used in this study. All phytoplankton were identified to species using detailed taxonomy. In the enumeration results, the species were grouped under the taxonomic headings: blue-greens, greens, diatoms, euglenoids, and others.

Sampling was carried out once a month from May to December for a total of eight dates. Whole water samples were not taken the first time, however, so there are only seven dates in the available data set. Seven stations were used as shown on Figure 7 and in appendix Table B-1. The latter table shows the station name, abbreviation, computer code number, and location information of the station, including river mile point, and T. These final values give an indication of whether a station was in the average thermal plume area (based on QLM, 1969), and if so, to what extent it was influenced. Chemical-physical data are given as ranges within each season, and are taken from the surface samples of the nearest water-quality station. The exception is the column for temperature, which was taken simultaneously with the plankton samples and is given in degrees centrigrade.

The stations sampled were RNCE, Roseton North Control East; RNCW, Roseton North Control West; RSCE, Roseton South Control East; RSCW, Roseton South Control West; RDE, Roseton/Danskammer East; RI, Roseton Intake; and DI, Danskammer Intake. The first two were about one mile north of the plant area off New Hamburg while the two south controls were aproximately three miles south of the power plants and just north of the Newburg-Beacon bridge. These four stations were chosen as controls because they were judged to be relatively unaffected by the power plants and typically representative of the river. They are all in fairly shallow water although the south

Figure 7. Map of Hudson River at Roseton and Danskammer Point Generating Stations illustrating the location of plankton sampling stations in 1973



controls are considerably further out from shore than the north controls. The water quality data were taken for both east and west stations from the two-mid-channel stations, CH-1 and CH-6, for north and south respectively. The next station, RDE, was taken between the two plants and across from them on the east side of the river. Because it was not in the thermal plume it was included as a control station (making a total of five control stations). The results show, however, that this was a mistake, because this station was not typical of the other 'normal' river stations. RI and DI samples were taken some distance off the respective plant intakes and are the only two stations located within the plume. They were classed as experimental stations in the analysis. Sampling at DI was only begun in September so that there are only four sample dates for it.

The temperature was even across stations, remaining between 22 C and 27 C throughout the summer (June to September), then declining to 5 C in December. Several of the other physical-chemical changes were related to the salinity fluctuations. This parameter peaked in late October. It is likely, however, that on October 18 the south controls were the only stations with over $0.100^{o}/oo$ salinity.

Table B-2 lists the samples which were taken during this program. Of the 49 possible samples for seven stations and seven dates, there were seven missing, all but one were from the experimental stations. The remaining 42 samples constituted an extremely sparse data set. While this data may be enough to illustrate major seasonal trends and station patterns, these 42 cases cannot characterize the distribution of the large number of species involved, and uniquely determine the interactions among them. Also, in order to perform meaningful statistical analysis, that is, to assign a significance probability to the observed differences and detect dependence or

interaction among factors, it is necessary to quantity natural variation in population densities. Therefore, replicate samples were required but not taken.

The 42 samples were collected from the surface during the day, and therefore, represented only portions of the plankton community and its environment. This again indicates that the sampling program was inadequate and the samples biased for niche analysis. Two of the most important factors to phytoplankton (light and temperature) undergo large fluctuations in nature. Therefore, in order to obtain an accurate representation of the plankton community, it is necessary to sample several dates across both time and space. The stations were adequately chosen, although the experimental stations might have been more effective if they had been closer to shore and the plume. The control stations should not have included station RDE.

Other data that would prove useful if collected include parameters as temperature, light, dissolved oxygen, and salinity, and perhaps for phytoplankton: nitrogen, silica and phosphorus, taken in situ with the plankton sample or at least at the same station.

2. The Species and Their Trophic Characterization (B-3 to B-4)

The species list (see Table B-3) contains 153 taxa (usually species), consisting of 23 bluegreens, 51 greens, 36 diatoms, 1 euglenoid and 4 others as well as 38 taxa listed but not found in the 1973 whole-water samples. This detailed taxonomy was detrimental to this analysis, as the data were too sparse for so many species. The phytoplankton were first analyzed by density in units of cells/liter and stratified across taxonomic group. The three groups: blue-greens, greens, and diatoms were used as trophic classes, on this case, because of their different sets of ecological adaptations.

The analysis was also performed using biovolume values for the phytoplankton with data stratifications across size class. The total plasma volume per liter for each species in a sample, was used as a measure of algae abundance, by taking the cell counts and multiplying them by the volume/cell for each species, as listed on Table B-3. These figures were obtained by LMS from actual measurement as well as from the literature. The size classes were grouped according to the total volume per organism. Organism here refers to a cell for unicellular algae, or a colony for colonial or filamentous algae. Values were obtained from the volume/cell and estimated mean number of cells per organism, for each species. They were grouped as follows: under 2,000 m^3 were termed small; between 2,000-10,000 m^3 were termed medium; and greater than 10,000 m^3 were termed large. With these ranges, approximately 30 species were grouped into each category. An important mistake was made, however, in assigning too low a number of cells for Oscillatoria sp. which generally occurs in very long chains. Thus, this species was grouped with small taxa, but should have been included with the large ones.

The carbon content of each species is listed in Table B-3 and was calculated using Strathman's (1967) equations:

$$C = (0.866)\ V^{(0.758)} \text{ for diatoms, and} \qquad \text{(IV-1)}$$

$$C = (0.347)\ V^{(0.378)} \text{ for nondiatoms,} \qquad \text{(IV-2)}$$

where V is biovolume and C is the corresponding carbon content estimate. Table B-4 gives the frequency of occurence for all species by station.

3. Stratification of Data for Niche Analysis (B-5 to B-7)

The final data frame for the phytoplankton is given in Table B-5. When available, cases were used and there were seven dates for each station and seven stations for each date. The first date, however, had only three stations and the last stations only four dates. It would have been desirable to discard these irregular samples but that would have resulted in only one experimental station to be considered, therefore, this was not done.

There were over 100 species originally identified; too large a number for this analysis considering the limitations of the data set. Therefore, about six dominant species from each taxonomic group were selected to improve the data characterization for each sub-community. The species were chosen as follows; the 115 algal species were ranked by frequency to a cutoff value of less than 75% occurrence in all environments. The remaining species were then chosen according to relative abundance criteria. This method will therefore select 1) the most frequent species, almost always those that are found in more than 3/4 of the samples, and 2) the most abundant species, usually those possessing at least 5% of the total algal community density. In addition, there were minimum criteria for the species before it was included in the analysis. These were 1) occurrence in at least 10% of the environments, and 2) a relative abundance of 0.5% of the total community density or greater.

The values generated are listed on Table B-6 with the relative abundance (percent density) and frequency of occurrence. Also listed are the number of dates and the number of stations at which each species occurred.

With phytoplankton, one species then replaces another in the community structure and therefore changes the ranking of the dominant

species. For this reason, and because of the different number of cases, the ranking procedure was repeated for each station. The results are listed at the end of Table B-6, check marks on the right indicating those species that were used for the run for that station. All of the species in the far left column were used for all, control, and experimental stations, as well as in the two-way stratifications. The second page of Table B-6 is a matrix of percentages of algal groups in each and all environments. In other words, for a given station and date, the percentages or total densities for bluegreens, greens, and diatoms, are given in each matrix. The percentages are also given for each date, each station, and for all of the data. Note particularly how the proportion of bluegreens decreases in RDE while greens and diatoms both increase.

Table B-27 repeats Table B-6 for the phytoplankton by biovolume runs, giving the six species used in each size group. The percentage matrix was of limited usefulness and the large group constituted the dominants.

The stratifications used for phytoplankton densities by taxonomic group are listed on Table B-7. First, a by-stations stratification with all, versus control, versus experimental comparisons, as well as versus individual station, is given. Second, a two-way stratification between groups of dates, summer versus fall, and groups of stations (all, versus control, versus experimental) is presented. This will generate a run for each combination of groups. For biovolumes, this two-way stratification was repeated by date and station, with the addition of all-dates. There was no by-stations stratification done for biovolumes nor a by-dates stratification for either densities or biovolume values.

4. Results by Density and Functional Group

a. Stratification by Station Tables (B-8 to B-15)

In the first portion of phytoplankton results, the data stratifications by functional groups (all groups, bluegreen, diatom, and green species) are given by station (all, control, and experimental stations as well as the seven individual stations). Thus, there are 10 columns to be considered for each of the four species groups (Table B-8). For each station only the most common species were used, depending on the number of environments in the available data set for that station. For all stations this constitutes a total number of 22. The total number of environments is 42. The Danskammer intake station was represented by the least number of samples because fewer samples were collected or counted at this particular station.

Thus, we are analyzing only a subset of the community for which there was adequate data. For phytoplankton, the size of the subset was determined more by the number of samples taken than the number of species present. This caused limitations in the stability analysis since the distribution of each species in each environment had to be adequately characterized. Presence or absence is not an adequate indicator of community structure, nor is total density over all environments. Thus, the number of species could not exceed the number of samples available and still yield reliable results. This criterion was exceeded when all species groups were considered together and, while corrections and adjustments were made, comparisons could not be made for the stability measures for separate groups. In general, the implications are that differences due to the (bonified) rare species in the pure measures ($\hat{B}$ as opposed to $\hat{B}/E$) are negligible but for particular phytoplankton stratifications there may

be biased estimations of some of the other measures. For instance, the diversity measures are lower than what they should be and, yet, the phytoplankton assemblage is undoubtably the most diverse group of all. Time and financial considerations prevented us from quantifying the roles of species numbers and their evenness. Thus, while certain comparisons can be made within the phytoplankton group, there should be some care taken in relating them to other groups.

It was difficult to analyze the differences which did occur in the phytoplankton community since missing samples particularly affected station DI (43% missing). Because the samples missed were all from the first half of the year and mostly from an experimental station, considerable bias was introduced which could have affected the measures in indirect ways. For instance, since the first half of the year was not sampled at DI, species which might have bloomed or peaked in this time appeared to be much rarer at this station than they really were. Therefore, within station diversity often decreased while the among station diversity always decreased because there were fewer stations. Since the few dominant species were not affected as much as the others, the dominants kept the means over species niche values higher, such as $\overline{B}/B$ and $\overline{D_i/K_i}$, and in fact, increased these values at the experimental stations while B/E and $\overline{\%K_i}$ decreased.

Table B-6 shows that the dominant group was the bluegreens (75% of all data), which dominated at all stations from August to November except for a decrease to 59% over all dates at station RDE. At this station, there was an increase in greens to 30% (its maximum value) in August and September. Diatoms dominated evenly across stations (at 60%) for the first two and the last dates of the year.

Oscillatoria sp., a filamentous blue-green, was the most abundant species, and it tended to dominate the community structure results for several of the various types of data stratification considered (Table B-8). In fact, most of the species listed as dominants in the all-groups category were blue-green algae, including Lyngbya sp., another filamentous blue-green; Microcystis sp. and Merisomopedia sp., platelike colonial bluegreens. (Melosira sp. was a dominant diatom.) Oscillatoria was superabundant and constituted 64% of the total phytoplankton community. Blue-greens are usually most prevalent in environments with high temperatures and light intensities. Their added ability to fix nitrogen also aids them in competitive relations with other species. The presence of so many bluegreens dominating the river phytoplankton community tends to indicate that 1) the river is nutrient rich; 2) many of these samples were taken during high temperature and light conditions; and 3) that the river is a somewhat polluted environment. This would not necessarily be specifically related to thermal pollution, but the general conditon of the river as indicated by the presence of these species. It should also be noted that surface habitat (so excessively sampled in this study) would tend to overestimate bluegreens.

Most diversity was attributable to within-environment patterns of the community, thus the value for mean time-depth diversity ($\bar{H}_h$) was about the same as the total species diversity value. Corresponding to the decreased dominance of bluegreens at RDE, both H_T and mean H_h values increased. The experimental stations showed slightly less diversity than the control stations, but this was probably not important since fewer species at the experimental stations were considered.

The $\hat{B}/E$ value was slightly higher at the experimental stations, both when the stations were grouped together and when they were considered separately. It was interesting that most of the increase came from the Danskammer intake station and not from the Roseton intake station. This is noteworthy because the Danskammer intake was closer to the heated effluent than was the other station. The Roseton-Danskammer east station had a higher relative community niche breadth ($\hat{B}/E$) than did the other control stations. This station (RDE) consistently exhibited some peculiar community structure values throughout all of the data analysis. It is probably a poor choice as a control station, since it might be influenced by another form of perturbation such as an unknown effluent or simply freshwater entering the river from the Wappingers' Creek inflow.

The Roseton southwest control station (RSCW) also showed some small differences which tended to make it similar to the experimental stations. This station being on the same side of the river as the power plants and downstream, would be the control station most likely to be affected by plant effluent. On the other hand, RSCW has a missing sample as do the experimental stations and many differences may be attributable to this fact.

These increases in the relative community niche breadth ($\hat{B}/E$) indicate that the phytoplankton were more uniform in more environments. Values of the niche breadths for the community and mean species ($\hat{B}$ and $\overline{B}$) values remained remarkably constant regardless of the value of E. The value of $\overline{B}/\hat{B}$ also remained consistent (except for a drop at RSCW probably because of the fewer number of stations) indicating that the changes in niche breadth by station were for all species considered and did not apply to a few of them, dominant or otherwise.

The total density, D, dropped by one half at station RDE, the reason for this decrease was not apparent. Slight increases in the competitive success ratio, $\overline{D/K}$ at RDE and DI, indicate that D followed K at the other stations but rose relative to it at RDE and DI, or vice versa, K dropped relative to D. N also dropped at these two stations, probably because of the bias introduced by the missing samples. At RDE, the drop in K relative to D is proportional to the drop in N and therefore, probably a result of it. This was not the case, however, at Danskammer Intake and the values of both the percent carrying capacity, $\overline{\%K}$ and the $\overline{\%K_i/(B_i/B)}$ ratios increased here but remained consistent over the other stations. Note that there is a slight increase for these measures in the experimental stations as compared to control and all stations but there is no evidence of it at RI, since only DI increases. If not a result of sampling problems, this could indicate that 1) the environmental conditions were more suitable for phytoplankton growth, 2) nutrients were more plentiful and/or 3) predation was less severe.

The Roseton southwest control station (RSCW) also exhibited a slightly higher value of $\overline{\%K_i/(B_i/B)}$ because there were fewer environments sampled causing a lowered niche breadth value and/or because this station may also be affected by heated effluents depending on the tide and currents. The fact that the relative increase observed in carrying capacity at Danskammer Intake is not related to the number of samples or species or the niche breadth, as it was at RDE, indicates that this is not a sampling effect. That this phenomenon occurred only at DI and not at the otherwise similar stations RDE and RI strongly suggests that the impingement and entrainment of aquatic animals is leading to decreased predation pressure at this station.

Species niche breadth over N, (B'/N) values were consistent except at Roseton/Danskammer east (RDE) reflecting the increase in diversity at this station. The mean value of alpha was also consistent over all station stratifications and even the covariance of alpha was constant, which indicates similar stability properties for the matrices.

It is possible to hypothesize that power plants could affect a phytoplankton community in several ways. Heat is usually beneficial for blue-green algae and would enhance that particular component of the community. It was interesting that the species composition was not different at the experimental stations in comparison to the other stations, thus, if heat was perturbing the community it was not radically altering the community taxonomically. It is possible, however, that the physiology of individuals of the same species differed amount the stations. The plant could also result in decreased predation, caused by the damaging of predators in the entrainment and impingement processes. These latter forms of perturbation cannot be adequately separated from thermal additions without the aid of loop analysis (Lane and Wright 1977). It is likely that the result of these perturbations may be two or three link effects away from the phytoplankton community itself and that their effects may operate through a variety of feedback pathways. In terms of increased food supply, heated effluents could increase the rates of decomposition and recycling of nutrients; this would increase nutrient availability in the area. Although there are many different ways that heated effluents could operate through the pathways of an ecosystem, the relative importance of these general pathways of effect are presently only conjecture. These data indicate that at least

certain components of the phytoplankton community are more prevalent in the experimental areas.

In terms of stability measures, the value for corrected determinant were generally higher for the control stations. The determinant had to be corrected for most of the matrices, since the number of species in all groups is much greater than the number of samples available for any one station. Consequently, less confidence can be placed in these determinants as stability indicators. Also, comparisons between runs with different numbers of species and/or environments (such as all, control, and experimental stations) are dubious.

The matrices for stations: RI, RNCW, and RNCE had the highest alpha covariance values. The variances of the eigenvalues (S^2_λ) were similar for all, and control stations, which indicates that these were coherent groupings of stations. The Roseton/Danskammer east (RDE) station and to a lesser extent Danskammer Intake (DI) exhibited several measures of slightly enhanced stability including: reduced variance, higher harmonic mean of the eigenvalues, and lower kurtosis of the eigenvalues. The range, variance, and arithmetic mean of the reciprocal of the eigenvalues and the matrix determinant corroborate this result. These results could have been an effect of the missing samples, however, enhanced stability was found at the Roseton/ Danskammer east (RDE) station and the Danskammer Intake (DI) station while Roseton Intake (RI) showed the least stability. The two stations, RDE and DI, have repeatedly showed the greatest differences from the other stations in terms of niche values, which indicates that their respective communities are different from those of the other stations. Thus, there appears

to be an effect, and it may be enhancing stability not detracting from it. With certain communities, however, the success of one subset of species occurs at the expense of another. Enhanced stability of any one biological class or a particular trophic level should not be the goal for the ecologist making management decisions, particularly if he sacrifices the desired community for a less desirable one.

The coefficients of variation for the niche measures discussed above are given in Table B-9. Generally, these values were low and demonstrated uniformity over the various data stratifications including control, versus experimental, versus all stations for H, $\overline{H}_d$, $\hat{B}/E$, $\overline{B}_i/\hat{B}$, E, $\overline{B}_i/E$, $\%K_i$, $\overline{\%K_i(B/\hat{B})}$, $\overline{D_i/K_i}$, $\overline{\alpha}$, cov α, λ_{max}, S^2_λ, and $1/\lambda_{min}$.

The especially large coefficients of variation were related to the corrected determinant for all stratifications. For experimental stations, large coefficients of variation were related to the minimum eigenvalue λ_{min}, H.M.λ, $1/\lambda_{max}$), $S^2 1/\lambda$, and arithmetic mean of the reciprocal eigenvalues, whereas for the all stations stratification only the corrected determinant, the variance (S^2_λ) and the harmonic mean of the eigenvalues was over one. In general, the stability measures being more sensitive to sampling, etc. can be expected to exhibit higher coefficients of variation.

In Table B-10 and B-11 the community structure and stability values for the bluegreen phytoplankton community by station are presented. In Table B-11 the coefficients of variation are given for Table B-10. The coefficients of variation were low for most of the different stratifications for the blue-green

community. Blue-greens are usually regarded as being rather capricious, opportunistic organisms which bloom suddenly and often disappear quickly. In these data, the bluegreens appear to be an integral component of the community and possess a highly organized structure. Most of the variation measures were extremely low, including values for diversity (H), niche breadth, the various ratios of niche breadth, $\overline{D_i/K_i}$, and $\overline{\%K_i/(B_i/\hat{B})}$, and values of mean alpha, B', B'/N, and H'. The higher coefficients of variation were related to some of the stability measures, including values for covariance of alpha and the determinant of alpha. These latter coefficients of variation were high for each of the three major data stratifications. Also, the values of the minimum eigenvalue, for experimental stations, and the harmonic mean of the eigenvalue, for both experimental stations and all stations, were high, as was the maximum reciprocal eigenvalue for all three data stratifications. In general, the consistent nature of the bluegreen community is substantiated by a superficial examination of these coefficients of variation.

At the Roseton/Danskammer East station (RDE), the bluegreen algae fell to 55% of the total phytoplankton community from 70% to 80% at the other stations with minor differences in the species composition within the bluegreens. Oscillatoria sp. dominated evenly at all stations and constituted 80-90% of the total blue-green community. Both the diversity (H) and $\overline{H}_h$ declined for the Roseton southwest control (RSWC) station, the Roseton Intake (RI) station, and the Danskammer Intake (DI) station. The values for the mean time-depth and mean time diversity were lower for experimental stations than for all or control stations, however, the remaining values were relatively constant. Again this indicates that most of the diversity was

within environments while among-station diversity was low and among-date diversity very low, particularly at the control stations. Compared to the other phytoplankton groups, the bluegreens showed low diversity because of the over-dominance of the one species of Oscillatoria.

In the comparison of the community niche measures (total diversity, niche breadth and the carrying capacity ratios), for all versus control versus experimental stations, there was notably more consistency than there was either in the corresponding comparisons for all species groups or in the stratification by individual stations. This illustrates that there was little difference on a global level between control and experimental station groups with regard to blue-green dynamics.

The mean value of alpha was slightly higher in the experimental stations, which indicates that species tend to overlap to a greater degree within the control stations. We have found this to be true in other aquatic communities when competitive pressures are not as severe. This could also result from increased nutrient concentrations or when alterations in physiology are operative allowing enhanced competitive success and subsequently, more overlap. Densities were not different although they were higher in the experimental stations, and this agrees with the latter hypothesis. It is not possible, however, to relate density per se to some of the niche characteristics without further theoretical development.

In general, the by-stations comparison of bluegreens showed approximately the same patterns as for all species groups. The former result is probably related to all phytoplankton patterns and therefore is more evident when all the data are considered

together. Sampling error effects would not be evident in the other groups and thus, they would have a diluted influence on the all group values. The Roseton south control west stations (RSCW) exhibited lower relative species niche breadth values ($B_i/\hat{B}$), as well as higher $\%K_i/(B_i/\hat{B})$ values as did all-groups, possibly because of missing samples or some relatively long range plant effects.

For the Roseton-Danskammer east (RDE) station, the relative species niche breadth ($\bar{B}_i/\hat{B}$), and mean species niche breadth over E ($\bar{B}_i/E$) were both larger while the relative community niche breadth ($\hat{B}/E$) remained even. This indicates a large increase in the niche breadths of one or two species but not a community-wide effect. There was also a slight rise in relative species breadth (B'/N) showing a rise in diversity which was not apparent from H' measure because the number of environments decreased. The total density was reduced by 50% with a corresponding decrease in carrying capacity. All of this suggests that the decline in bluegreens at the RDE stations influenced most of the species but did not change the order of dominance. The dominant species, however, were influenced more than the others so the resultant community was more balanced and diverse and the non-dominant species had relatively larger niche breadths.

Reference to Table B-24a (niche values for dominant species) shows that Lyngbya sp. and the unidentified one-celled bluegreen species were unaffected while the Oscillatoria sp., Chroococcus sp. and Merisomopedia sp. populations were decreased by over one half. Also, Merisomopedia sp. was exceeded by a bloom of Merisomopedia glauca here. The lower densities of several dominant bluegreens in comparison to the greens at this station may be related to nutrient conditions. If this is, in fact, a heat-related effect, it is unlikely that the influx from Wappinger's

Creek would be colder water. On the contrary, infra-red scans of this inflow show it to be warmer than the main body of the river.

It is possible that heat from the power plant is supporting the bluegreen community on the west side of the river, and at the control stations, either because the water movements carry sufficient heat over much longer distances than was thought or because of the largely unknown dispersal rates and associated mechanisms of phytoplankton. Thus, the algal communities at west control areas may have been affected more by the plants than on the other side of the river.

In regard to bluegreens by station, the Roseton Intake station had a low percent carrying capacity ($\overline{\%K_i}$) and correspondingly a low mean niche overlap ($\overline{\alpha}$) as did the north-west control station (RNCW). Danskammer intake station had differences which were observed in the all-groups table. The diversity (H) was low but the relative species breadth (B'/N) value was high indicating an effect of too many missing samples. Both the relative community niche breadth ($\hat{B}/E$) and $\overline{B}/E$ values rose while the relative species niche breadth ($\overline{B}/\hat{B}$) remained constant. This was indicative of a consistent species-wide increase in niche breadth. Carrying capacity increased relative to D as shown by $\overline{\%K_i}$, which follows from the high niche overlap ($\overline{\alpha}$) and there was a net increase in $\overline{K_i/(B_i/\hat{B})}$. $\overline{D/K}$ values were slightly higher at RDE, RI and DI, but this seems to have been because of the fewer number of samples. This reiterates the previous indications that bluegreens are actually well-adjusted at the experimental station, DI, due to some conditions which allow increased values of competitive overlap, niche breadth, and carrying capacity. This trend was not found in the greens and

diatoms. The low coefficients of variation at DI are most likely because of the fewer number of samples.

The stability measures did not produce large station differences or coherent trends. The matrix determinant, the harmonic mean of the eigenvalues (H.M.λ) and the variance of the eigenvalues (S^2_λ), as well as their related parameters showed stations RSCW, RNCE and DI to be the least stable and RDE and RI the most stable. Values for S_λ and K_λ were lower for RDE, RI, and finally for DI (which could be the result of missing samples). RNCE had a notably high covariance of α with RI second highest of all the stations.

The determinants for the all stations and the control stations exhibited the greatest consistency, as did S^2_λ, H.M.λ, and the range, variance and arithmetic mean of the reciprocal eigenvalues. This involves the ecological significance of global versua local stability, in the sense that the individual stations did not appear as stable as some of the larger data groupings. This indicates a stable global system which can result from local instability.

The community structure and stability values for the green algal phytoplankton community by station is given in Tables B-12 and B-13. In general, the coefficients of variation were extremely low for the green algae and perhaps constitute important consistent properties. Several of the measures were consistent over the major data stratifications, that is control versus experimental versus all stations. The highest variability values were related to stability criteria, and include the covariance of alpha, the determinant, the minimum and harmonic mean of the eigenvalues, as well as the minimum reciprocal eigenvalue.

These parameters may be the least stable properties of phytoplankton communities which is contradictory, since these parameters are the measures used to evaluate stability. The stability measures are more sensitive to sampling errors (no. cases, linear dependencies, etc.) that are discussed elsewhere in the report and these measures also tend to have larger relative ranges of natural variation in comparison to the community structure values. Both of these factors would tend to increase their coefficients of variation.

Some of the differences in coefficients of variation for the experimental stations are sensitive to the fact that only two experimental stations are considered as opposed to five control stations. Thus, when the two values are alike, the coefficients of variations are apt to have lower values and when they are different the coefficients of variation are high. Since only two values were considered in the calculation of this statistic, both the high and low results are biased. Also values for the two stations involved were computed from data containing many missing samples making them less numerically stable and more biased.

The breakdown of the various stations for the green community showed that there were several differences in the ordering of dominant species for that community. Scenedesmus quadricauda, was usually the most abundant green algae, and it constituted about 22% of the community. The values for mean-depth diversity ($\bar{H}_d$), the mean-time diversity ($\bar{H}_t$), mean time-depth diversity ($\bar{H}_h$), and total diversity (H_T), were consistent for all the various data stratifications. There was also an appreciable among-date diversity for this group and a smaller among-station diversity. Stations that deviated the most were the

Roseton south control west (RSCW) station, the Roseton/Danskammer east (RDE) station, and the Danskammer intake (DI) station where diversity values decreased for both within-H and among-H measures. This was probably a function of the reduced number of samples and species, particularly in regard to relative species breadth (B'/N). There may still, however, have been a small decrease in within-environment diversity at RSCW and a larger one at DI as there were blooms of Dictyosphaeium and Actinastrum at these stations, respectively. The diversity values also showed a decreasing trend going down the table from total diversity (H_T) to mean time-depth diversity ($\overline{H}_h$) for each of the three major data stratifications.

Some of the other community structure values also exhibited consistencies, including: $\hat{B}/E$, $\overline{B}_i/\hat{B}$, $\overline{B}_i/E$, D, K, $\overline{\%K}_i$, $\overline{\%K_i(B_i/\hat{B})}$, $\overline{D_i/K_i}$, B_i', B_i'/N, and $\overline{\alpha}$. Many of these measures were also uniform on a percentage basis including; $\hat{B}/E$, $\overline{B}_i/\hat{B}$, $\overline{B}_i/E$, D, K, %K, and $\overline{\%K_i(B_i/\hat{B})}$, and can be considered important components in maintaining the integrity of the community structure.

The Roseton/Danskammer east (RDE) station did not differ from the other control stations as much as in the two rankings just discussed (all species and bluegreens). In fact, community niche breadth ($\hat{B}/E$) and density showed substantial increases with low coefficients of variation. This might be because of specific environmental conditions here but it could also be because of reduced competitive pressure from bluegreens. Usually $\overline{\%K/(B_i/\hat{B})}$ values are generally higher for greens and diatoms than bluegreens. The Danskammer intake (DI) station still tended to be the most different station, not only in terms of diversity (H) which has already been mentioned, but also in terms of the relative community niche breadth ($\hat{B}/E$), the relative species niche breadth ($\overline{B}_i/\hat{B}$), mean species niche breadth

$(\overline{B}_i/E)$, $\overline{D_i/K_i}$ and the coefficient of variation for $\overline{D/K}$. All of these values were higher at DI than those at other stations. The Roseton south control west (RSCW) station also exhibited differences, in that values for $\overline{\%K_i}$, $\overline{\%K_i(B_i/\hat{B})}$ were low while the competitive success ratio $\overline{D_i/K_i}$ was slightly higher, although with a high variation over species. The mean α and diversity values were also lower for this station. It is unknown why this particular station would be different; however, this result was obtained from other stratifications and it is possible that this station was subject to some power plant influence.

For stability measures, values for the covariance of alpha were similar for all of the data stratifications. All stations, RSCW, RDE, and DI stations showed stability in terms of the determinants, range, variance and kurtosis of the eigenvalues. For all and control stations highest stability was indicated by the harmonic mean of the eigenvalues and the range, variance and arithmetic mean of the reciprocal eigenvalues.

The Roseton Intake station (RI) showed the least stability with regard to the harmonic mean and range of λ as it has for all stratifications so far considered. The other moments of the distribution of eigenvalues, however, show it to be of average stability and a conclusive statement cannot be made.

The community structure and stability values by station for the final major species group, the diatoms, are given in Tables B-14 and B-15. The coefficients of variation for this group were (except for stability measures) the lowest, for the phytoplankton groups by density. In general, all types of stratifications

for phytoplankton resulted in the identification of many consistent properties. The highest measures of variation were related to the eigenvalue distribution, and secondly to values associated with the matrix properties including: covariance of alpha, and corrected determinant.

Table B-14 gives several "by station" stratifications that were described by the coefficients of variation values. The most abundant species were Cyclotella sp. and Melosira sp., each relatively numerous at 48 and 35% respectively for all stations. Navicula sp. and Asterionella formosa were the two second most abundant species and Nitzschia sp. was common at the Roseton/Danskammer east (RDE) and Danskammer intake station (DI). Also at DI, Melosira sp. increased to 48% becomming the dominant species. Regarding species composition, these were the two most different stations (DI and RDE), and the species differences may represent plant effects.

The diversity values were similar for all the major data stratifications by station. The components of diversity analysis indicated that there was some among-date diversity, though not as much as for the greens and little or no among station diversity, leaving most of the diversity attributed to differences within stations. For the separate stations, Roseton/Danskammer east (RDE) and Danskammer intake (DI) had lower values for total diversity (H). Roseton/Danskammer east (RDE) also had a lower value for mean time-depth diversity ($\bar{H}_h$). This result occurs when few species tend to dominate the community. At the Danskammer intake (DI), the among-environment H dropped to zero.

There were several consistent patterns in the other niche values. For example, relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B}_i/\hat{B}$), and $\overline{B}_i/E$, were consistent for all the stratifications except that $\hat{B}/E$ values were lower for the experimental stations. RI had the lowest B/E and $\overline{B}/E$ values. For DI only the $\hat{B}/E$ value decreased slightly with a rise in the relative species niche breadth. This suggests that only one or two dominant species decreased and reference to Table B-24c shows that this was the case with Melosira sp. At the Danskammer intake station, this species doubled its density and halved its niche breadth and mean row while the other species stayed the same or showed small increases in both measures. This indicates that there were large increases of Melosira sp. in only a few environments.

Other measures were consistent except at RSCW where there were slightly high mean α and $\overline{\%K_i/(B_i/\hat{B})}$ values, and DI where D went up slightly and $\overline{D/K}$ increased substantially. At this station $\overline{\%K_i}$ and $\overline{\alpha}$ were consistent and $\overline{\%K_i/B_i/\hat{B}}$ decreased substantially indicating success for a few species in a few environments. Values for B' were relatively consistent, but were low at RSCW, RDE and DI. The B'/N value was low for the DI station and the value for H' was low in the experimental stations as well as at the Danskammer intake station. Thus, as with the greens and the bluegreens, the diatoms showed station-specific differences that were mostly related with Danskammer intake and Roseton-Danskammer east stations.

An analysis of the stability measures demonstrated that the greatest indication of stability was related to the all, and

control station groupings for the covariance of alpha, the corrected determinant, the harmonic mean of the eigenvalues, and the range, variance, and arithmetic mean of the reciprocal eigenvalues. Thus, there are indications that global, not local stability considerations prevail. The minimum eigenvalue and harmonic mean indicated slightly lower stability at RSCW, RDE, and RI and much lower at DI while variance, skewness and kurtosis of eigenvalues exhibited marked differences only at DI. This could be related to locally unstable algal blooms.

The minimum eigenvalue which is probably one of the best indicators of stability was highest for all and control stations stratifications. This also indicates that there may be some global aspects of phytoplankton community structure represented in these data that would not normally be under consideration. This is not particularly surprising since the present state of knowledge about this subject is miniscule.

From the results to date, we cannot say that the Roseton/Danskammer east station is actually any more different than are the more clearly-delineated experimental stations RI and DI. Consequently, there may be as much perturbation in other parts of the river from other effects as the thermal plants appear to contribute (for example, RDE versus DI and RI). However, it does appear that the heated effluent or other power plant effects do affect phytoplankton community of the Hudson River at Roseton/Danskammer point.

b. Stratification by Date

The next basic set of niche stratifications was conducted by date, for experimental, control and all stations for all groups of phytoplankton (Tables B-16 and B-17).

The date stratifications for densities and biovolumes are two-way stratifications over date groups (summer and fall) and over station groups (control and experimental). As such, the tables of measured coefficients of variation are in two parts, a and b. The first page gives coefficients taken over station for each date group and a third column over the four categories for each date group and both stations. The second page contains coefficients across season for all-stations, control-stations, and experimental-stations. Since we are mainly interested in the change across dates only, the simple means and coefficients of variation on the second page are discussed in the text.

Coefficients of variation for the date stratifications, for all groups, are given in Table B-17b. Most of the niche measures were consistent except for those related to stability criteria. Variable values including those for the corrected determinant, the minimum eigenvalue, the harmonic mean of the eigenvalue and the maximum, variance and arithmetic mean of the reciprocal eigenvalues. The values for these measures exhibited a higher degree of variability (over .3) whereas almost all the other measures had coefficients of variation under .3. Usually density and carrying capacity show the next highest variation, and this occurred in these stratifications as in most of the other types of data stratification.

The breakdowns for the date patterns are given in Table B-16. Dates are divided into June to September (summer) versus October to December (fall). There were no particular shifts in species dominants with season. This was a somewhat unexpected result since most phytoplankton species are extremely seasonal and usually exhibit seasonal trends in their population dynamics.

Much of the basic structure of the phytoplankton community can be attributed to Oscillatoria sp. which is the primary dominant species, seasonally, as well as by station. In seasonal considerations, Oscillatoria sp. accounted for 61 to 77% of the total community. Cyclotella sp. was usually the second dominant although Lyngbya sp. tended to replace Cyclotella sp. in the species hierarchy during the colder months. Melosira sp. also became more important in the fall when Merisomopedia sp. and Microcystis sp., two bluegreen species, became relatively less important.

As expected, diversity values were generally higher in the summertime. Also to be expected, the control stations showed higher diversity than the experimental stations because more samples were used in the calculation of these values. It is interesting that the control station values were even higher than the all station values, indicating the diversity dropped when experimental stations were included. In the fall, October to December, diversity values were similar, except slightly higher for experimental stations. It is also interesting that the results for mean time-depth diversity ($\overline{H}_h$) were related to this observation, in that this measure often had a higher value than that for total diversity (H). There was an appreciable among-station diversity particularly for experimental stations from June-September.

The niche breadth values for experimental stations were consistent from October to December as well as from June to September. The relative community niche breadth ($\hat{B}/E$) values decreased for all and control stations in the summer months. The value of $\overline{B}_i/E$ declined, while the relative species niche breadth ($\overline{B}_i/\hat{B}$)

rose slightly for experimental stations in the summer. Thus, a few individual species did slightly better than their respective community.

In general, the fall measures were more consistent than were the summer measures. In the warm months, there is more activity in an aquatic community. This is especially true in regard to predation dynamics and turnover rates of food resources, thus, increased summer variation is not a completely unexpected result.

The value for density was highest at the experimental stations within the summer grouping, but generally, density and carrying capacity values were lower in the summer than in the fall. Turnover rates were probably higher. Average percent carrying capacity, $\overline{\%K_i(B_i/\hat{B})}$, and $\overline{D_i/K_i}$ exhibited greatest differences were at the experimental stations in the summer months. These values were similar to those for all stations. These values indicate a lower competitive success ratio ($\overline{D_i/K_i}$) but higher values for percent carrying capacity ($\overline{\%K_i}$) and $\overline{\%K_i(B_i/\hat{B})}$ than for the control stations. Other measures were consistent for other date stratifications. Values for B', B'/N, and habitat diversity (H') indicated that the phytoplankton community exhibited decreased balance at the experimental stations in the summer, and also that niche values for these stations were not as consistent over dates in comparison to the other data stratifications. The mean values of alpha were also consistent over all the stratifications except for the experimental station values in the summer. The niche values were most different for this stratification than for any of the other temporal stratifications. This is an expected result insofar as a summer community already stressed by high temperature, might become more unbalanced by a further addition of heat.

For both June-September and October-December stratifications the corrected determinant, eigenvalue range and harmonic mean as well as the $1/\lambda$ values show the experimental stations as being more stable than the controls. Interestingly, the all-stations values show little indication of stability. In addition, the variance contradicts this while the skewness and kurtosis values are consistent. The covariance of alpha was consistent for June-September and it decreased in the fall more for control and all stations than experimental stations. It remained positive in all cases. This indicates greater stability for the October-December period although not as much was found in the by-station stratifications. In general, the rest of the October to December values exhibited more consistency and stability than the June-September stratification.

Coefficients of variation for the bluegreen algae (Table B-19b) exhibited the same patterns as did the all species group. The values were relatively low for all measures except those of percent carrying capacity and density, and for some of the stability criteria, including the corrected determinant and the variance of the reciprocal eigenvalues.

As with the results of all-groups, most of the October-December values showed more consistency than those for June-September. For the measures of species niche breadth ($\overline{B}$), D, and K, the coefficients of variation over species were quite high. In addition, from June-September to October-December there were usually more differences in the control stations (which largely influenced the all-stations) than in the experimental stations. This indicates the possibility that the constant influx of heat from the plant is buffering the normal seasonal changes, thus, allowing more outwardly stable communities.

The experimental stations, however, showed the highest values of the coefficients of variations associated with the stability criteria, including the corrected determinant, the minimum eigenvalue, the harmonic mean of the eigenvalue, and the maximum, variance, and arithmetic mean of the reciprocal eigenvalues.

The overall variation was higher for bluegreens than it was for all groups, which may indicate that there is some global aspect of phytoplankton communities that make taxonomic groupings and local station representations somewhat artificial (expectedly).

Regarding bluegreen species by date (Tables B-18 and B-19), there is little seasonal change in the dominant species levels, however, the control-stations and all-stations for June-September showed more Merisomopedia sp. than other environments. The overall density of blue-greens, however, increased at experimental stations. The diversity (H) measures were lower for experimental stations in the summer but changed only for mean time and mean time-depth in the fall. The general low value of all the diversity measures is directly related to the fact that Oscillatoria sp. dominated the phytoplankton community often to the extent of 85%. In general, the diversity ($\bar{H}_t$) related to the within temporal factor was the highest, although many of the differences were not large.

Of the niche breadth measures, the relative species niche breadth ($\bar{B}_i/\hat{B}$) was consistent, the relative community niche breadth ($\hat{B}/E$) and the $\bar{B}/E$ values differed in being low for all and control stations in the summer. The $\overline{\%K_i(B_i/\hat{B})}$ and the $\overline{D_i/K_i}$ values were quite consistent for all stratifications, however, the $\overline{\%K_i(B_i/\hat{B})}$ value decreased and the $\overline{D_i/K_i}$ value

increased in the summer particularly for all and control stations. The species niche breadth (B') and B_i'/N values were consistent for all stratifications, while habitat diversity (H') declined at experimental stations in both the summer and the fall. This indicated that the habitats were less-well represented by the various data stratifications. The value for mean alpha was higher for the bluegreen species both in summer and fall at the experimental stations. This indicates that competition was probably lower in these environments and the species were able to overlap more strongly than they were in other situations. There were also more differences in the community structure values for experimental stations, in the summer, than for the other types of stratifications. This indicates that the experimental stations were different from the control stations.

The stability measures showed that the all and control stations were more stable in terms of kurtosis of lambdas, and that all stations were stable in terms of the range and variance of the eigenvalues. For other stratifications, however, the experimental stations appeared to be more stable in terms of the values for covariance and corrected determinant of the alpha matrix, and the variance of the reciprocal eigenvalues. All stations in the October-December ranking were more stable in regard to the harmonic mean of the eigenvalues and the range, variance, and arithmetic mean of the reciprocal eigenvalues. The experimental stations were different for the summer in regard to the variance of the eigenvalues, the kurtosis of the eigenvalues and the reciprocal eigenvalue range. In general, as with the other groupings, the skewness and kurtosis of the eigenvalues were quite similar in summer and winter except for those differences already noted in the experimental stations.

The corrected determinant indicated enhanced stability at the experimental stations in summer and less in the winter. With only four environments for experimental stations in summer, however, the corrected determinant may not be reliable. The other measures, alpha covariance, harmonic mean of the eigenvalue, eigenvalue range and variance (as well as the values for $1/\lambda$) show the summer values to be fairly consistent with only a slight increase for the experimental stations. In the fall, however, the sharp decrease in stability was indicated for the experimental stations. This is not what was expected from the other indications and illustrates that it is difficult to conclusively account for results based on so few cases, particularly for the stability measures. Beyond this, our present understanding of the biological dynamics involved cannot be expected to explain even valid numbers. Conversely, the skewness and kurtosis, while substantiating the slight increase in stability at the experimental stations in summer, remained consistent in the fall.

For the community of green phytoplankton, the same pattern emerges for the coefficients of variation (Table B-21-b). These values were all extremely low. Using .5 as the cut off point, there were few coefficients of variation over this value except those related to the density and carrying capacity at the experimental stations, and the covariance of alpha, the determinant, and the variance of the reciprocal eigenvalues at all, experimental and control stations. The niche values were homogeneous for all data stratifications for greens and in general, this group exhibited less variation regardless of the stratification type than the bluegreens.

The niche measures and some of the major trends for green algae stratified by date are presented in Table B-20. In regard to

dominance, Scenedesmus quadricula (or one of four others dominants) constituted 24 to 28% of the community. Dictyosphaerium sp. tended to replace Scenedesmus quadricula in the fall stratification. Dictyosphaerium sp. and Tetastrum sp. were also more common in the fall, while Pediastrum duplex or one of three others: Actinastrum hanteschii, Ankistrodesmus sp. and Mougeotia sp. were common in the summer stratification. These trends are more representative of seasonal dynamics of algal populations than was apparent with the corresponding bluegreen community.

For diversity (H), a typical pattern of decreasing values, from total ($\bar{H}_T$) to mean depth ($\bar{H}_d$) to mean time ($\bar{H}_t$) to mean time depth ($\bar{H}_h$) diversity, was apparent in the data; except at experimental stations where the mean time-depth diversity was larger than the mean time diversity. In general, diversity (H) was consistent. As in the by-stations table there were large values of among-time diversity and smaller values for among-station diversity. This among-station diversity vanished at the experimental stations in summer, however, this and other small changes following this pattern may be due to the fact that only four environments were used in this run.

The relative community niche breadth ($\hat{B}/E$) increased at the experimental stations in the summer. This was associated with an increased value of the relative species niche breadth ($\bar{B}_i/\hat{B}$) at the experimental stations in the summer, as well as the $\bar{B}_i/E$ value which decreased in both the all stations and control stations during the summer period. The percent carrying capacity and mean alpha were higher at the experimental stations in the summer, which indicated that green algae were relatively more successful at this time of year. The K values were consistent while D was lower in summer especially at the experimental

stations. If not a missing sample effect, all of this may indicate that there was considerable overlap in the greens' competition patterns indicated by the niche breadths and alpha values. The other measures of percent carrying capacity [$\overline{\%K_i}$, $\overline{\%K_i(B_i/\hat{B})}$ and $\overline{D_i/K_i}$] exhibited values that were relatively more consistent in the fall to winter period than in the summer months. For some of these measures, such as $\overline{D_i/K_i}$, there was increased variability over species in the winter as opposed to the summer months. Values for B, B'/N, were relatively consistent over the two major date stratifications, while in the experimental stations habitat diversity (H') decreased.

For stability measures, in summer, the all stations values showed the most stability in relation to the values of K_λ, the covariance of the alpha, and the range, the variance and harmonic mean of the eigenvalues. In the fall, for the all stations values, stability measures were high for the minimum eigenvalue, the variance and harmonic mean of the eigenvalues, and the range, variance and arithmetic mean of the reciprocal eigenvalues. In comparison to other data sets, the skewness and kurtosis of the eigenvalues were relatively consistent over all stratifications, except when they declined for experimental stations in the summer. Thus, the trend of increased global stability with local instability emerges, for the all stations group and, to a lesser degree, the control stations showing enhanced stability. This is in contrast to some of the separate stability measures we obtained for individual station stratifications which seemed to indicate that experimental stations exhibited more stability. Also repeated was the trend that with these few environments, the determinant, even corrected, is of limited value in assessing stability and in some cases, it is unreliable. Eigenvalue measures such as harmonic mean, variance,

skewness and kurtosis seem to be more numerically stable, although in some cases, their function is not completely understood. The reciprocal eigenvalues patterns were mostly similar to the eigenvalue measures.

The coefficients of variation for the diatoms are given in Table B-23b while the niche values by date are given in Table B-22. The same trends were apparent here as for greens when a cut-off point of .5 was used. The density and carrying capacity exhibited the greatest variation for all and experimental stations, whereas the covariance of alpha, the harmonic mean of the eigenvalue, the minimum eigenvalue, and the maximum, variance, and arithmetic mean of the reciprocal eigenvalue showed more variability for the experimental stations. Thus, there was more variability in the experimental stations but for most stratifications and most niche measures, variability was generally low.

In Table B-22, niche measures assoicated with these coefficients of variation are given. The diatoms, like the bluegreens, tended to maintain their dominant pattern throughout the seasonal cycle. The dominants included Cyclotella sp., Melosira sp., and Navicula sp. which together constitue over 80% of the diatom community. In general, the percentage of diatoms in the total community was relatively low for experimental stations, with a value of only 5.6%. At other times of the year and for other data stratifications, diatoms were about 10% to 14% of the total community abundant. Diversity values were generally low and most of the total diversity (H) could be accounted for by the mean time-depth diversity ($\overline{H}_h$). There was a small amount of among-date diversity while the among-station H was negligable except for control-stations and all-stations in the summer. This pattern is similar to the previous one in Table B-20.

Besides diversity, the consistent patterns in other niche values included the relative community niche breadth ($\hat{B}/E$), and the mean species niche breadth over E, ($\bar{B}_i/E$). The exception was the experimental stations in the summer when these values both increased. The values for density, however, were lower in the experimental stations in the summer. The relative species niche breadth ($\bar{B}_i/\hat{B}$), the percent carrying capacity ($\%\bar{K}_i$), $\overline{\%K_i(B_i/\hat{B})}$, $\overline{D_i/K_i}$, and $\bar{\alpha}$ values were consistent for all data stratifications. As with the greens, the B', and B'/N values were identical for both data stratifications, and the value for habitat diversity (H') declined somewhat for experimental stations. This result was related to the low number of environments. Values for coefficients of variation over species were approximately equal and low.

The stability measures exhibited a slight decrease in stability with less variability except for the corrected determinant which was a misleading result. These trends have been observed before. The covariance of alpha was small and negative except for experimental stations where it was small and positive. Eigenvalue ranges and variances showed slightly more stability in the summer unlike the bluegreen results. The most stable combination was all-stations in the summer and the least-experimental stations in the fall. The values of skewness and kurtosis of the eigenvalues were consistent. Some of the preceeding results are summarized in section B 4.d., but first we consider some of the niche patterns for individual species.

c. Niche Measures for the Dominant Species (Table B-24)

For each of the four major functional groups three or four dominant species have been chosen and their niche patterns

described in terms of station stratification and for biovolume, phytoplankton - date stratification.

In Table B-24a the results are presented for the four common species of bluegreens: Chroococcus sp., Lyngbya sp., Oscillatoria sp., and a one-celled unidentified form. For the over station stratification, a range of niche values which was greater than the arbitrary cut-off point of .15 was found for most niche measures. In this table, as well as the corresponding tables for other groups and stratifications, we have calculated two measures that were not given in the community niche tables. These include the row mean and column mean of the alpha values. These two measures give an indication of 1) the mean effect of other species on the species in question (row mean), and 2) the effect of that species on the other members of its community (column mean).

$\overline{D_i/K_i}$ was one of the most consistent measures. Several values for the coefficients of variation were greater than .3 (for species dominants tables, we have used two cut-offs, .3 and then .5). The bluegreens exhibited a moderate degree of variation, meaning that though many niche values were over .3, few were over .5. The most variable species in this bluegreen group is Lyngbya which had low $\overline{D_i/K_i}$ and the high $\overline{K_i/(B/\hat{B})}$ values. The effect of other species on it and its effect on other species were about equal. Chroococcus sp. had a relatively low $\overline{D_i/K_i}$ value and reasonably low mean alpha indicating high competitive pressure. The unidentified bluegreen behaved quite similarly to Chroococcus sp. and both had higher $B/\hat{B}$ values than the other species.

Oscillatoria sp., a dominant and abundant species, had a stable density and exceptionally low coefficients of variation.

Undoubtedly, this species is responsible for much of the structure of the bluegreen community. The value for $\overline{D_i/K_i}$ was high, indicating that it was competitively successful. This species is a long filamentous bluegreen which would not be as susceptible to predation as, perhaps, the one celled and other smaller forms. Another filamentous form, Lyngbya, was the second dominant species (by density) and had values corresponding to those for Oscillatoria sp. These two alga also exhibited high $\overline{\%K/(B/\hat{B})}$ ratios.

There were few coherent trends across the stations. At DI, there were increases in density, $\%\overline{K_i}$, $\overline{\%K_i/(B/\hat{B})}$, and both alpha means. At RDE, as previously mentioned, the values of D and K for Oscillatoria dramatically decreased while almost every other number in the column remained constant or increased slightly. In general, the most favorable stations seemed to be the south controls and DI while the least were RI and RDE.

In considering the comparison of the species with its community, that is, the relative species niche breadth $(\overline{B_i}/\hat{B})$ and the relative community breadth $(\hat{B}/E)$, in almost every case the species exhibited higher values of $\overline{B_i}/B$ than $\hat{B}/E$. This would be the expected result since the individual species niche breadth (B_i) would be smaller than B. Thus, part of this result is based in the mathematics and not the biology. In general, these species occupied about 50 to 70% of the available niche space.

The dominant green species niche values are given in Table B-24b. The blanks in the table arise because the species was not considered as a dominant for that run, not because it did not appear at all. These green species showed considerable

stability as did the diatoms (discussed on the following page). The most variable greens in terms of the .15 range of the niche values were Chlorella sp. and Scenedesmus quadricula. Chlorella sp. had high coefficients of variation for D, K, $\overline{D_i/K_i}$, and the row alpha mean. Ankistrodesmus sp. and Tetrastrum sp. were less variable. The $\overline{D_i/K_i}$ values were higher for Tetastrum sp. and Scenedesmus quad. and less variable than for the others. In general, the niche breadth measures exhibited the same pattern they do for the diatoms. From results of other phytoplankton communities, this is expected. Again, one species Chlorella sp. differs greatly at the station across from the plant area, RDE. In this case, density and $\overline{D_i/K_i}$ doubled while both niche breadth (B/E and $B_i/\hat{B}$) and both row and column alpha means dropped. The $\overline{K_i(B_i/\hat{B})}$ ratio remained constant. Unlike the bluegreens, the other greens showed similar patterns to Chlorella sp. but not nearly as extreme. There were also general increases in density and niche breadth at DI, RI and RSCW. Comparing the effect of the species on the community with the effect of the community on the species, for the first three species, the community generally exhibited a greater effect on species, then they had on the community. For Tetrastrum sp. these two effects were approximately equal. Thus, in summary, the greens are useful indicators of conditions in the river. In the future, this would probably be one of the better communities to use to evaluate changes in river conditions.

The diatom subgroup was also a good indicator of community structure; the data for this group is given in Table B-24c. Using the .15 cut-off value, Cyclotella sp. was less variable than the other species and its coefficients of variation were low. There were few instances of species having coefficients of variation values greater than .3, only four in all of the data,

and no instances of coefficients greater than .5. The species effect on the community, and the community effect on the species, were about equal except for Navicula sp. which experienced a slightly greater effect on the community than Navicula had on the other species. Generally, the diatoms had low $\overline{D_i/K_i}$ ratios, which indicated that they were not as successful in competition, especially in interactions with bluegreens. As in the other two groups of phytoplankton (bluegreens and greens), there were two species with much higher $\overline{D_i/K_i}$ ratios than the other two diatoms listed and these dominants had the higher densities. For the diatom community Cyclotella sp. and Melosira sp. dominated. The mean alpha values generally decreased in density for all groups. The niche breadths ($\hat{B}/E$ and $B/\hat{B}$) and the $\overline{K_i/(B_i/\hat{B})}$ ratios were about the same.

In regard to station effects, Navicula sp. exhibited a typical values at RDE. Density and $\overline{D_i/K_i}$ was reduced to 50% without any other large change although niche breadth was high. In contrast, B_i values for other species were generally low. Equally remarkable behavior was shown by Melosira sp. at DI. Density, $\overline{D_i/K_i}$ and $\overline{K_i/(B_i/\hat{B})}$ were high, while mean row alpha and niche breadth values decreased. This was indicative of a bloom which was restricted to a few environments, and thus, locally unstable. The densities of Navicula sp. and Melosira sp. also rose at DI along with values for $\overline{B}/E$ and $\overline{B}/\hat{B}$.

These tables exemplify how the same analysis can be applied to give a detailed species description of a local situtation as well as to analyse global trends and pattern in the dominants of a community.

d. Summary of Phytoplankton Community Results by Density and by Functional Group. (B-25)

(i) Overview of consistent properties

Table 6 summarizes the regularities of the niche measures, for stratifications by stations, density and functional group. What was striking in this table was the consistent nature of the phytoplankton community when all, control and environmental stations were considered. If a difference of .15 in the range of a niche measure is taken as a criterion, then the rows (which represent the comparison of all versus control versus experimental stations) had only two niche values that differed by more than .15. These were the values for $\overline{K_i(B_i/\hat{B})}$ for all species, and the mean value of alpha for the blue-greens. Each of these values are only .01 above the .15 cut-off point. Consequently, the phytoplankton were consistent over station stratifications.

Within groups (in regard to the stratifications over all, bluegreens, greens, and diatoms) there were differences that probably reflect significant aspects of community structure. For relative community niche breadth ($\hat{B}/E$) the diatom community was the best at filling the available ecological space, as they were in regard to the relative species niche breadth ($\overline{B_i}/\hat{B}$). Also, all species together were extremely efficient in regard to this latter niche measure. Considering $\overline{K_i/(B_i/\hat{B})}$, D_i/K_i, and $\overline{\alpha}$, the greens and diatoms had higher values than did all species of bluegreens. In other aquatic systems, we have found greens and diatoms to act quite similarly, and bluegreens to be the most unique of the functional groups. This result

Table 6: Summary comparison of important niche measures for the phytoplankton community by density, functional group and station.

Niche Measure	Functional Group	All Stations	Control Stations	Experimental Stations
$\hat{B}/E$	All species	.50	.47	.62
	Bluegreens	.43	.40	.54
	Greens	.61	.60	.66
	Diatoms	.73	.78	.65
$\overline{B_i/\hat{B}}$	All species	.82	.89	.75
	Bluegreens	.68	.71	.70
	Greens	.66	.66	.73
	Diatoms	.78	.78	.85
$\overline{\%K/(B_i/\hat{B})}$	All species	.72	.68	.84
	Bluegreens	.81	.80	.91
	Greens	.98	.98	.98
	Diatoms	1.00	1.01	.95
$\overline{D_i/K_i}$	All species	.071	.070	.067
	Bluegreens	.19	.18	.18
	Greens	.21	.21	.19
	Diatoms	.20	.20	.21
$\bar{\alpha}$	All species	.49	.49	.56
	Bluegreens	.44	.44	.60
	Greens	.56	.56	.63
	Diatoms	.75	.77	.74
H	All species	2.03	2.06	1.92
	Bluegreens	.94	.96	.85
	Greens	3.04	3.04	2.98
	Diatoms	1.78	1.76	1.81

is substantiated from the literature on the biology of these groups.

Diversity (H) values were highest for the all species group as well as the green community, that is, the species of these groups were more equally distributed in the environmental space. The diversity measures showed the greatest range of all the niche measures since they varied by a factor of .3. Thus, it appeared that the functional group differences were greater than the station differences.

In Table 7, results from stratification of alga (by density) by date and functional group were summarized. There were more variable values here than in the by-station stratification. Variability was especially prevalent in the summer period, June to September. These data therefore illustrate that the phytoplankton community was changing more in time than in space, especially in the summer months. This, of course, corroborates many other lines of evidence concerning the structure of aquatic communities.

The value for relative community niche breadth ($\hat{B}/E$) was lower for all species group, and also for bluegreen and greens. It was low at control and all stations in the summer months, while the diatom values were especially high for the experimental stations. The relative species niche breadth ($\overline{B}_i/\hat{B}$) value was high for the all species group in the experimental stations and also for the bluegreens in the control stations. Otherwise these two niche breadth measures were consistent over the major station categories for the various phytoplankton communities. Relative community niche breadth values ($\hat{B}/E$), indicated that the greens

Table 7: Summary comparison of important niche measures for the phytoplankton community by density, functional group and date.

Niche Measure	Functional Group	June-Sept. All Stations	June-Sept. Experimental Stations	June-Sept. Control Stations	Oct.-Dec. All Stations	Oct.-Dec. Experimental Stations	Oct.-Dec. All Stations
$\hat{B}/E$	All species	.45	.61	.41	.65	.68	.64
	Bluegreens	.34	.58	.28	.59	.57	.61
	Greens	.47	.68	.46	.75	.75	.75
	Diatoms	.73	.96	.74	.84	.80	.88
$\overline{B_i}/\hat{B}$	All species	.78	.91	.84	.79	.80	.83
	Bluegreens	.74	.78	.85	.64	.76	.65
	Greens	.68	.82	.68	.68	.74	.70
	Diatoms	.70	.71	.72	.80	.84	.82
$\overline{\%K_i/B_i/\hat{B}}$	All species	.69	.85	.66	.78	.83	.77
	Bluegreens	.68	.76	.62	.88	.92	.89
	Greens	.93	1.00	.95	.98	.98	.97
	Diatoms	1.03	1.04	1.02	1.00	.94	1.02
$\overline{D_i/K_i}$	All species	.081	.071	.090	.067	.067	.065
	Bluegreens	.21	.24	.24	.18	.17	.18
	Greens	.17	.15	.17	.20	.19	.19
	Diatoms	.22	.19	.21	.20	.21	.19
$\bar{\alpha}$	All species	.44	.68	.44	.53	.58	.55
	Bluegreens	.35	.51	.36	.48	.68	.47
	Greens	.55	.77	.57	.60	.66	.62
	Diatoms	.71	.73	.73	.77	.75	.82
H	All species	2.27	1.59	2.47	1.91	2.01	1.85
	Bluegreens	.92	.79	.97	.93	.86	.93
	Greens	2.84	2.77	2.81	2.98	2.95	2.96
	Diatoms	1.83	1.71	1.83	1.75	1.80	1.71

and diatoms were the most effective groups. Values for $\overline{\%K_i/(B_i/\hat{B})}$ for the all stations and control stations for all species, were relatively low, while values for bluegreens at experimental stations were quite high. This indicates that bluegreens were efficient in utilizing their available niche space. The green and diatom groups were even more efficient, however, as they possessed values from .2 and .4 above that for all species and bluegreens.

In Table 7 the $\%K_i/(B_i/\hat{B})$ ratio for bluegreens varied from .62 to .92. This ratio for diatoms, however, was not variable. For $\overline{D_i/K_i}$ values the bluegreens and greens were within the level of variation, .15 cut-off (and so for both tables those two categories are consistent). The diatoms were consistent for $\overline{\%K_i/(B_i/\hat{B})}$. For bluegreens, this measure is variable, with the experimental stations always being higher. The ratio $\overline{D_i/K_i}$ was highest for the bluegreens and diatoms at most times of the year and its values significantly increased in the fall and winter months for both the bluegreens and greens.

The mean value of alpha was consistent except in the summer for all species, bluegreens and greens which increased at the experimental stations, and for bluegreens the summer values were lower than the fall values. This would indicate that either competition was more severe or that the bluegreens did less well in the colder months; the latter observation agrees with what is known about bluegreen biology. The greens and diatoms exhibited the greatest overlap at all times of the year.

The diversity values were lowest for the blue-green group, and highest for the green species. At experimental stations, diversity decreased for all species, bluegreens and greens. This perhaps indicates an effect of the thermal plants on the experimental stations, which was more pronounced in the summer than the fall.

When Table 6 and Table 7 are compared, there are many other consistent properties that are recognizable for particular groups. Thus, many niche measures, are consistent over both stations and date groupings with the following exceptions: the values for relative community niche breadth ($\hat{B}/E$) were low at control stations for all and bluegreen species, and at the experimental stations for diatoms. Relative community niche breadth exhibited a uniform value, except for bluegreens at control stations which had a high value. As already mentioned, the mean value of overlap for bluegreens was high in the fall. This tends to make that particular row of both the Tables 6 and 7 variable, although the measure was consistent within a grouping.

The diversity measures were lower for the greens during the summer, but still relatively consistent. Consequently, there were definite niche values for each functional group of phytoplankton and that over time and station there were many consistent indices of the phytoplankton community at this site in the Hudson River. Although the community has an integrity, it appeared that this integrity was more nebulous during the summer then in the fall. In general, temporal variations were more significant then those contributed by the stations, however, there were several changes

in community structure and stability measures at the experimental stations. At the present time some of these changes may be beneficial; for example, enhanced stability. We were restricted with the data set from continuing the analysis to the point that these apparent ecological contradictions would be resolved. It is likely, however, that although enhanced stability arises, it is undesirable because it represents increases in unwanted species over more desirable ones.

(ii) Summary of statistical results

This section summarizes all of the foregoing and utilizes the statistical results from tables grouped under the common number: B-25. For each functional group of organisms analyzed in this study the statistical results are given in detail in the appendix tables. Only the important points from these results are presented in the in-text table on summary statistics and it is only this latter table that is discussed.

Except for the stability measures, most of the coefficients of variation for phytoplankton were fairly low over both stations and dates (Table 8). The t-test comparisons between control and experimental stations usually found no significant differences. When the coefficient of variation was relatively high for the experimental stations, reference to the detailed t-test table often showed that one or the other (but not both) of the experimental stations was significantly different from the control stations. A significant difference does not necessarily imply a large difference; however, a very low or very high value for the

Table 8: Summary comparison of statistical results for the phytoplankton community by density and functional group

	BY STATION: ALL $\bar{x}$ (σ_x)	BY STATION: CONTROL $\bar{x}$ (σ_x)	BY STATION: EXPERIMENTAL $\bar{x}$ (σ_x)	σ_E	BY DATE $\bar{x}$ (σ_x)	BY STATION/DATE $\bar{x}$ (σ_x)	STATION/DATE (σ_x) (σ_x)	STATION σ_E	DATE σ_E
ALL GROUPS									
Species diversity H	1.82 (.19)	1.91 (.19)	1.60 (.11)	.20	2.09 (.12)	1.98 (.12)	(.13) (.04)	.43	.84
B/E	.54 (.20)	.51 (.18)	.63 (.19)	.33	.55 (.26)	.54 (.21)	(.14) (.18)	.43	.28
B/B	1.01 (.13)	1.04 (.14)	.92 (.03)	.14	.79 (.01)	.85 (.06)	(.02) (.05)	.75	.26
mean alpha $\bar{\alpha}$	.62 (.27)	.60 (.26)	.66 (.30)	.20	.49 (.13)	.56 (.13)	(.16) (.01)	.22	1.00
$\%K/(B/B)$	.73 (.11)	.70 (.10)	.79 (.11)	.32	.74 (.09)	.78 (.11)	(.11) (.04)	.17	.70
D/K	.08 (.19)	.08 (.20)	.09 (.14)	.47	.07 (.13)	.07 (.16)	(.09) (.14)	.53	.27
minimum λ	.27 (.78)	.27 (.73)	.26 (1.35)	.97	.01 (1.35)	.16 (1.35)	(1.30) (.69)	.21	.58
harmonic mean λ	.68 (.41)	.72 (.60)	.60 (1.06)	.84	.01 (1.30)	.53 (1.11)	(1.20) (.38)	.12	.72
variance λ	7.01 (.13)	7.14 (.13)	6.69 (.25)	.64	5.82 (.17)	7.22 (.27)	(.28) (.02)	.14	.93
BLUEGREENS									
H	.77 (.25)	.84 (.22)	.41 (.46)	.10	.93 (.09)	.69 (.09)	(.10) (.01)	.10	.90
B/E	.46 (.19)	.43 (.12)	.55 (.22)	.41	.47 (.38)	.51 (.30)	(.18) (.20)	.51	.40
B/B	.94 (.15)	.99 (.18)	.91 (.01)	.37	.69 (.16)	.76 (.11)	(.01) (.15)	.93	.23
$\bar{\alpha}$	.66 (.22)	.63 (.14)	.73 (.39)	.71	.42 (.22)	.57 (.26)	(.25) (.25)	.22	.39
$\%K/(B/B)$	.83 (.13)	.81 (.11)	.87 (.23)	.75	.78 (.16)	.80 (.17)	(.07) (.19)	.66	.095
D/K	.21 (.15)	.20 (.14)	.25 (.03)	.01	.20 (.11)	.21 (.18)	(0) (.24)	1.00	.595-2
minimum λ	.01 (.94)	.01 (.91)	.01 (1.41)	1.00	.05 (.64)	.03 (.77)	(0) (.44)	1.00	.53
harmonic mean λ	.02 (1.41)	.03 (.94)	.01 (1.41)	.28	.21 (.64)	.12 (.76)	(.35) (.22)	.61	.76
variance λ	2.55 (.48)	2.56 (.29)	2.52 (.46)	.97	1.48 (.36)	2.22 (.43)	(.44) (.25)	.16	.42
GREENS									
H	2.38 (.14)	2.49 (.08)	2.12 (.25)	.51	2.91 (.03)	2.87 (.03)	(.01) (.04)	.82	.015
B/E	.61 (.12)	.60 (.13)	.63 (.10)	.65	.61 (.32)	.66 (.21)	(.12) (.19)	.54	.24
B/B	.87 (.11)	.85 (.07)	1.01 (.10)	.38	.68 (0)	.74 (.08)	(.09) (.03)	.15	.72
$\bar{\alpha}$	.71 (.18)	.67 (.11)	.79 (.02)	.52	.58 (.06)	.66 (.13)	(.13) (.03)	.19	.79
$\%K/(B/B)$	.94 (.07)	.93 (.05)	.94 (.06)	.86	.96 (.04)	.98 (.02)	(.02) (0)	.091	1.00
D/K	.24 (.20)	.24 (.18)	.26 (.31)	.80	.19 (.11)	.18 (.11)	(.04) (.14)	.71	.095
minimum λ	.01 (.94)	.01 (.91)	.01 (1.41)	1.00	.04 (.34)	.02 (.36)	(0) (0)	1.00	1.00
harmonic mean λ	.03 (.81)	.03 (.73)	.02 (1.41)	.70	.16 (.34)	.08 (.31)	(.25) (.18)	.32	.57
variance λ	3.03 (.25)	3.05 (.27)	2.98 (.29)	.93	3.25 (.01)	3.25 (.15)	(.15) (.07)	.20	.64
DIATOMS									
H	1.70 (.09)	1.72 (.09)	1.66 (.12)	.74	1.74 (.03)	1.76 (.04)	(0) (.04)	.90	.96
B/E	.75 (.12)	.78 (.09)	.66 (.08)	.09	.79 (.10)	.85 (.11)	(.06) (.01)	.53	.93
B/B	.86 (.11)	.84 (.05)	.93 (.21)	.63	.75 (.09)	.77 (.09)	(.01) (.11)	.93	.93E-2
$\bar{\alpha}$	.80 (.05)	.82 (.04)	.76 (.01)	.01	.74 (.06)	.76 (.06)	(.04) (.05)	.47	.26
$\%K/(B/B)$	.98 (.07)	1.00 (.04)	.94 (.14)	.64	1.02 (.02)	1.01 (.04)	(.02) (.04)	.60	.35
D/K	.21 (.20)	.20 (.12)	.25 (.28)	.50	.21 (.07)	.20 (.06)	(0) (0)	1.00	1.00
minimum λ	.003 (1.45)	.004 (1.20)	.0004 (1.40)	.17	.03 (.21)	.02 (.25)	(0) (.70)	1.00	.24
harmonic mean λ	.013 (1.40)	.017 (1.20)	.003 (.72)	.21	.57 (1.06)	.08 (.72)	(0) (.71)	1.00	.20
variance λ	3.48 (.16)	3.72 (.09)	2.87 (.25)	.35	3.15 (.18)	3.39 (.10)	(.03) (.09)	.77	.24

significance alpha seemed to depend on there being a low coefficient of variation over the control stations particularly for the low degrees of freedom used in these statistics. The F-test (ANOVA) showed few significant variations and when it did, the total variance was so low that although the relative difference between the station and date coefficients of variation was large, it could not be considered important. In the following discussion, trends are sometimes explained in terms of separate stratifications from the original niche tables.

The following is a summary of the differences and patterns in the results as expressed by the statistics in Table 8 and appendix Table B-25. Note that the numbers referred to by alphas such as $\alpha = .1$ are significance alphas and not niche alphas. They give the probability that an observed difference is significant. Thus, there is a 90% chance that the observed difference that is non-random. Means are given with their coefficients of variation following in parenthesis.

- All-groups

The comparisons of individual stations and their stations show the results for the all-group classification were dominated by bluegreens, especially Oscillatoria sp. at 64%. The number two dominants were Lyngbya sp. and a diatom, Cyclotella sp., at 6% and 5%, respectively. In the summer, the overall phytoplankton density was 4×10^6 cells/liter at the control stations and 7×10^6 cells/liter at the experimental stations while in the fall it was 13×10^6 cells/liter. Diversity values appeared to decrease, however, considering the B'/N ratio, the fall control

stations, fall experimental stations and summer experimental stations exhibited consistent values, while the summer control stations increased in diversity. This increase was high but less than that for the green group alone.

The pattern of greater consistency in the fall than in the summer and over experimental stations versus control stations, resulted in the summer control-stations and usually all-stations catagories being different from the rest. This result was repeated for the rest of the community structure values. For the summer_control stations, niche breadth decreased ($\hat{B}/E$ and $\overline{B}/E$ both went from .6 to .4) as did $\overline{\%K_i}$ (from .8 to .5) and $\overline{\%K_i/(B_i/\hat{B})}$ (from .9 to .7) while $\overline{D_i/K_i}$ increased (.07 to .09). The deviations from the pattern were a slight increase in $\overline{B}/\hat{B}$ at the summer experimental stations which is probably because of the low E, and niche overlap, which was .5 evenly in the fall, .4 for the summer control stations and .7 at the summer experimental stations. This illustrated an overall seasonal change (α_f = .1).

These results were similar to the patterns shown by the stability measures, with experimental stations being more stable than control groups for both seasons (α_f = .1 for H.M.$_\lambda$ and var$_\lambda$) but considerably less so in the fall with no overall change over date (α_f = .7 for H.M.$_\lambda$ and α_f = .9 for var$_\lambda$).

There was a significant decrease in value for total diversity (H) from 1.9 (.2) at the control stations to 1.6 (.2) at the experimental stations. The relative community niche breadth ($\hat{B}/E$) value, increased (α_t = .1) from .5 (.2) at

the controls to .7 at DI. The value $\bar{B}_i/\hat{B}$ is consistent at .1 (.1) Accordingly, the $\bar{\alpha}$ increased (α_t = .1) from .6 (.06) at the control to .7 at the experimental stations. $\overline{D_i/K_i}$ increased from .08 (.2) to .1 (α_t = .1) while $\%K_i/(B_i/\hat{B})$ increased from .7 (α_t = .1) to .8 (.1). These somewhat contradictory results probably resulted from the inadequate data set.

The stability measures were more variable than the other niche values. Minimum eigenvalue (λ_{min}), skewness (S_λ), and kurtosis (K_λ) all declined slightly at both RI and DI which indicated a trend toward instability. Stability measures also indicated greater variation by date although there were not large differences between control and experimental stations. RI, in fact, showed a little more stability and had the smallest minimum λ. At DI, the variance, skewness, and kurtosis all dropped together (α_t = 0.3, .04, .05, respectively) which was unexpected since variance and kurtosis values are usually negatively correlated.

- Blue-greens algae

The blue-greens represented the dominant phytoplankton group because of Oscillatoria sp. which bloomed in August to November; it constituted 64% of the overall phytoplankton density. Excluding Oscillatoria, the bluegreens and diatoms were about equal in dominance each constituting about 10% of the population. While diatoms were fairly stable over date and station, however, the bluegreens were extremely seasonal and showed a relatively high degree of station difference.

Normally 75% of phytoplankton were bluegreens at an average density of 7.4×10^6 cells/liter and a coefficient of variation of 27%. The species composition was Oscillatoria sp. at 85% and Lyngbya sp. at 7%, which were the two dominants at most stations and are both filamentous forms. They were followed by other colonial forms at about 3%, Merismopedia sp. and Microcystis sp. which bloomed at Roseton Intake. There was also an unidentified unicellular bluegreen which did not account for much density, but was the most frequently occurring species.

Because of the dominance of Oscillatoria, the diversity was low compared to other groups with little or no among-environment diversity. The other community measures throughout the stratifications were also low with high variation over both environments and species. The stability measures, while showing fairly high variation were the highest of the phytoplankton. Individual species usually exhibited high variation in their niche measures and only on the community level do the consistent properties appear. In this case, one species forms so much of the community that the other species cannot balance its fluctuation and by comparison are doing poorly. The mechanisms underlying the high stability values requires more research.

Seasonally, the experimental stations showed little difference between summer and fall and the only trends applying to all stations were an increase in density ($\alpha_f = .08$) and $\overline{K_i/(B_i/\hat{B})}$ (from .7 to .9, $\alpha_f = .1$) while $\overline{D_i/K_i}$ decreased

(from .24 to .18, α_f = .006) and diversity was consistent (α_f = .9). The stability measures were confusing as there was a somewhat inconsistent and small rise in the harmonic mean of the eigenvalue. There was an equally inconsistant drop in variance and kurtosis. The control station showed a great deal of variation going from low values to the summer up to values similar to the experimental stations in the fall. Also, this meant that there were considerably more consistent patterns in the fall while differences between stations, occured in the summer. The diversity value was .8(.2) at the control stations but dropped to .6(.2) at the experimental stations (α_t = .1). At all stations, the mean within-group diversity was about equal to the total diversity (H) and the among-station diversity was 0.

- Greens

The greens exhibited mostly the same seasonal and station patterns as the bluegreens. However, in terms of density they were the lowest and for diversity (within and among) the highest of the algal groups. Except at RDE the greens represented 4% to 6% of the phytoplankton abundance. Scenedesmus quadricauda was the dominant species in terms of abundance (21%) and frequency but there was little pattern in species composition.

Diversity was high at 2.8 in the summer and increased (α_f = .02) to 3 in the fall with no station difference (α_f = .8) and the among environment diversity was about 1. Density increased over season and $\overline{D_i/K_i}$ also was consistent over stations (α_f = .7) but dropped (α_f = .1) from

summer to fall while $\overline{\%K_i/(B_i/\hat{B})}$ was generally consistent (both: $\alpha_f = .1$). These values are unlike those for the bluegreens but the other measures showed approximately the same pattern; this is, summer experimental-stations, fall control-stations and fall experimental-stations were more similar to each other than to the summer control-stations. Except as mentioned, they were all intermediate in absolute value between bluegreens and diatoms. Stability patterns were quite similar to the bluegreens as well. This reflects that while environmental patterns were similar to those of the bluegreens, the green community was closer to the diatoms in terms of density and diversity. By station, the niche values of green algae were fairly consistent.

The mean diversity value H = 2.5(.1) decreased to 1.7 at DI ($\alpha_t = .03$). Both the within and among-diversity decreased accordingly. Also the F-test demonstrated significantly greater variation in date over station.

Values for relative community niche breadth ($\hat{B}/E$) were consistent at .6(.1) while the $\bar{B}/\hat{B}$ value increased from .8(.1) to 1.1 at DI ($\alpha_t = .02$) indicating an increased relative niche breadth ($\hat{B}/E$). For one or a few species, but not all species, the mean value of alpha rose slightly but significantly ($\alpha_t = .02$) from .7(.1) at the controls to .8(.02) at both experimental stations. Values for $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ remained consistent ($\alpha_t = .8$) and $\overline{\%K_i/(B_i/\hat{B})} = .9(.1)$ and $\overline{D_i/K_i} = .2(.2)$ over all stations. The ANOVA values showed significance differences among stations for $\overline{\%K_i/(B_i/\hat{B})}$ and among dates for $\overline{D_i/K_i}$; however, all the coefficients of variation were so low, these are probably not important.

The stability measures were also remarkably consistent and station DI increased slightly in stability. Variance, skewness and kurtosis of the eigenvalues decreased at DI again indicating sampling bias.

The value for relative community niche breadth ($\hat{B}/E$) rose from .4(.1) at the controls to .6 at DI (α_t = .02) and $\overline{B/\hat{B}}$ was consistent at 1.0(.2) for all stations, indicating a species-wide increase in niche breadth. Mean value of alpha also rose from .6(1) to .9 at DI (α_t = .04) and while $\overline{K_i/(B_i/\hat{B})}$ values remained consistent at .8 (.1), $\overline{D_i/K_i}$ rose from .2(.1) at the controls to .25(.03) at the experimental stations (α_t = .01). The f-test, however, showed density, carrying capacity, and ratios involving them to be more variable over date.

There were no significant differences in stability criteria between control, and experimental stations, although values for minimum, skewness and kutosis of the eigenvalues all decreased slightly at both RI and DI, which indicated a trend toward instability. These measures also exhibited greater variation by date.

- Diatoms

Diatoms were also consistent over stations. This group was the most consistent of the phytoplankton groups being relatively stable seasonally and spatially. At 10% of total phytoplankton the density was about the same as the blue-greens without Oscillatoria sp. or the green algae at their late summer maximum. The total diatom density was about 10^6 cells/liter with a coefficient of variation of only

14% over stations. The dominant species composition was also constant with Cyclotella sp. at 48%, Melosira sp. at 35% and Navicula sp. at 8%.

In terms of relative community niche breadth, .8(.1); mean nich overlap, .8(.05); and $\%\overline{K_i/(B_i/\hat{B})}$, 1.0(.07); the diatom community values were the highest of the phytoplankton groups. Diversity was high and density was stable, all of which indicates this group is the best organized of the three considered. Stability was on the average the lowest with no apparent reason.

Total diversity was constant at 1.8 as was among environment diversity at .2 (both over station and date, $\alpha_f = .9$). The only seasonal differences were relatively small but station exhibited consistent increases in density ($\alpha_f = .01$) and a similar slight drop in stability ($\alpha_f = .2$). Diversity, both measures of niche breadth, niche overlap, $\%\overline{K_i/(B_i/\hat{B})}$, and $\overline{D_i/K_i}$ all had coefficients of variation over date under .01.

The value for mean diversity ($\overline{H}$) was 1.7(.1). The most significant difference ($\alpha_t = .3$) on the t-test table was that the diversity (H) dropped to 1.6 at DI as the among groups diversity became negligible. It was about .2 at the other stations. The relative community niche breadth value ($\hat{B}/E$) = .8(.1) at the control stations but it decreased to .66(.1) at both experimental stations ($\alpha_t = .1$). However, the value for $\overline{B}/\hat{B}$ increased. The other tables showed that the value of $\overline{B}/\hat{B}$ increased at DI while $\hat{B}/E$ decreased at RI ($\alpha_t = .01$). Therefore, the decrease was for all species at RI but only for some at DI.

The value for $\bar{\alpha}$ = .8(.05) decreased slightly at both experimental stations (α_t = .01), and $\overline{D_i/K_i}$ value increased from .2 to .3 at DI (α_t = .02). This can be attributed to a decline of the density values while carrying capacity values remained constant. As usual, the value for $\overline{D_i/K_i}$ was consistent.

- Group comparisons

The Hudson River phytoplankton community was dominated by one species of bluegreen, Oscillatoria sp. a form which constituted 64%, and bluegreens were 75% of the all-phytoplankton community. Oscillatoria sp. is a freshwater genus forming large filamentous colonies, prevalent in conditions of high heat, light and nutrients, perhaps dominating a polluted river. It dominated blue-greens at 85%. The remaining community was dominated by other blue-greens, Lyngbya sp. (64%), another filamentous form, and diatoms: Cyclotella sp. (48%) and Melosira sp. (35%). These two groups were each about 10% of the total phytoplankton population, leaving 6-1/2% for greens and others; there was a further 8-1/2% of phytoplankton counted but not included as common species.

Many niche measures, mostly those relating to the community as a whole, are lowest for blue-greens and highest for diatoms, leaving the greens intermediate, except for being lowest in density and highest in diversity. The diversity is, of course, sensitive to the number of species used and thus may not be reliable in terms of its absolute value for phytoplankton.

The relative community niche breadth was .5 for bluegreens, .6 for greens and .7 for diatoms, while relative species niche breadth was quite variable and its pattern depended on the stratification. Its coefficients of variation over species, however, decreased regularly going from bluegreens to diatoms. Niche overlap went from about .5, depending on the stratification for bluegreens, to about .6 for greens and .8 for diatoms, while $\overline{\%K_i}$ followed the same pattern. In each case, the all-groups values were quite close to those for the bluegreens.

$\overline{\%K_i/(B_i/\hat{B})}$ was .8 for bluegreens and 1.0 for both greens and diatoms, while $\overline{D_i/K_i}$ was consistent at .2 although it dropped to .1 for all-groups. The coefficients of variation of species for $\overline{D_i/K_i}$ was highest for bluegreens and lowest for greens. This indicates that the diatoms, and to a lesser degree, bluegreens, were distributed across the available environmental space, competing more effectively with each other. These conditions throughout most of the sampling period favored bluegreens, Oscillatoria sp. in particular, and perhaps a few species of diatoms over the others.

Surprisingly, the stability measures reversed this trend and both the harmonic mean and the variance of the eigenvalues show (although not with much consistency) that the diatoms were notably less stable than greens or bluegreens. With this type of data, however, it is also possible that some kind of consistency in the biomass contributed to the stability of the bluegreens since biomass is directly related to the largest eigenvalue.

There was much seasonal change in both total abundance and species composition which is best presented by Figure III-6 in Volume II in the 1973 LMS Report to CHG&E which gives weekly whole water phytoplankton abundance for the Roseton-Danskammer area in 1973. This shows that diatoms were relatively constant over months at about 10^6 cells/liter and for the first two and last months sampled, that is, in June, July, and December, diatoms dominated the phytoplankton at about 60%. Diatoms are noted for doing relatively well in low heat and light conditions as well as in marine environments. The greens and bluegreens went through a period of rapid growth in June-July which, particularly for bluegreens, produced high population levels from August through November and subsequently declines in December. The greens increased almost to the level of the diatoms while bluegreens increased from low levels in June to 10^7 cells/liter except for a few weeks in September and October when their bloom populations were sharply diminished by the intrusion of the salt front into the area.

As for regularity across stations, the four north and south control stations were consistent. The average total density was 9×10^6 cells/liter with a coefficient of variation of only 12%. The most different station was usually the south-west control which showed some similarities to the Danskammer Intake station.

The total phytoplankton density at the experimental stations (Roseton Intake, at 8×10^6 cells/liter) decreased slightly compared to the controls, while at Danskammer Intake there was a slight increase in overall abundance to 11×10^6

cells/liter. While some species decreased, several dominants increased significantly in abundance. There were indications of blooms of Oscillatoria sp., Melosira sp. and Navicula sp. which all rose 30% or more at DI. There was the sampling bias, however, which affected this station. Only four out of the usual seven samples were taken for this station and this would have increased the impact on the mean values of any bloom densities which were measured.

The unique station was, across the river from the power plant, which was included as a control station and in some respects probably should not have been. This station also has missing samples, although not as many (2 out of 7) and not with as much bias as DI did. The differences show, however, were greater and in the opposite direction from those for experimental stations. Bluegreens were not as abundant at this station and overall phytoplankton density was only 5×10^6 cells/liter of which bluegreens were only 55%. The species composition within the bluegreen group did not change. In contrast, the green population increased at this station from 5×10^6 cells/liter at the control stations to 7.5×10^6 cells/liter at RDE. The diatoms density remained relatively constant over all stations at 10^6 cells/liter with a coefficient of variation of only 14%. As a whole, they were also less variable over date than the other groups and the diatoms represented an extremely stable population. The greens and bluegreens, on the other hand, were more sensitive to the conditions imposed both seasonally and by station.

The stability measures were by no means coherent, particularly considering those for all-groups, but they tended to

show the experimental stations as slightly less stable than the controls and, in fact, seemed to show the reverse of what the community structure values had been. Another important pattern was that the all-stations values usually showed more stability than either of the subgroups, indicating global stability prevailed even though local environments were often unstable.

In comparing community structure values for each station individually, there were differences between control stations (RNCE, RNCW, RSCE, RSCW, AND RDE) and experimental stations (RI and DI) in addition to differences among the control stations. The two experimental stations, however, were usually not similar, DI showing differences greater than and sometimes in the opposite direction from RI. The most different station was often the RDE control station which was across the river from the plant.

Diversity, as with some other measures, showed a sensitivity to the number of species used and the number of samples taken, as well as to local blooms of algae which altered species relative abundances patterns (particularly for those stations with fewer samples). The major differences in diversity were an increase in the within-environments diversity at RDE for bluegreens, while they increased in among-environment diversity at the experimental stations. Diatoms and greens both decreased in among-diversity at DI (note that among diversity was calculated incorrectly). Relative community niche breadth went up at DI for greens and bluegreens but for diatoms it decreased slightly at RI. Relative species niche breadth increased slightly at DI for

diatoms and greens. The stability measures demonstrated instability for bluegreens and diatoms at DI and for greens at RI. The bluegreens also showed instability at RSCW.

The bloom proportions of Oscillatoria sp. alone are evidence that the whole river is in an undesirable state. This does not necessarily imply a plant effect, however. Although the Danskammer Intake station exhibited the highest concentrations of bluegreens, Oscillatoria sp., in particular; the niche values show that all the groups are doing better here with extra heat, except the diatom community which appear to be robust to the conditions at this station. The Roseton plant was not operating and although the Roseton Intake station showed similarities to DI, it seemed unaffected and similar to the control stations. The southwest control station, RSCW, which was downstream from the plant, showed more similarities with DI than did the other controls, (notably a stronger bluegreen community). This result could also be related to problems with missing samples although it does not seem to be.

Bluegreens were least abundant at RDE, the station across the river from the plant, and were to some extent replaced by greens. There were no real changes in community structure except that relative community niche breadth ($\hat{B}/E$) increased for greens while relative species niche breadth ($\overline{B}_i/\hat{B}$) increased for bluegreens. Both groups showed a notable increase in stability at this station. Generally, the community of this station appears to be the best adapted of all. There are several possible reasons for this and it is a critical question for the discussion.

5. Results by Biovolume (Size Category)

a. Stratification by Date (Tables B-26 to B-34)

Table B-26 contains the frequency and the percent abundance values for the various size categories of algae that were included in the biovolume analyses. The size ranges used were: small, under two thousand cubic microns; medium, two thousand to 10 thousand cubic microns; and large, over 10 thousand cubic microns.

In determining biovolume estimates of colonial species, it is difficult to determine the number of cells each colony has in nature and the natural variation of colony size. This is especially true for filamentous algae. Sometimes the filament should be counted as 20 cells per organism and other times 10 or 50 cells per organism. The exact number is usually an arbitrary one. However, we have tried to make these units as ecologically meaningful as possible. The biggest error in the present biovolume categories that were chosen is the classification of Oscillatoria sp. which is a filamentous bluegreen alga. Grouping it with the small species was a serious error, for in nature, it often occurs in large colonies. A second error may be the inclusion of Amphiprora sp. with the large species. Amphiprora sp. is a marine diatom which is large and unicellular. It was found only in eight environments and on two dates, but in such large densities that, with its large cell volume, it dominated the biovolume figure at 42% overall. Since its two occurrences were in the fall, it was originally thought that the salt front intrusion was responsible for the bloom. However,

upon checking the report[1] which contained the raw phytoplankton densities from which our original data set was key-punched, it was found 1) that there was only one occurrence of Amphiprora sp. in October, the month of the salt front intrusion, the remaining occurrences were in December - an unusual month for a salt water species; 2) that the densities were large and, for every station equal to those for Asterionella formosa two lines below; 3) that there was no evidence of the bloom and, in fact, no occurrences at all of Amphiprora sp. in the net or filtrate sample data for the dates in question; and 4) that there was no mention of this supposedly large bloom in the text of the report. The conclusion drawn from all of this, is that these figures for Amphiprora sp. were typographical errors which were passed on to our results and were discovered too late to reanalyze the data. This mistake effects not only the table for the large size phytoplankton which is already influenced by the Oscillatoria sp.'s misclassification, but also the all-sizes of phytoplankton table which listed Amphiprora sp. as the overall dominant.

Table B-26 also contains percentage composition of the community by small, medium and large, over all the stations (labelled depth) and dates (labelled time) that were used. Most of the community biovolume was attributable to the large species. This was an expected result. The medium and small species groups had similar total biovolumes. Any other differences can be related to the misplacing of Oscillatoria. Also, in December, the last month, the percentage of large species biovolume went from about 50% to 83% while the other groups declined sharply.

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[1]Appendix III-A in Volume V of the 1973 LMS Report to CHG&E.

This was obviously a result of the Amphiprora sp. error. Aside from these errors the table values would have been extremely constant indicating that biovolumes may be a more reasonable measure of phytoplankton community structure than numbers of individuals.

Table B-28b gives the coefficients of variation for the small phytoplankton. Using the cut-off mark of .5 the following measures showed high variation: 1) for control stations over date: density, carrying capacity, covariance of alpha, corrected determinant, and variance of $1/\lambda$; 2) for experimental stations: covariance of alpha, corrected determinant, minimum eigenvalue, harmonic mean of the eigenvalues and maximum, variance and arithmetic mean of $1/\lambda$. Measures such as total diversity, relative niche breadth, D, K, $\overline{\%K/(B_i/\hat{B})}$, had lower coefficients of variation for the experimental than control stations. Table 28a had lower values for fall than summer for these measures plus %K, $\overline{D_i/K_i}$, $\overline{\alpha}$, max λ and variance λ.

In general, the coefficients of variation associated with stability measures, however, were lower than they had been in the phytoplankton data previously considered. The coefficients of variation by date groups are given in Table B-28b. It must be kept in mind, however, that these coefficients were only calculated on two cases.

Table B-27 is the breakdown by date for the small phytoplankton. The dominant species composition was remarkably consistent. Oscillatoria sp., a bluegreen, remained the first at 78% of the biovolume followed by diatoms: Navicula sp. at 11% and Cyclotella sp. at 7%. The diversity measures were slightly larger, and mean time H_t was greater than mean-depth or total diversity,

H_T. When all dates were stratified into June-September and October-December, these differences were attributable to the summer conditions, as the June-September stratification showed a marked among-date diversity at the control stations only. The fall diversity values were lower and similar.

The relative community niche breadth ($\hat{B}/E$) and the mean species niche breadth over E ($\overline{B}/E$) showed the same pattern as did the diversity values and these former values were consistent. Coefficients of variation over species were low. Niche breadths were higher at the experimental-stations for all-dates and June-September and all of October-December. This indicated that the small phytoplankton community was better at using the available ecological space in the experimental stations in the summer and at all stations in the fall period. In terms of relative species niche breadth ($\overline{B_i}/\hat{B}$), these values were high and consistent throughout all the data stratifications. The values for $\overline{\%K_i}$, $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ were similar for all dates for all, control and experimental stations. For the summertime, the experimental stations again showed an increase in both the $\overline{\%K_i}$; and $\overline{\alpha}$ values while the control station values decreased. The summer control stations also had a comparatively low $\overline{\%K_i/(B_i/\hat{B})}$ value, and a somewhat higher value for $\overline{D_i/K_i}$ than at the experimental stations, although these values were consistent for the October to December stratification. Because of the success of Oscillatoria sp., $\overline{D_i/K_i}$ had a high coefficient of variation over species as did the blue-greens by density.

In the stratification for small phytoplankton, the fall values were consistent and the summer ones were not. It was the summer

control stations that were the most different. The all station group values for the summer are mostly influenced by the control stations and the all-dates by the fall. This pattern is similar to the table for bluegreens stratified by date. This similarity is undoubtedly based on the misclassification of Oscillatoria sp. If this species had not been included with the small ones, the group would have exhibited greater regularity with almost no variation over station. Also, the small group results would have become more similar to diatoms, since the next two dominant small species are diatoms.

The values of B'/N, were also consistent, for all-dates and for fall but not at the experimental stations, for June to September. H' was greatest for all-stations regardless of the date grouping and it decreased substantially for experimental stations. Since H' is a measure of niche breadth, this result merely represents the disparity in the number of environments for each category.

The values of kurtosis and the harmonic mean of the eigenvalues suggested a decrease in stability at the experimental stations during the fall months. The other values were all consistent except for S_λ^2, S_λ, and K_λ values at the experimental stations in the summer when there was a reduced number of eigenvalues caused by missing cases. The corrected determinant and covariance of alpha followed the same patterns but to varying degrees.

For the medium-sized species, the coefficients of variation over date are given in Table B-30b. Considerably less variation was exhibited than for the small species. For the control stations the only coefficient over .5 was for the variance of $1/\lambda$. For experimental stations, the usual values were over the cut-off:

D, K, corrected determinant, minimum eigenvalue, harmonic mean of eigenvalues and maximum, variance and arithmetic mean of $1/\lambda$. Table B-30a demonstrated low variation across stations for October-December while Table B-30b showed less variation at the control stations, although this was not a consistent result.

Table B-29 shows the breakdown of the niche measures by biovolume for the medium group by date. As with the small species, the medium sized species composition remained relatively consistent throughout this data stratification. Nitzschia sp. and Scenedesmus quadricula were the primary dominants followed by Cymbella sp., Actinastrum sp., Nitzschia sp. and Cocconeis sp. On the whole, the medium group demonstrated a high degree of consistency, as did most of the biovolume groups. With regard to community structure, the fall values were consistent while there were more station differences in the summer. Unlike the smaller algae, there was no consistent similarity within either station group for the fall.

The medium sized algae had a diversity pattern similar to the greens. There was considerable (though less than with the greens) among-environments diversity of which most was attributable to date and the rest to station. The only difference across stations was a general decline in among-environment diversity at the summer-experimental stations. This decline corresponded with a rise in Nitzschia sp. to 43% of the biovolume, but a decrease in total D, which had a large coefficient of variation. In addition, there was a large increase in $\overline{B_i/\hat{B}}$, a small increase in $\overline{\%K}$ and $\overline{\alpha}$, and a small decrease in $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ accompanied by a high coefficient of variation. This indicates the success of one species at the expense

of the others and the general community and it agrees with the previous results. As a whole, however, this may be the unavoidable result of the bias in the sampling design which particularly affected this set of stations. All other date stratifications were consistent except the values of B'/N which reflected the decrease in diversity and H' which was sensitive to the number of environments sampled.

The stability measures demonstrated greater global stability. The determinant (not counting the one corrected), as well as the eigenvalue range, variance and harmonic mean, all indicated high stability, but slightly less at the experimental-stations than at the controls and slightly less at the controls than at the all-stations. The skewness and kurtosis values showed changes only at the summer control stations, while the alpha covariance was fairly high and consistent.

The coefficients of variation for the large species appear on Table B-32b. In this stratification there was more variation over date in species composition between the two dominant species: Amphiprora sp., which was an erroneous occurrence in December, and the real dominant species, Melosira sp. As before, control stations showed considerably less variation than experimental stations and possessed the same patterns with regard to the different measures. For control stations, the measures with a coefficient of variation over the arbitrary cut-off of .5 are density, carrying capacity, corrected determinant and variance of $1/\lambda$. For experimental stations, variable measures were D, K, the covariance of alpha, the corrected determinant, the minimum eigenvalue, the harmonic mean of the eigenvalues, and the maximum, variance and arithmetic mean of $1/\lambda$. There were several other coefficients of variation just under .5.

Table B-32b showed substantial variation over date, Table B-32a illustrated low variation over station for each date group.

When the large size group was considered in the niche table breakdown, Table B-31, there were some shifts in species dominants including Amphiprora sp., which appeared only in October to December and was not present at all in the June to September period. In the summer months Melosira sp. dominated at 37% of the total community followed by Pediastrum duplex, Conscinodiscus sp. and Pediastrum tetrastrum. At the experimental station, Pediastrum duplex was replaced in the community by Mougeotia sp. In the fall, Amphiprora sp. dominated the large group at 68% and raised the total biovolume D value. Amphiprora dominated all dates at 58%. Unfortunately its high density and percentage of the biovolume have been attributed to a typographical error in the original data sheets. If it had not been for this, D would have shown only a slight increase from summer to fall and the species composition would have remained unchanged from fall with the exception that Pediastrum duplex would have decreased from second position to third, well below Coscinodiscus sp. The all-size groups table shows that if Oscillatoria sp. had been included with the large algae as it should have been, it would have been about equal with Coscinodiscus sp., except at the summer experimental stations where it dominated and would have made the summer station differences more marked than they were.

The diversity values were lower in the fall than in the summer, particularly for among-environments as might be expected. There was the usual trend of decreasing from total diversity to mean depth diversity to mean time diversity for the various stratifications. There was a significant among-environment H but

it was not accounted for by time or space. The diversity values, however, would have been heavily affected by Amphiprora sp.

As usual, there were many consistent values. The relative community niche breadth value ($\hat{B}/E$) was low at .35, considering all dates and yet it was higher in separate date rankings, particularly for the experimental stations from June to September when the relative community niche breadth ($\hat{B}/E$) reached .82. The relative species niche breadth ($\overline{B_i/\hat{B}}$) was high for all dates. Its value was consistent for June to September, then higher in October to December, with one low value for control stations. Values of $\overline{\%K_i}$ were consistent at all times of the year, although low at control stations for October to December. The $\overline{\%K_i/(B_i/\hat{B})}$ value was only about .52 for all dates, 1.02 from June to December, and .51 from October to December. This indicated that environmental conditions were probably better in the summer; in fact, twice as good as they were in the winter. $\overline{D_i/K_i}$ values were consistent for all times of the year. Values for B', B'/N, and H' were also regular, except for experimental stations where these values were low for all date combinations. The coefficients of variation over species were also generally high for $\overline{D_i/K_i}$ and $\overline{\%K_i/(B_i/\hat{B})}$ in the fall.

The results describe two completely different communities in the summer and fall. This can be attributed, however, to the apparent domination of the community by Amphiprora sp. which was probably not what happened. The indications are that if the Amphiprora sp. and Oscillatoria sp. errors were corrected, the large species would follow exactly the same pattern as the other three groups of algae. For example, community structure was consistent over dates although population success is indicated there in the fall while the summer values show marked

differences between experimental and control stations. This is apparently due to blooms or generally high relative success of one species, in this case Oscillatoria sp.

The more stable conditions were found in experimental stations for June to September for values of the corrected determinant, and the skewness and kurtosis of the eigenvalues; however, this is also the run with the fewest environments. The other values, eigenvalue range, harmonic mean, and variance were largely consistent showing more stability at all-dates: all-stations, and the least stability at the experimental stations in fall.

The coefficients of variation for all species of all sizes considered are given in Table B-34b. In general, the same measures were consistent for both control and experimental stations. They included values for $\overline{D}_i$, $\overline{K}_i$, $\overline{B}_i'$, corrected determinant, and variance of the reciprocal eigenvalues. Several of these high coefficients of variation were equal in both station groupings, although generally the experimental stations showed higher values; for example, the coefficient of variation for the determinant was greater than .5. This result is consistent with the supposed perturbation in this part of the river. As usual, Table B-34a had low coefficients of variation for October-December.

The breakdown of differences for all biovolume species classifications (eighteen species were considered) is given in Table B-33. Partly because the biovolumes are larger in the fall than summer, the dominant species for all-dates are the same as those for October-December. The overall dominant species is the erroneous Amphiprora sp., a diatom at 58%, following it are Melosira sp., Coscinodiscus sp. and Oscillatoria sp., two

diatoms and a bluegreen, respectively. There was considerable change in the species composition during summer. Amphiprora sp. was either not found or not a dominant. However, Pediastrum duplex was a dominant, although at a lesser percentage than the dominant Melosira sp. at 26%. Also, at the experimental stations, Mougeotia sp. replaced Pediastrum duplex and there was an overall decrease in biovolume except for Oscillatoria sp. which increased to 29%.

Diversity measures were regular for all components of diversity across station. The general decreasing trend from total diversity to mean time-depth diversity was also apparent. Diversity tended to increase in the summertime and decrease slightly in the winter. Most of the total diversity and its variation could be accounted for within environment diversity values. However, there was a smaller among station diversity and a larger among-time diversity. In terms of individual niche values, the relative community niche breadth value ($\hat{B}/E$) was constant within a particular data stratification, being higher in the summer than in the winter and unaccountably low for all dates. The value for relative species niche breadth ($\overline{B}_i/\hat{B}$) was highest at all dates, lowest in the summer period, and quite high in the winter. This indicated that these species did well in a global sense, and that they did well in the winter. The community in general, however, did better in the summer.

The mean species niche breadth per environment ($\overline{B}_i/E$) was relatively consistent for all stratification, varying less than the .15 cut-off. Values for $\overline{D_i/K_i}$, $\overline{D}_i$, and $\overline{K}_i$ were consistent for all groupings. The $\overline{\%K_i}$, $\overline{\%K_i/(B_i/\hat{B})}$, and $\overline{D_i/K_i}$ values were all regular within a grouping; $\overline{\%K_i/(B_i/\hat{B})}$ was the highest for the summer ranking. The mean species niche breadth value was

low, whereas %K was identical for all date stratifications. B'/N and H' were constant within a grouping, although the B_i'/N value was twice as high in the summer as in the winter. In the experimental stations, H' decreased for all dates and for the summer values. The mean value of alpha was constant and its coefficients of variation were approximately the same for all stratifications both within and among dates.

The covariance of alpha was positive and relatively high in all cases while the corrected determinant was low in all cases except the experimental stations of summer and fall. The best indicators of stability: eigenvalue range, harmonic mean and variance showed all-dates to have greater stability at all-stations than either control or experimental stations. For June-September, the experimental-stations had a high harmonic mean; however, the accompanying high variance implied a problem with the low number of cases. The kurtosis as usual was considerably more consistent than any of the other stability measures, showing mostly the same changes but to a lesser extent. In this case, the kurtosis implies that the pattern from all-dates may be repeated. For the fall dates, all measures showed more stability at the experimental stations and considerably less for all-stations, thus, reversing the previous pattern. However, the remarks concerning the misleading results due to the inclusion of Amphiprora sp. in the analysis are explained in the preceding discussion of the large size group.

In comparing the phytoplankton results by biovolume with those for density, it appeared that the biovolume or size group exhibited more consistency. This may not be entirely true, however, because they were stratified differently, thus, making direct comparisons difficult. For example, the coefficients of variation, across two values (the control-group and experimental

group) should not be too strictly compared with the coefficients over all seven stations.

Something which is striking about the tables is the similarity between tables with the same dominant species. For instance, the small algae appear to behave as the bluegreens do, and Oscillatoria sp. is the dominant species in each table; unfortunately, mistakenly in the case of the small algae. Similarly, the medium size class, which contains the dominant green Scenedesmus quadricauda, behaves somewhat like the green groups and the large algae in the summer, when the diatom Melosira is dominant, and is not unlike the diatoms, although Melosira is only one of two dominant species in that stratification. This suggests that measures of community structure and dynamics are determined to a large extent by (dominant) key species and whatever groupings of species are measured, they will tend to behave as the dominant species does.

b. Niche Measures for the Dominant Species (Table B-35)

Only a few interesting comparisons can be made for the dominant species. There are two reasons for this. One is that these data, because of time and/or financial restraints, were never stratified by station. Therefore, biovolume results could not be directly compared to the results for dominant species by density and functional group. Also, since only two date stratifications were used, this biases the coefficients of variation and many interesting patterns for dates cannot be delineated.

In the small group, all four dominants (Oscillatoria sp., Cyclotella sp., Navicula sp., and Chlorella sp.) had several measures, such as $\overline{\%K_i/(B_i/\hat{B})}$, which had coefficients of variation

over .5. Note that, as with the functional groups, the niche breadth patterns with species, with community, and with all environments were approximately the same. The values of $\bar{B}/\hat{B}$ did not change much from summer to fall and their values were quite high. D went up in the fall for all but Chlorella sp. and $\overline{\%K_i/(B_i/\hat{B})}$ rose in all cases as did $\hat{B}/E$. $\overline{D_i/K_i}$ decreased for Navicula sp. and for Chlorella sp. This measure, however, would be affected by the inclusion of Oscillatoria sp. whose niche values are clearly out of place here. The indications are that Navicula sp. was a dominant species and that in the fall, conditions stabilized for the small algae, but not as much for Oscillatoria sp. Except for Cyclotella sp., both mean alphas tended to rise in the fall. For Cyclotella sp. the community effect was higher than the species effect, while for Navicula sp. and Chlorella sp., they were about even, and for Oscillatoria sp., the community effect was understandably low. In fact, except for Oscillatoria sp., all of the measures of those species were about equal and showed the same pattern.

The medium species were the most consistent and showed the same patterns as the small algae but with more regularity. In the fall, D and $\overline{\%K_i/(B_i/\hat{B})}$ increased slightly, as did the niche breadth measures, while $\overline{\%K_i}$, $\overline{D_i/K_i}$, and the $\bar{\alpha}$ remained constant for all species. In this case, two species Nitzschia sp. and Scenedesmus quadricula appeared to share dominance. The community effect was greater than the species effect in all cases and, except for D, there were no differences across species. As previously mentioned, the medium algae (as did the large) showed a high degree of stability.

For niche measures, the large group showed by far the most variability across species and date. The dominant species

Melosira sp. and Coscinodiscus sp. exhibited the same patterns as discussed before with general increases in D and $\overline{\%K_i/(B_i/\hat{B})}$ and, particularly, Coscinodiscus sp. increased its niche breadth and average effect on the community in the fall. Because of the almost bloom-like success of the bluegreen, Oscillatoria sp., and the error with the diatom Amphiprora sp., the $\overline{D_i/K_i}$ ratio, which was high in the summer, decreased to average levels in the fall. Of other species listed, Pediastrum duplex varied little across date except for a decline in the fall in regard to community effects.

c. Summary of Phytoplankton Community Results by Biovolume (Size Category) (Table B-36)

(i) Overview of the consistent properties

In general, the community structure and stability measures characterized by biovolume showed several consistent patterns. This leads us to believe that the size groupings of algae may be important, if not more important than functional stratifications by taxonomic groups. Bluegreens, for example, tend to be quite consistent and they exhibit niche characteristics that are definitely different from those of diatoms and greens. These latter two groups, however, are relatively more similar. It may be that analyzing across taxonomic groups and considering size differences in terms of nutrient uptake rates, susceptability to predation, and various other physiological and ecological processes, may be a more interesting way to illustrate phytoplankton dynamics and community structure.

Table 9 centers on a summary comparison of six of the more important niche values for the small, medium, large, and all

Table 9: Summary comparison of important niche measures for the phytoplankton community by biovolume and date

Niche Measure	Size Category	All Stations	Control Stations	Experimental Stations
$\hat{B}/E$	Small	.52	.49	.63
	Medium	.79	.83	.74
	Large	.35	.35	.37
	All species	.45	.45	.47
$\overline{B_i/\hat{B}}$	Small	1.13	1.18	1.09
	Medium	.59	.58	.66
	Large	1.02	1.10	.92
	All species	1.06	1.07	1.08
$\overline{\%K_i/B_i/\hat{B}}$	Small	.68	.66	.76
	Medium	1.02	1.01	1.03
	Large	.52	.53	.50
	All species	.57	.58	.58
$\overline{D_i/K_i}$	Small	.20	.20	.20
	Medium	.30	.30	.29
	Large	.33	.33	.31
	All species	.12	.12	.12
$\bar{\alpha}$	Small	.64	.63	.70
	Medium	.50	.50	.58
	Large	.41	.43	.42
	All species	.52	.53	.55
H	Small	1.12	1.14	1.07
	Medium	2.48	2.49	2.40
	Large	1.87	1.94	1.67
	All species	2.66	2.74	2.45

species community characteristics. As for the previous phytoplankton taxonomic stratifications, we used a .15 cut-off as a guideline for summarizing trends. Stratification the data by size categories identified $\hat{B}/E$ values as a consistent property. There are no differences within a size category for all, versus control, versus experimental stations. The values in the columns, however, for all stations are not regular. The medium-sized species were more than twice as effective in utilizing the environmental space than were the large species. Thus, the medium species were disproportionally high in their relative community niche breadth and the large algae were disproportionally low. This is also true at the control and the experimental stations. The small species increase in terms of relative importance at the experimental stations, but remain lower over all and control stations. The large species remain of little importance. The values of relative species niche breadth $(\overline{B}_i/\hat{B})$ are all consistent within a size category. The columns, however, for all, control and experimental stations do not contain regular values.

The values for $\overline{K_i/(B_i/\hat{B})}$ are consistent measures within size categories, but there are some differences for a given station category. The medium species were also disproportionately large in utilizing the available niche space. The small species utilized their niche space to a lesser extent, having their maximum utilization at the experimental stations. Large species have smaller values. Values of $\overline{D_i/K_i}$ were almost the same across within-size categories. For this particular factor, medium and large species acted as a coherent unit. The small species (and the all-species) tended to be low in their measures of competitive success.

This may be because of the fact that small species are more effective competitors with each other and tend to overlap less. The mechanism underlying this type of competitive pattern is not known as is the explanation for the all species grouping. This is also indicated by the fact that in the breakdown among size groups there is more competitive success within a size group. In terms of mean value of alpha, these values were consistent over all of the various stratifications. The small species exhibit the most divergent patterns of ecological overlap, since they are overlapping greatly with each other at all, control and experimental station groupings. Thus, this indicates they may be competing less and, therefore, able to overlap more in this particular environment. The exact mechanism underlying this pattern is not known. However, on a biovolume type of classification, smaller mass would be supported to a greater degree by a given environment, and perhaps that is why higher overlap is possible.

In regard to diversity values, these were largely consistent within a size category. Values for large, small, and all species, however, decreased at the experimental stations. Within a particular classification the all species and the medium species have the highest values of H_T for the various groupings. This indicates that these are the more "ecologically-even" types of phytoplankton size components in the river. In general, the small species are different in terms of $\overline{D_i/K_i}$ and H_T. The large and medium species differed more in terms of relative community niche breadth and relative species niche breadth, $\overline{\%K_i/(B_i/\hat{B})}$ and diversity. All species were the most different in terms of diversity and the experimental stations exhibited some differences in particular for small species.

(ii) Summary of statistical results

- The "small" category

For the small species group, the ANOVA tests found little difference in variance among date or among station (Table 10, B-36). Within a date group or station group, however, differences were demonstrated by the coefficients of variation. For the community structure values, there was almost no variation across stations in the fall and little across date for the experimental station group. Usually values for fall control stations, fall experimental stations, and summer experimental stations were equal, while summer control stations showed the only differences.

The community density increased in the fall, and was lower for the control stations in the summer. The blue-green, Oscillatoria sp., was the dominant species in the small group and strongly influenced this and other patterns. As explained, however, this was a misclassification that did not take into account Oscillatoria's tendency to form large filamentous colonies. The dominant species table indicated that the real dominant in this size category was Navicula sp., a diatom, which also tended to be more successful in the fall. For all stations, the species composition was Oscillatoria sp. 78%, and Navicula sp. 11%, but for control stations in the summer it was Oscillatoria sp. 64%, and Navicula sp. 20%. Associated with this result, the value of diversity was low when compared to other groups at about 1.0. In the summer control stations, the diversity increased to 1.6.

Table 10: Summary table for phytoplankton by biovolume

	BY STATION/DATE				
	$\bar{x}$ (cx)	STATION, DATE (cx)	(cx)	STATION df	DATE df
SMALL					
species diversity H	1.15 (.25)	(.12)	(.18)	.60	.42
$\bar{B}/E$	.59 (.19)	(.11)	(.18)	.52	.21
$\bar{B}/\bar{B}$	1.14 (.06)	(.02)	(.07)	.75	.09
mean alpha $\bar{\alpha}$	.72 (.17)	(.14)	(0)	.32	1.00
$\overline{\%k_i(B/B)}$	.76 (.11)	(10)	(.04)	.26	.69
$\bar{D}/k$	.20 (.17)	(.12)	(.05)	.41	.74
minimum λ	.02 (.64)	(.31)	(.31)	.60	.60
harmonic mean λ	.08 (.61)	(.39)	(.30)	.48	.60
variance λ	3.26 (.31)	(.27)	(0)	.29	1.00
MEDIUM					
H	2.36 (.10)	(.08)	(.07)	.39	.42
$\bar{B}/E$	.81 (.14)	(.04)	(.16)	.77	.04
$\bar{B}/\bar{B}$	.66 (.13)	(.14)	(0)	.09	1.00
$\bar{\alpha}$	.54 (.11)	(.10)	(.07)	.25	.45
$\overline{\%k_i(B/B)}$	.98 (.05)	(.04)	(.04)	.46	.35
$\bar{D}/k$	.28 (.13)	(.11)	(.01)	.29	.93
minimum λ	.04 (.80)	(.84)	(.03)	.14	1.00
harmonic mean λ	.13 (.74)	(.83)	(.13)	.09	.86
variance λ	2.07 (.22)	(.23)	(.03)	.13	.90
LARGE					
H	1.85 (.20)	(.02)	(.25)	.90	.006
$\bar{B}/E$	.64 (.22)	(.12)	(.24)	.56	.11
$\bar{B}/\bar{B}$	.73 (.26)	(.09)	(.27)	.75	.13
$\bar{\alpha}$	.48 (.06)	(.03)	(.06)	.59	.18
$\overline{\%k_i(B/B)}$	.77 (.39)	(0)	(.47)	1.00	.96-4
$\bar{D}/k$	.32 (.08)	(.02)	(.09)	.76	.06
minimum λ	.07 (.75)	(.20)	(.81)	.78	.13
harmonic mean λ	.21 (.74)	(.22)	(.76)	.75	.15
variance λ	1.59 (.11)	(.03)	(.13)	.86	.011
ALL SIZES					
H	2.73 (.20)	(0)	(.05)	1.00	.556-4
$\bar{B}/E$	.69 (.10)	(.03)	(.11)	.74	.07
$\bar{B}/\bar{B}$	.92 (.21)	(.06)	(.21)	.78	.19
$\bar{\alpha}$	.60 (.13)	(.10)	(.04)	.39	.72
$\overline{\%k_i(B/B)}$	.79 (.24)	(0)	(.30)	1.00	.116-2
$\bar{D}/k$	.10 (.14)	(.07)	(.07)	.59	.59
minimum λ	.10 (1.26)	(1.40)	(.45)	.09	.71
harmonic mean λ	.37 (1.44)	(1.36)	(.24)	.032	.83
variance λ	6.92 (.23)	(.19)	(.05)	.31	.83

The value of relative species niche breadth, $\bar{B}/\hat{B}$, was high and consistent at 1.1, while the rest of the measures indicated that the community was more successful in exploiting the available ecological space in the fall than in the summer. The relative community niche breadth, $\hat{B}/E$, was about .65 everywhere except the summer control stations where it declined to .4, while the mean niche overlap, $\bar{\alpha}$, was high at .7 in the fall and very high at .9 for the summer experimental stations, but was only .6 for the summer control stations. The stability measures showed fairly low stability overall, with little variation in time or date. There were indications that the fall experimental stations exhibited the low stability and the more reliable measures suggested relatively high stability at the summer controls.

Values of $\overline{D_i/K_i}$ and $\overline{K_i/(B_i/\bar{B})}$ consistently had high coefficients of variation over species, and in addition, the dominant species table demonstrated several differences in the seasonal pattern of bluegreens versus the other small dominants listed. Considering the similarity of patterns for small species to those for the bluegreens, if Oscillatoria had not been included, the small algae may have shown a general increase in success from summer to fall with little or no station differences.

- The "medium" classification

The medium algae were dominated by two species, Nitzschia sp. at 27%, and Scenedesmus quadricauda at 24%. The latter species was first in the summer while the former dominated in the fall. It increased, however, to 43% at the control stations in the summer with a corresponding decrease in

diversity. For most of the measures, the medium group was the most consistent and successful of the biovolume groups. Like the small group, the community structure values were completely consistent in the fall, but showed differences between the station groups in the summer. In this stratification, however, the summer experimental stations were not as similar to the fall groups and the summer control stations could not be placed in an aberrant category.

Relative to the other groups, the diversity of the medium group was greatest, 2.4 (.1), and there was a significant among-environment component. Also highest were the values of community niche breadth averaging .8 (.1) and $\overline{\%K_i(B_i/\hat{B})}$ at 1.0 (.1) while the coefficients of variation over species for $\overline{D_i/K_i}$ were the lowest. The other measures indicated success and stability but not quite as much as the large group.

As for differences, the total density and relative community niche breadth, $\hat{B}/E$, increased (α_f =.04) from summer to fall, but for each season was consistent over station while the species niche breadth and mean niche overlap were greater at the experimental than control stations in the summer. In contrast, $\overline{D_i/K_i}$ and $\overline{\%K_i/(B_i/\hat{B})}$ both decreased for summer experimental stations but showed no overall date change (α_f =1 for $\overline{B_i}/\hat{B}$ and α_f =.9 for $\overline{D_i/K_i}$). Like the small algae, the medium-sized community is generally healthier in the fall but there are also indications that at the summer experimental stations one species, Nitzschia sp., is more successful at the expense of the other species.

The stability measures followed the same pattern, there were differences (α_f =.1) for stations but no change over date (α_f =.9). Also, the minimum eigenvalue (λ_{min}) and harmonic mean (H.M.λ) described the experimental stations as having comparatively lower stability. This result did not agree as usual with the variance and kurtosis of the eigenvalue which both went down for the summer control stations indicating comparatively higher stability.

- The "large" classification

The large species community changed radically over date but remained consistent over station. For all community structure values, the ANOVA tests produced values of α_f over station of .6 to 1, while over dates α_f ranged from .0001 to .2. The density was generally lower in the summer but there were also many indications of greater success. Oscillatoria sp. should have been included within the large group.

For the summer community, Melosira sp. was dominant at 37% and diversity was high, both within and among date components. Community niche breadth rose slightly at the experimental stations while mean species niche breadth remained constant. D (biovolume) decreased at the experimental stations but all the other measures including stability were constant over stations. Most values were similar to those of the other groups except $\overline{K_i/(B_i/\hat{B})}$, and $\overline{D_i/K_i}$ which were fairly high and had low coefficients of variation across species.

In the fall, the community structure did not appear to change except for the probably erroneous values of Amphiprora sp. at all stations in December. Since this is a large species, it dominated over the fall at 68% and over all dates at 57%. The summer diversity was lower than in the fall with no among-date component. Aside from a decline in species niche breadth at the experimental stations, the community structure values were consistent. Compared with fall, the summer community niche breadth fell slightly and the mean species niche breadth rose. D was higher while $\overline{\%K_i/(B_i/\hat{B})}$ decreased from 1.0 to .5, and $\overline{D_i/K_i}$ changed little.

The large species group demonstrated the largest stability of the three size groups. While the minimum eigenvalue and harmonic mean indicated low stability at the fall experimental stations, the variance and kurtosis of the eigenvalues demonstrated a general but slight decrease in stability in the fall.

- All sizes

The results in Table 10 for all groups are dominated by the large size group, and since it includes Oscillatoria sp., will provide better results for some measures than the table for the large group. As usual the October-December period was consistent for all community structure values while June-September showed a few station differences. As with the large table, the fall and summer had significant differences although not as marked as with the large size category. Oscillatoria sp. was the fourth dominant and it was tied with Coscinodiscus sp., except for the experimental

stations in the summer where it replaced Melosira sp. as the dominant species without modifying diversity. Comparing the all-groups to the large species table, within environments diversity increased and community niche breadth increased, while $\overline{\%K_i/(B_i/\hat{B})}$ and particularly $\overline{D_i/K_i}$ decreased.

For the summer, the species niche breadth, the niche overlap and the percent carrying capacity increased at the experimental stations while everything else remained the same (α_f =.6 to 1). This result corresponded with a large increase in the relative density of Oscillatoria sp. In the fall, Amphiprora sp. was dominant but at a reduced 58% of the community. The station groups were consistent and compared with the summer, diversity decreased (α_f =.0001), community niche breadth decreased slightly (α_f =.07) and species niche breadth increased (α_f =.2). $\overline{\%K_i/(B_i/\hat{B})}$ decreased (α_f =.061).

The stability measures for summer and fall, considering the numbers of species and cases, cannot be considered as reliable as those for separate groups, particularly since the harmonic mean of the eigenvalues showed the most stability for experimental stations (α_f =.03) and less for all-stations. All-dates however demonstrated higher stability for all-stations and equal stability between control-stations and experimental stations.

- Group comparison

Comparing the groups, without regard to minor date and station differences, we see that the most variable group, the one showing the overall weakest community structure and

the most instability is the small group. Its higher variation, however, can be explained by the fact that it was largely dominated by one species, Oscillatoria sp., which was a misplaced large species. This also accounts for the small group being more like the large group than was the medium group. The small group had the highest mean relative species niche breadth, the highest mean niche overlap, and the highest percent carrying capacity. The medium group and summer large group were similar and successful at utilizing the ecological space. The medium algae showed higher diversity, higher niche breadth, higher $\overline{K_i/(B_i/\hat{B})}$, and higher stability than the summer large group which were in turn higher than the fall large group for those measures. The other measures, niche overlap and competitive success $(\overline{D_i/K_i})$ remained constant over date for the large group.

As for the date and station variance, some of the minor variation in relative niche breadth and stability can be attributed to the discrepancies in sample number. The clear trends appear to be that the fall values are consistent. The summer values for the small and medium size groups exhibited the only station differences. The experimental stations were better than the control stations and as good as or better than the fall, and more similar to the fall values than the control stations. The population levels are lower at the experimental stations than the control stations, but most of the dominants in each class are more successful. In fact, Oscillatoria sp. in the small group and Nitzschia sp. in the medium group bloomed on at least one date. These differences could be explained by one or more hypotheses and are discussed in the DISCUSSION, Section A.

C. ROTIFER COMMUNITY

1. The Sampling Program and Selection of the Stations (Tables C-1 and C-2)

Rotifers are part of the micro-zooplankton community and were sampled on the same dates, and at the same stations as the phytoplankton. Therefore, the remarks made in the previous section apply here.

To collect the micro-zooplankton, a 76μ Wisconsin-type plankton net (11.4cm) was pulled vertically up through the water column from a given depth. The net was towed consecutively from 10 feet, 20 feet and 30 feet to the surface for the purpose of sampling the corresponding depth strata. The animals collected were preserved in 5-10% formalin for enumeration which was accomplished with 3 aliquots in a Sedgwick-Rafter counting chamber. The length of the tow and the area of the net opening was used to calculate the volume sampled. The counts were expressed as number of organisms per cubic meter. In contrast to the phytoplankton, the zooplankton taxonomy was not as detailed. The cladocerans and rotifers were identified to genus while the copepods were only identified to class and order. This meant that only the rotifers had appropriate taxa to justify niche analysis. The cladocerans and copepods were completely disregarded.

Table C-1 is similar to Table B-1 except for the addition (to the table) of water quality data from the bottom samples. Table C-2 lists the samples taken, as with Table B-2. There was an additional zooplankton collection in May, so there is a maximum of 8 dates sampled. With the exception that varying depths were sampled, the remainder of the inadequacies of the phytoplankton program apply

here. It would appear, however, that due to clogging of the nets, only the first portion of the tow effectively sampled the rotifer community. This could have several effects, such as underestimation of peak abundances due to varying degrees of clogging. Usually, the mean density decreased as the net was pulled from the deeper depths.

2. The Species and Their Trophic Characterization (Tables C-3 and C-4)

There were 16 rotifer genera or taxa sampled, including one unidentified encapsulated form which was found on one date; these species are listed in Table C-3, with size and information on trophic classification. There are two main feeding strategies among rotifers. Some feed by filtering (or sedimentation) small food particles, while others are seizers and actively take in food particles. Regardless of feeding behavior, both types feed on the same size class of organic material and, therefore, all rotifers were analyzed together as a single group of competitors. This stratification may be erroneous in that it is possible that all species were not competitors, however, the available data and literature were inadequate to delineate trophic status in more detail. The unidentified encapsulated form was probably a resting stage for one (or more) species. It would not have been an active part of the rotifer community and was, therefore, not considered as a resource competitor. Table C-4 is the frequency of occurrence table and total occurrences are given by date, station, and depth. There is also a column for the number of dates on which each species was found.

3. Stratifications of the Data for Niche Analysis (Tables C-5 and C-7)

Table C-5 is the data frame which illustrates that all available data were used for a total of 143 samples over 8 dates, 7 stations,

and 3 depths. Of the species present, only those found in more than 10% of the samples were used (with the exception of the encapsulated form). The 8 species that were used in the analysis are listed in Table C-6 along with their relative abundances and frequencies.

The stratifications used and the associated data-coding information are given in Table C-7. Ordinary stratifications were run by station, by date, and by depth. The by-station stratifications included a comparison of all, 4 control, and 2 experimental stations, while the by-date runs included May-August, July-October, September-December comparisons (note the overlap). Finally, runs across date for each depth were made, constituting a two-way stratification. Stations 3 and 5, which were poorly sampled, were excluded from these two-way cases. The dates were run in pairs, that is May-June, July-August, September-October, and November-December, over the 3 separate depths and all depths together.

4. Results by Density

a. Stratification by Station (Tables C-8 and C-9)

In the Tables C-8 and C-9, the community structure and stability values for all, control, and experimental stations, as well as the seven separate stations are given. These stations are the same as those discussed for the phytoplankton community. Stations 6 and 7 are treated as experimental ones, while the first five are control stations.

There are many missing samples especially for the stations RDE, RI, and DI, as was the case with the phytoplankton data set. Out of a total of 143 samples over date, station, and depth, 110

of them were taken at the control stations, and only 33 of them for the experimental stations. Nevertheless, the bias related to date is not as pronounced as for phytoplankton because there was a set of samples taken in May with only one station missing. The worst month was June when only 4 out of 7 stations were sampled and the worst station was DI where only 4 out of 8 months were sampled.

There were few problems with the species list and those species which were deleted were not common enough to be adequately sampled or, in the case of the encapsulated form, were clearly not competing. The rotifers were counted by genera and 8 were used here. An adequate sample to species ratio was maintained throughout the stratifications so that none of the determinants needed correction.

Table C-9 includes the coefficients of variation for the community stratification by station. For this stratification, most of the niche measures for control stations were consistent and there are few coefficients of variation that are over .5, all of which relate to matrix properties [determinant; the minimum eigenvalue, and the maximum, variance, and arithmetic mean of the reciprocal eigenvalues.] Likewise, for the all stations group, there was little variation in the community structure measures. Only the determinant, $\min_\lambda$ and max $1/\lambda$, $S^2 1/\lambda$, and $\overline{1/\lambda}$ showed significant variation over the .5 level. In the experimental stations, however, several factors exhibited variation. In all, varying factors included the determinant, $\min\lambda$, H.M.λ, and max $1/\lambda$, $S^2 1/\lambda$, and $\overline{1/\lambda}$. Generally there was more variation in the niche measures at the experimental stations then at the control stations.

In Table C-8, niche measures are given. The only notably different experimental station was Danskammer Intake, DI, while Roseton Intake, RI, seemed completely unaffected. The station across the river from the plants, RDE, showed similarities to DI but was not as different as it had been for the phytoplankton. The other station that exhibited differences for phytoplankton was the south-west control, RSCW. It was equally different for rotifers, but consistently in the opposite direction from DI. Density was significantly less at RSCW compared to the other stations, and significantly increased at DI. Keratella sp. and an unidentified bdelloid were the two most abundant species at all stations, as well as the separate stations throughout the study. There was some indication that there were species differences among the stations in that the Roseton Intake (Station #6) and Danskammer Intake (Station #7) exhibited a change from Ploesoma sp. to Notholca sp., and Brachionus sp. This is also true when separate stations were averaged. In terms of diversity, there was a trend of decreasing diversity from total, to mean depth, to mean time, to mean time-depth diversity. These trends were common in our results as already discussed for phytoplankton. In general, the mean-time depth diversity accounted for about 60% of the total diversity. Diversity was not particularly high in any situation, however, and it was generally consistent, declining slightly for among-date diversity values at the experimental stations. There was a slightly decreased value for within H at RSCW but also a considerable increase in both among-date and among-depth diversity.

The relative community niche breadth value was consistent when all, control and experimental stations were compared. Values of mean species niche breadth, and the mean species niche breadth over E were also consistent. Species tended to utilize their

community niche breadth slightly more at DI as indicated by $\overline{B}_i/\hat{B}$. The community utilized approximately 68% of the available ecological space while individual species utilized approximately 40% of the available community niche breadth, and about 28% of the available environments. These measures were less consistent when these stations were considered separately. The south controls, RSCE and RSCW, and Roseton Intake, RI, had lower values of relative community niche breadth than did the other stations. The relative species niche breadth, however, was consistent except that the value for the Danskammer Intake station was high. The values for $\overline{B}_i/E$ and $\hat{B}/E$ were consistent for all separate stations as well as station groups.

The carrying capacity ($\overline{\%K_i}$) was consistent except at Danskammer intake station where species possessed a higher carrying capacity. The $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ ratios were consistent for control stations but with small decreases at RI for $\overline{\%K_i(B_i/B)}$ and at DI for $\overline{D_i/K_i}$. As mentioned previously, the coefficients of variation for experimental stations were high, but the values themselves were consistent. Values for species breadth, (B'_i), and relative species breadth (B'/N) were constant in the comparison of the stations. The value of B' declined substantially at the RSCE station, the RDE station, and Danskammer Intake station. The mean value of alpha, $\overline{\alpha}$, was constant and could be considered consistent for all stations, versus control, versus experimental stations comparisons, as well as for each of the separate stations, except the DI station, where it increased. This latter station had the most thermal influence (more than the RDE station). The Danskammer Intake Station also showed the most variation for rotifers than any of the other stations sampled.

The stability measures of the experimental stations exhibited reduced stability, particularly at DI and RDE. For all stations, the measures indicating increased stability included minλ, $S^2 1/\lambda$, and H.M.λ, and range $1/\lambda$, $S^2 1/\lambda$, and $\overline{1/\lambda}$. For control stations, values for the determinant, the min λ, the $S^2 1/\lambda$, and H.M.λ, as well as range $1/\lambda$, $S^2 1/\lambda$, and $\overline{1/\lambda}$ showed increased stability. In the experimental stations only values for the covariance of alpha exhibited an increased stability.

Comparing the separate stations, the RSCW station exhibited the most stability including values for the minimum value, harmonic mean, range, skewness and kurtosis of the eigenvalues; and variance and arithmetic mean of the reciprocal eigenvalues. For the latter station, covariance of alpha was stable, as was the skewness and kurtosis of the eigenvalues. Consequently, when considered by station, the rotifer community appeared to have a high degree of integrity. The exception being for the Danskammer Intake station which exhibited some changes, although not large ones in comparison with the other community stratifications. The shift in species in this station indicated that perhaps there was some other type of influence acting on this location of the river.

b. Stratifications by Date (Tables C-10 and C-11)

At first glance, the rotifer by-date table seems relatively irregular. As the coefficients of variation table, C-11 shows there were few consistent properties except for relative community niche breadth, $\hat{B}/E$, and $\overline{\%K_i/(B_i/\hat{B})}$ which were regular throughout the rotifer community. There were definite seasonal patterns, however, and some interesting relationships were

elucidated among the measures consistently over the months. In this particular stratification, the September to December groupings showed the least variation. Only the value for covariance of alpha (cov α) and the carrying capacity ($\bar{K}_i$) showed variation over .5. For the May to August date stratification, covariance of alpha, the determinant, the minimum lambda, the H.M.λ; and the maximum, variance and arithmetic mean of the reciprocal lambda values were greater than .5. For July and August, values for the covariance of alpha, the determinant, the minλ, $S^2 1/\lambda$, and H.M.λ, and the maximum, variance and arithmetic of the reciprocal lamdas showed high variation over the .5 level. In general, this high variation in the stability measures was consistent with the findings in other functional groups. Because of the high variation with two of the date stratifications, the all month groupings also showed variation in $\%K_i$, cov α, $|A|$, min λ, H.M.λ and the maximum and variance of the reciprocal lambda values.

Table C-10 illustrates the breakdown by months from May to December with the three monthly groupings, May to August; July to October; and September to December. There were substantial changes in species dominants with seasons. Keratella and the unidentifed bdelloid, the two dominant species, accounted for over 50% of the community abundance. Keratella was fairly low and decreased from May until September and then increased to 60% from October to December. Trichocera was not abundant in the latter part of the year, while Notholca was. Ploesoma and Polyarthra were not abundant in the last part of summer. Density followed a seasonal pattern being higher in the colder months, May, June and December than in the late summer, August to October. There were two other decreases in July and November, which were unexpected but associated with relatively

higher percentages of the dominant species, Ploesoma at 53%, and Keratella at 68%.

These density patterns were reflected by the within-environment diversity measures. There were significant diversity components among stations and depths which, comparing their values, were understandably attributable mostly to stations. Total diversity declined only for July and November. While comparison of the four month groups showed a steady decrease in all components of diversity, the among diversity for the separate stations followed an increasing trend from May to September and it decreased from October to December.

The other major pattern was mean relative species niche breadth ($\overline{B_i}/\hat{B}$), which was highly correlated with niche overlap ($\overline{\alpha}$), percent carrying capacity ($\overline{\%K_i}$), competitive success ($\overline{D_i/K_i}$) and also with the stability measures: minimum eigenvalue, and harmonic mean of the eigenvalues. The correlations were stronger if the inadequately-sampled month of June is not considered. As the group comparisons illustrate, the ratio $\overline{B}_i/\hat{B}$ is usually consistent although it decreased slightly in mid-summer. There are decreases at the two previously mentioned months, July and November, with another in September, which might be attributable to the salt front intrusion.

As with the station stratifications, the mean time-depth diversity measures appeared to account for approximately 60% of the total diversity. In general, the diversity measures declined as the year progressed, although this may not be a significant change. There is the familiar decreasing trend from total diversity to mean time-depth diversity. The values for the relative community niche breadth were consistent for all the

seasonal groupings, except for December when it increased. The first three dominants are consistent: Keratella sp. (37%), and unidentified bdelloid (20%), and Trichocera sp. (11%). These decreases may be associated with some changes in the species dominance. For example, when the niche breadth decreased in July, Keratella was declining as the dominant in the community. When niche breadth increased again in October, Keratella sp. was also increasing at that time. This seemingly irregular pattern is, however, repeated in numerous other measures and could be an (mathematically-related) artifact, although it seems to be a real effect. As $\bar{B}_i/\hat{B}$ decreased, so did $\bar{B}_i/E$, percent carrying capacity ($\overline{\%K_i}$), and mean value of alpha, while the minλ, and H.M.λ increased. $\overline{D_i/K_i}$ also increased as relative species niche breadth ($\bar{B}_i/\hat{B}$) decreased but the relationship was not as strong and there was also an increase in the June values. These correlations were also found, though not as noticably, in the other rotifer stratifications.

The $\overline{\%K_i/(B_i/\hat{B})}$ values were, as usual, consistent except for a slight decrease at RI. The value of B'/N, which relates diversity to the number of species, showed a decrease in the group comparison as the year progressed. The separate month values exhibited a large increase in June, perhaps a sampling effect, and a decrease in November when Keratella sp. was highest in species composition. On the other hand, the niche breadth measure, H', increased through the season groupings.

The July to October period possessed the most consistency in terms of the stability measures: covariance of alpha, the corrected determinant, the minimum, the variance, the harmonic mean, skewness and kurtosis of the lamdas and the range, variance, and arithmetic mean of the reciprocal lambda values.

September to December rankings and all month rankings showed enhanced stability in terms of the skewness and kurtosis of the eigenvalues, and the range, variance, and arithmetic mean of the reciprocal eigenvalues. The all months values were also stable in regard to the minimum, variance, and arithmetic mean of the reciprocal of the eigenvalues. Much of the stability in the July to October ranking can, therefore, be related to the July period when the value for covariance of alpha, the determinant, the minimum, range, variance, and harmonic mean of the lambdas indicated enhanced stability of the community. The skewness and kurtosis of lamda were particularly low in July, whereas the skewness and kurtosis measures for May, October and December appeared to indicate stability. It is interesting that enhanced stability appeared to come about at the time of year (July) when the most changes were taking place including the most deviations from the consistent patterns of community structure.

c. Stratification by Depth (Tables C-12 and C-13)

The rotifer community was sampled at three different depths: 0 to 10 feet, 0 to 20 feet, and 0 to 30 feet in Table C-13. The coefficient of variation for depth indicates that there was little variation in the niche measures, except for the determinant, and the maximum reciprocal lamda (max $1/\lambda$) values.

In Table C-12, the niche measures for all depths, versus the three separate depths are given. The depth stratification brought out the most consistent properties in the rotifer analysis in spite of the lower densities at the two deeper depths. This implies that the rotifer community was locally uniform particularly with respect to depth, and the sampling

method. This result also implies that fluctuations in total population level do not directly affect community structure as a whole or most of the measures of it we have used. What differences there were, were at the 0-10 foot level and were mostly too small to be considered important.

Values for diversity were similar for all of the components of diversity. Again the same trend of decreasing diversity from total diversity to mean time-depth diversity was apparent. About the only unusual community structure values were H and B' at 0-10 feet which indicated a significant rise in among-environment diversity. This is supported by the depth x date stratification where diversity shows the same pattern for all months.

With regard to niche breadth measures, values for $\overline{B}_i/\hat{B}$, $\overline{B}_i/E$ and $\hat{B}/E$ were all consistent with no exceptions. Values for density were greatest in the 0 to 10 foot stratification, followed by the 0 to 20 foot depth community. The carrying capacities followed the same trend of increasing from surface to bottom. This is of course was a common result with the rotifer distribution patterns. There was slightly less competitive overlap and slightly more competitive success at 0 to 10 foot than below. Values of percent carrying capacity ($\%K_i$) and $\overline{\%K_i/(B_i/\hat{B})}$ were consistent. Consequently, all of the community structure measures were extremely similar, with little variation or deviation from the mean values.

Stability measures for the all depths situation were consistent including variance, harmonic mean, skewness and kurtosis of the eigenvalues and the range, variance, and arithmetic mean of the reciprocal lamda values. The depth indicating the greatest stability was the 0 to 10 foot range with slightly lower values for all-depths combined.

d. Two-Way Stratification by Date and Depth (Tables C-14 to C-17)

Tables C-14 and Table C-15, show a two-way stratification by date and depth for the rotifer community. The coefficients of variation for these tables are given in Tables C-16 and C-17. In the first coefficients of variation table (C-16), depths over all dates were stratified by 0 to 10, 0 to 20, 0 to 30 feet, and all depths. All of the community structure values had coefficients of variation less than .5. Thus, the rotifer community exhibited a high degree of structure or integrity, especially in regard to its niche values. Several of the values of the stability measures had coefficients of variation over .5. These included $|A|$, minλ and H.M.λ, and max $1/\lambda$, $S^2 1/\lambda$ and $\overline{1/\lambda}$. The mean alpha and the stability measures showed a decrease in variation from 0-10 foot to the 0-30 foot intervals.

In Table C-17, the coefficients of variation are given over depths for each date group. The column on the second page labeled 'All months/All depths' is for the coefficients of variation over depths for the all-months group while the column labeled 'All depths/All months' is taken over all categories for each depth and two month period. The same trends were apparent here as were apparent in Table C-16, but some of the stability measures have more variation, and the diversity measures less. The months of September and October showed the least variation for community structure values. For example, the May and June stratifications had values for the coefficients of variation for density and stability that were low and only the determinant and variance ($S^2 1/\lambda$) of the reciprocal eigenvalues had large variation. Most of the values, however, were just over the minimum cut-off point (.5). Depth variation was shown in

the July and August stratifications and included the values of the determinant, the minimum and the harmonic mean of the eigenvalues, and the maximum, variance and arithmetic mean of the reciprocal lambdas. The November and December stratifications also exhibited low variation. Only the covariance (cov α) and determinant of the alpha matrix exhibited variation over .5. Values for all depth-all month stratifications were lower with only the corrected determinant and the maximum of recriprocal eigenvalues showing higher than .5 variation.

Tables C-14 and C-15 give the breakdown of this two-way stratification by date and depth. Tables C-14 and C-15 are essentially the same table listed in two parts. Table C-14 has 0 to 10 foot and 0 to 20 foot depths and C-15 has 0 to 30 foot depths as well as all depths which we have already considered. Consequently, we will consider both of these tables together. In Table C-14, the community was stratified for two month intervals for each depth, 0 to 10, 0 to 20, and 0 to 30 feet. As demonstrated by the other tables there was little variation in species composition across depth but there was a definite seasonal pattern. In addition, it was indicated that in regard to depth variation it was mostly in the July and August period. The first two dominants, Keratella sp. and the unidentified bdelloid, were most abundant in the first and last parts of the year. The bdelloid was highest in May and June when it was dominant (30%), while for the rest of the time Keratella sp. was higher at 40 to 60%. In July and August, there was a decline in density except at the surface and the two dominants were Ploesoma sp. and Trichocera sp. There were large numbers of Ploesoma sp. at the surface then, and it dominated at 31%. At the other two depths, Trichocera dominated at 32%. This big shift in species dominants may account for some of the changes

described earlier in the stability measures at this particular time of year. The diversity values were all similar for the various depth stratifications. There was a slight reduction over depth in the early part of the year. In general, the within-diversity values decreased through the year while the among-diversity components were highest in July and August. In all cases, the November and December values were lower than at other times of the year. Usually, the mean time- depth ($\bar{H}_h$) diversity accounted for 60% of the total diversity. Values of the components of diversity, usually decreased in a regular pattern from total (H) to mean depth ($\bar{H}_d$) diversity.

The community niche breadth patterns were consistent with the other data stratifications. With the exception of the relative community niche breadth, ($\hat{B}/E$), the niche breadth values were regular over the whole stratification. There was a slight increase in the early part of the year. This may be a sampling effect. Values of relative species nich breadth ($\bar{B}_i/\hat{B}$) and B_i/E were consistent. Exceptions included: the all months, and July and August, 0 to 10 feet; the November, 0 to 20 feet; and the all months, 0 to 30 feet values, were not included in the consistent patterns. Values of $\bar{B}_i/E$ were regular for all depths for 0 to 30 foot except for the all months values. These were not consistent for 0 to 10 and 0 to 20 feet depth ranges. Although the relative species niche breadth had a higher range of fluctuation than expected, niche breadth patterns were consistent, particularly in this stratification.

The other measures showed similar patterns. The niche overlap ($\bar{\alpha}$) was constant except at 0-10 feet in July and August where it decreased slightly. The percent carrying capacity ($\overline{\%K_i}$) was

most stable at the 0-30 foot level and, in fact had a large increase at 0-20 feet for November and December where relative species niche breadth also increased. $\overline{\%K_i/(B_i/\bar{B})}$ decreased here as well and also at 0-30 feet for the same months but otherwise it was more stable. The $\overline{D_i/K_i}$ values exhibited a larger correlation with the among-environment diversity in this table, declining over depth slightly, increasing in July and August and decreasing in November and December. Also, the coefficient of variation over species for this measure rose substantially in the last two months as Keratella sp. became dominant.

The stability measures showed patterns similar to $\overline{D_i/K_i}$ for all depth categories, the values for all-months exhibited the greatest stability in all measures (covariance of alpha, determinant of alpha, minimum, harmonic mean and, variance of the eigenvalues and the reciprocal eigenvalue measures). The all-depths measures also showed consistently higher stability than those for separate depths, again demonstrating global stability effects.

There was a slight decrease in stability from the 0-10 foot level as compared to the lower depths while, in all cases, the summer months were much higher than the first or last date group. For 0-10 feet and for the all-depths group the July-August period was the highest in stability as shown by the covariance of alpha, the minimum, the variance, the harmonic mean of the eigenvalues and the reciprocal eigenvalue measures. For 0-20 feet and 0-30 feet the covariance of alpha, the minimum eigenvalue and the harmonic mean of the eigenvalues indicated the greatest stability. The variances of eigenvalues were

lowest for July and August, however, and in general, the eigenvalue variance (S^2_λ) for these months was about equal to that for all-months. The smallest skewness ($S\lambda$) and kurtosis ($K\lambda$) measures occurred in May and June in all cases except 0-20 feet where stability was the greatest in July and August.

e. Niche Measures for the Dominant Species (Table C-18)

The dominant rotifer species are given in Table C-18. This stratification is over stations. Generally, there were no particular trends with stations. The rotifers were extremely variable, more than the phytoplankton, as has been already discussed with the rotifer community results. Most of the niche values for the four species studied had ranges greater than .15. In all of these stratifications, we use either .15 or 15 units, depending upon which is appropriate for the particular niche measure. Unfortunately, the second dominant species, the unidentified bdelloid, was omitted from the table.

Keratella sp. was the most abundant and least variable of all species. Its $\overline{D_i/K_i}$ ratio varied by only 10%. In terms of its effect on the community versus the effect of the community on it, Keratella sp. asserted the greater effect on the community, as did Polyarthra sp. For Trichocera sp., these effects were approximately equal although Ploesoma sp. had a lower effect on the community than did the community on the species. There were several values that possessed coefficients of variation with cut off points greater than .50, especially in regard to Ploesoma sp. Trichocera sp. and Ploesoma sp. generally exhibited similar patterns for niche breadth measurements. The $\overline{D_i/K_i}$ ratios appeared to follow those of D, and the $\overline{K_i/(B_i/\bar{B})}$ values for all species were approximately the same. This may

indicate that predation was a major factor in delineating community structure since these species were relatively the same size and exhibited similar patterns.

f. Summary of the Rotifer Community Results (Table C-19)

(i) Overview of the consistent properties

Rotifer results are summarized in in-text Table 11. Selected niche measures for all stations, versus control, versus experimental, versus the depth stratifications for all dates for 0 to 10 feet, 0 to 20 feet, and 0 to 30 feet are given. The relative community niche breadth ($\hat{B}/E$) was consistent over these various stratifications, as is the relative species niche breadth ($\bar{B}_i/\hat{B}$), $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$, and the mean value of alpha (α). The total diversity value (H_T) showed slightly more variation because of its larger magnitude, but it can still be considered consistent.

Generally, the rotifer community was highly structured, and although the general patterns were discernable at single stations, more structure was apparent as larger chunks of the environment were considered. There was some variation associated with the community, especially in July and August. Interestingly enough, however, these months also exhibited increased stability patterns. In terms of the station stratification, there was some deviation from normal values at the Danskammer intake station, however, this deviation was not large.

(ii) Summary of statistical results

The rotifers showed less variation by station than phytoplankton and, if not regular over dates, showed definite

Table 11: Summary comparison of important niche measures for the rotifer community by station and date

Niche Measure	All Stations	Control Stations	Experimental Stations	Depths 0-10	Depths 0-20	Depths 0-30
$\hat{B}/E$	.68	.69	.67	.74	.68	.66
$\overline{B_i}/\hat{B}$	.38	.38	.44	.35	.46	.41
$\overline{\%K_i/B_i/\hat{B}}$	1.01	1.00	.95	1.01	.97	1.01
$\overline{D_i/K_i}$	.30	.30	.26	.33	.25	.28
$\bar{\alpha}$	.31	.31	.35	.28	.37	.34
H	2.58	2.56	2.47	2.64	2.45	2.57

seasonal patterns (Table 12). There were several interesting results in the rotifer tables. This group featured a high community niche breadth ($\hat{B}$) and $\overline{\%K_i/(B_i/\hat{B})}$ values and, well, both within and among diversity components were fairly as high. The coefficients of variation over species were low.

The local community, that is at a given date and station, was extremely consistent. For most measures, although there were differences in density and small changes in diversity, there were only two stations which showed many differences.

There were some interesting relationships among the measures given in the by-dates tables. Total diversity followed the percent composition of the dominant species as well as being dependent on the number of species used. The within components (mean H) seemed to vary with density. The relative species niche breadth was highly correlated with mean niche overlap, percent carrying capacity, and some of the stability measures, [minimum eigenvalue (min) and harmonic mean of the eigenvalues (H.M.λ)]. In fact, the niche breadth (B) and carrying capacity ($\overline{K}_i$) values were almost equal: as $\overline{B}_i/\hat{B}$ went down, stability went up. Relative community niche breadth, ($\hat{B}/E$), and $\overline{\%K_i/(B_i/\hat{B})}$ were consistent.

Considering specific patterns, there was only one by dates. The 0 - 10 feet samples showed a higher diversity and density (α_f = .07) than 0-20 feet or 0-30 feet depths with a lower relative species niche breadth (α_f = .02) and niche overlap (α_f = .04).

The ANOVA tests demonstrate that there was more variation with respect to date that over depths. In general, the

Table 12: Summary comparison of statistical results for the rotifer community

	ALL $\bar{x}$ (σ_x)	BY STATION (CONTROL) $\bar{x}$ (σ_x)	BY STATION (CYDEMPLENE) $\bar{x}$ (σ_x)	σ_E	BY DATE $\bar{x}$ (σ_x)	BY DEPTH $\bar{x}$ (σ_x)	BY DATE/DEPTH $\bar{x}$ (σ_x)	DEPTH, DATE (σ_x)(σ_x)	DEPTH σ_E	DATE σ_E
species diversity H	2.47 (.06)	2.51 (.05)	2.38 (.09)	.57	2.04 (.13)	2.35 (.04)	2.20 (.11)	(.03) (.12)	.79	.29E-3
~~B/E~~	.70 (.10)	.71 (.12)	.69 (.08)	.74	.75 (.09)	.69 (.06)	.74 (.08)	(.03) (.07)	.54	.045
~~B/B~~	.44 (.13)	.41 (.05)	.50 (.13)	.31	.93 (.18)	.41 (.14)	.72 (.15)	(.13) (.09)	.017	.37
mean alpha $\bar{\alpha}$	.36 (.19)	.33 (.14)	.41 (.28)	.51	.46 (.26)	.33 (.14)	.43 (.13)	(.12) (.09)	.036	.31
$\frac{\%K/(B/B)}{D/K}$	.47 (.04)	.48 (.03)	.44 (.05)	.46	1.00 (.06)	1.00 (.03)	.98 (.07)	(.04) (.04)	.26	.25
	.27 (.17)	.28 (.12)	.23 (.25)	.46	.24 (.26)	.29 (.14)	.24 (.24)	(.16) (.21)	.17	.042
minimum λ	.11 (.76)	.14 (.63)	.05 (1.13)	.21	.09 (.64)	.20 (.29)	.04 (1.05)	(.25) (.79)	.82	.22
harmonic mean λ	.32 (.49)	.32 (.35)	.19 (.88)	.30	.29 (.51)	.44 (.23)	.15 (.76)	(.16) (.54)	.85	.20
variance λ	1.33 (.31)	1.18 (.18)	1.72 (.39)	.46	1.71 (.42)	1.10 (.29)	1.89 (.24)	(.20) (.20)	.15	.22

rotifers did better in the first and last months than during the mid-summer; however, between these periods there were additional decreases in abundances. The measure which followed this pattern of being highest in May, June and December, low in August, September and October and lowest in July and November was density (α_f = .04) which increased when the others declined. In addition, there were several measures which similarly changed in September: relative species niche breadth (α_f = .4); niche overlap, α_f = .3); percent carrying capacity (α_f = .6); and the stability measures (α_f = .2 or less); these measures often varied over depth.

It is not clear what factors are responsible for these trends in the rotifer community. There appears to be no direct relation with phytoplankton; however, rotifers have other food sources besides the algae. There are competition and predation pressures from other organisms such as microzooplankton, macrozooplankton, and immature fish. However, because information on microzooplankton and macrozooplankton is incomplete, no assessment can be made of their effects.

There were relatively few station differences, specifically for only two stations: the experimental station DI and the control station RSCW. In regard to the t-test results there were no significant differences between control stations and experimental stations as groups. The control station (RDE) that exhibited so many unusual results for phytoplankton exhibited several similarities to DI, whereas RSCW usually deviated in the opposite direction. For the control stations, the coefficients of variation for the niche values were all under .2 except for the stability measures which were somewhat higher.

The t-tests for separate stations showed that most measures differed significantly at DI. The changes included a decrease in total H from 2.5(.06) to 2.2 (α_t =.1) which was associated with a decrease in among-date diversity perhaps because there were fewer dates sampled here. Mean relative species niche breadth ($\overline{B_i/\hat{B}}$) rose slightly from .4(.1) to .54(α_t =.02). Density and carrying capacity both increased; α increased from .3(.1) to .5 (α_t =.02), %K was .4(.1) for the controls but at DI .6 (α_t =.02), while $\overline{D_i/K_i}$ dropped from .3(.1) to .2 (α_t =.07). The stability measures showed reduced stability: the harmonic mean of the eigenvalues (H.M.λ) decreased from about .4(.4) at the control station to .07 (α_t =.1) at the Danskammer Intake and the variance from 1.2(.2) to 2.2 (α_t =.01).

RDE was the most similar station to DI having a low among-date diversity although there were many missing dates as well, a high density, ($\overline{D_i/K_i}$ =.2, α =.4) and low stability (H.M.λ = .2). In contrast, RSCW exhibited the greatest differences with DI, with the highest among date and depth diversities, considerably higher stability and slightly lower densities. The other community measures were not different enough from the rest of the control stations to generate high coefficients of variation. The only measures which remained constant at DI were B/E and $\overline{\%K_i/(B_i/\hat{B})}$, which were consistent and high compared to other groups over all stratifications. $\hat{B}$/E was .7(.1) over stations and varied less over date and depth. This measure was slightly lower at the south control stations and at RI, rose to .9 in December. $\overline{\%K_i/(B_i/\hat{B})}$ was 1.0(.04) by stations and was constant except for a drop to .9 at RI.

D. FISH LARVAE COMMUNITY

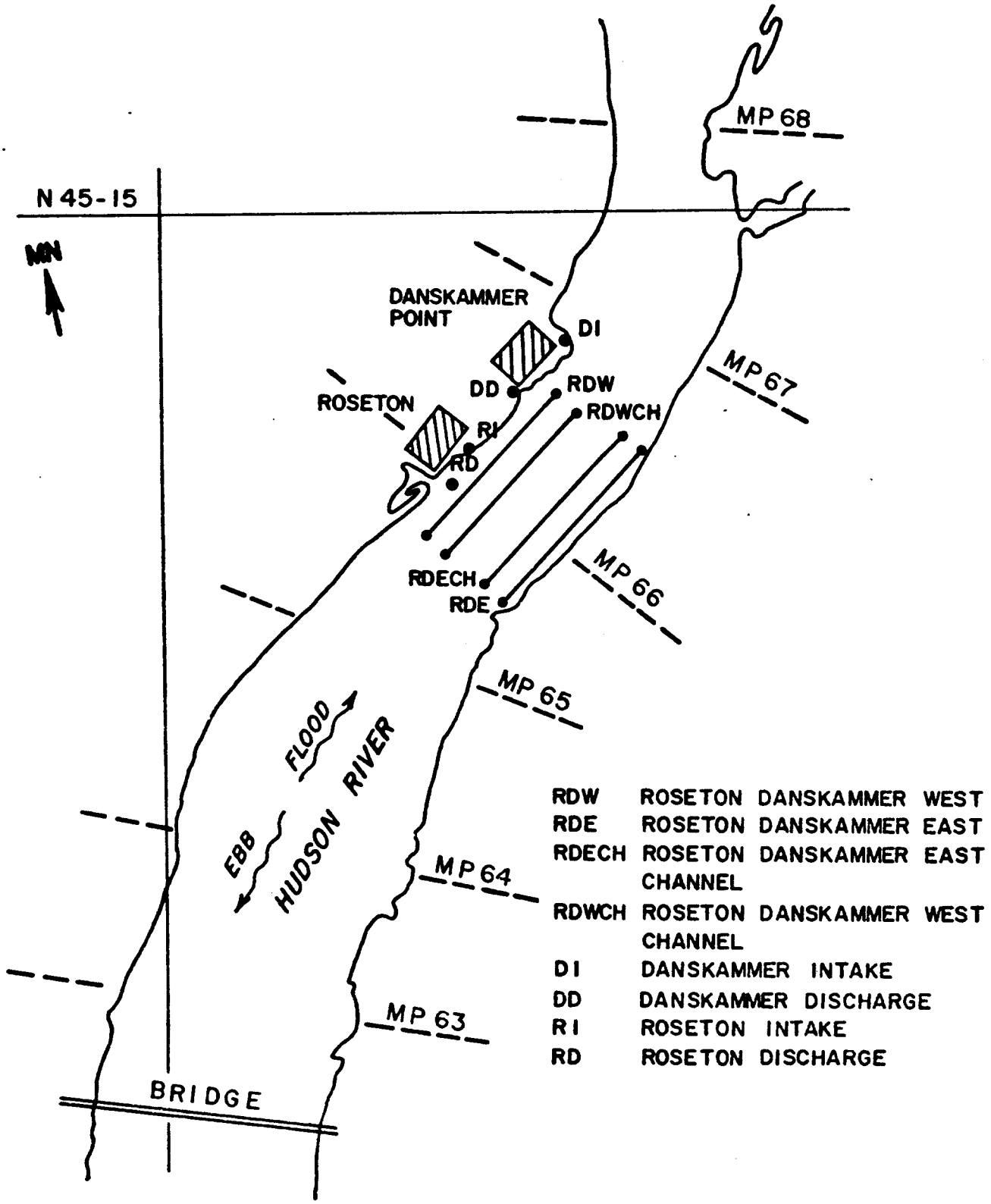
1. Sampling Program (Tables D-1 and D-2)

Fish larvae, sometimes called ichthyoplankton, are immature fish which are present only during certain parts of the year. At these times, their size, abundance and behavior, however, ensures them an important role in the plankton community. Because they usually are prevalent in the summer, sampling was carried out every 10-14 days from March 13 to August 30, 1973. The data appears in Appendix V-A, B, and are discussed in Chapter V of the 1973 LMS Report of CHG&E.

The sampling program in 1973 consisted of two parts carried out concurrently. The first part included trawls from the river. Five minute horizontal tows were made against the tide (or next expected tide) using a 500μ Hensen-type plankton net, six meters long, with a one meter diameter mouth fitted with a TSK flow meter. A half-meter net with 571μ mesh was used on an experimental basis to compare sampling efficiencies. Samples were preserved in 10% formaldehyde and returned to the laboratory for identification and sizing. The total number of larvae (all species) was counted and then counts were made by species. Using the flow data, these counts were reported as number of organisms/1000 cubic meters.

There were four transects across the river parallel to the shore and in the area between the two power plants (see Figure 8). These transects were RDE, RDECH, RDWCH, and RDW, or respectively, Roseton-Danskammer East, Roseton Danskammer East Channel, Roseton Danskammer West Channel, and Roseton Danskammer West; and they are listed in Table D-1 with associated information. However, no chemical data was available for RDWCH or for the 20 feet depth at station RDECH. CH-1 (East Shallows) was used for the RDE trawl and CH-3 (Roseton

Figure 8. Map of Hudson River at Roseton and Danskammer Point Generating Stations illustrating the location of fish larvae sampling stations in 1973



Intake) for RDW. Samples were collected from surface to bottom (which was 0-30 feet for RDE and RDW and 0-50 feet for RDECH and RDWCH) at 10 foot intervals over a 24-hour period (usually about 4 collections were made) so that a complete time-depth-location profile of a given date was obtained.

The surface data were accumulated from the 0 and 10 foot trawls while the bottom sample was taken from between 20 and 30 feet. CH-4 (East Deep) was used for the RDECH trawl. For the east mid-channel trawl, 0 and 10 feet were considered as the surface set, and 30, 40 and 50 feet were considered for the bottom set. The two trawls on the west qualified as experimental stations while the two on the east were used as controls. It has, however, been shown that this whole area is in some ways atypical of the rest of the river, therefore, it would have been better to have trawls conducted in the four regular control areas.

A second set of samples were collected on the same dates inside the plant to directly determine viability of larvae entrained in this area. Samples were taken at the intakes and discharges of both plants over the 24-hour period. Both one and one-half meter nets were used by lowering them on a specially built frame into the intake and discharge areas. At Danskammer Intake, a set of 3 half-meter nets placed at the surface (0 feet), mid-depth (5 feet), and bottom (10 feet) and a set of 2 one-meter nets at the surface and bottom were used. Danskammer Discharge was sampled with a one meter net lowered in front of one of the discharge pipes. Roseton Intake was sampled, (with the pumps running) using half meter nets at the surface (0'), mid-depth (10 feet), and bottom (25 feet) and Roseton Discharge with a half meter net over the pipe. Samples were taken alternately for viability studies and density determinations by varying the duration of the sample. The counting was

done as described above. Using flow meters the counts were expressed as density of organisms per 1000 m^3. Because these samples were collected under such different conditions it was felt that they could not be compared directly with the others without further studies and therefore, these final samples were not used.

This is the best of the sampling programs discussed in this report. Unfortunately, only about half the samples were processed to the point of identifying species so that usually only 2 of the depth profiles were usable for each date and station. The usable samples were evenly distributed among those which were collected in the day, those in the night and those which covered both time periods. The later samples were designated 'sunset.' In addition, since fish larvae are so seasonal, many samples around the beginning and end of the program contained few or no larvae. Table D-2 gives a complete list and schedule for all the samples taken (in both programs) including those which were empty or not identified. For the four river stations, the experimental samples taken with a half meter net are shown marked with asterisks in the column for the appropriate depth in feet. For the plant intake stations which were regularly sampled with both types of net, the columns marked S and B denote surface and bottom samples, respectively, taken with a one-meter net while the columns marked S*, M* and B* are for the surface, middle and bottom using a half-meter net. (The actual depths are given for each station in the previous paragraph). Finally, since the discharge samples were taken from a pipe outlet, no depth indication is given and the same kind of net was always used for each station (one-meter for the Danskammer Discharge and half-meter for Roseton Discharge). The samples used in the analysis are listed as underlined check marks.

2. The Species and Their Trophic Characterization (Tables D-3 and D-4)

Nine different taxa were identified, plus a category labeled 'other' for uncommon, unknown and damaged-beyond-recognition individuals. Table D-3 lists the species which were analyzed giving size and feeding information for each. It was impossible to distinguish any of the herring larvae (alewife, blueback herring, etc.) to species and therefore they were lumped into Alosa spp.; the exception was the American shad, which was distinguishable. This had unfortunate consequences since the different herring species were all numerous and bred at different times of the year. This lumping, therefore, masked the effect of several ecologically distinct and important species, by including them all in one overly large group throughout the year. The Alosa spp. included 79% of all individuals and was the dominant genus in every stratification. The frequency Table D-4 broken down by date and station demonstrated this, and it also points out the seasonal nature of the larval populations. No stratifications across species were performed.

3. Stratification of the Data for Niche Analysis (Tables D-5 and D-7)

The data from 7 dates, May 10 to August 12, and generally two of three possible time frames (day, sunset, and night) were coded for analysis. At each date and time, all stations had samples for 0, 10, 20 and 30 feet while RDECH and RDWCH also had 40 foot samples collected. Such regularity in the final data, however, was achieved only once in the 14 date-times. Two date-times had to be deleted because they were too irregular, this left 186 cases (out of 779 taken). The final data-frame is on Table D-5 with the number of cases in each category.

There were six species that were present in over 25 samples (5% of the total although using 10% would have been better); these were the species used. They are listed on Table D-6 with their relative abundances and frequencies.

The one way stratifications run were; by-station, by-dates, and by-time. The by-stations runs include all, RDE plus RDECH, RDW plus RDWCH, and RDECH plus RDWCH, as well as each station run separately. Coefficients of variation were computed for each of these sub-categories. In addition, runs were made for each date-time for a two way stratification by date and by time. See Table D-7 for coding information and a list of the runs made.

4. Results by Density

In many ways the results of the fish larvae community are more ambiguous and more difficult to understand than the results from the plankton communities. This may partially result from the fact that the fish larvae group are composed of immature individuals. In this group, not all of the species are feeding simultaneously, therefore, much competitive overlap will be obscured because of the seasonal patterns and variations in the biology of the particular species. From knowledge of the biology then, we would not expect this group to be as consistent or as integrated, in the sense of the other communities of adult organisms that have been included in this report. Also, many of these species may not have been actively feeding during the time of this study and thus do not represent an integral part of the larval community. This problem is complicated by the fact that many of the species that are present in the Hudson River do not mature in the Hudson River. Thus, for some species, the Hudson River is only a stopping-over place and many of

the more important life-history events occur in the open ocean. Also, the data for fish larvae were collected over a brief time span.

Six species of larvae were selected for niche analysis. They were: 1) tessellated darter from May 22 to July 12; 2) cyprinids (gold fish, etc.) from May 22 to July 31; 3) white perch from May 22 to August 14; 4) striped bass from May 10 to August 14; 5) Atlantic shad from May 10 to July 12 and 6) Alosa spp. which refers to all herring larvae except shad. The time periods given and the frequency distributions for the species illustrate their highly seasonal nature.

Compounding this problem is the definition of Alosa spp. 79% of the individuals were classified as belonging to the genus Alosa. This group, given its occurrence throughout the study period, and its fluctuating frequency curve indicate that it is really several species which were behaving differently yet lumped together. Thus, not only was there a lack of identifiable consistent properties because the whole community, as measured, depended on the fluctuations of a single 'species', as with Oscillatoria sp. in phytoplankton, but this single fish larvae taxon included behavior and distribution patterns of several species.

The stations used were different from those for phytoplankton and rotifers. Instead of the control stations and a few stations in the plant area, there were four transects going across the river from the plant. Two were on the west side of the river near the plant and two were on the east which we have used as control stations even though other results show this to be an atypical area. Also, samples were taken in two-week intervals instead of monthly ones. This sampling program included complete time-depth profiles at each

station and date, totalling about 800 samples, however, many trawls near the end of the summer caught few, if any, larvae and only half the samples were identified to species, thus yielding under 200 usable samples or cases. The identification was done for more or less complete profiles by depth and station for a given time of day and date while the times of day on a given date were selected arbitrarily.

In regard to both the coefficients of variation and among-environment diversity, the depth stratification is the least variable followed by the station stratification. This result was also found with rotifers. For both diurnal and seasonal (monthly) time references, there are highly significant degrees of variation. Thus, the fact that the times and dates were irregular, biases the results and makes this data set the least suitable for niche analysis. This is also true from a purely biological standpoint. For some dates, many or all of the samples were taken some time during the day, while for others, only a profile in the night was counted.

a. Stratification by Station (Tables D-8 and D-9)

The fish larvae were stratified much the same way as the other groups. Table D-8 contains the breakdown stratification of the niche measures by station grouping, in which, 1) pairs of stations were analyzed and then 2) the four separate stations were considered individually. Table D-9 contains the coefficients of variation for these niche measures.

When station stratifications were considered, the coefficients of variation in Table D-9 illustrated that there was little variation when .5 was taken as the cutoff value. With the eastern stations, RDE and RDECH, the mean value of alpha, the

covariance of alpha, the determinant, the minimum and harmonic mean of the eigenvalues, and the maximum and variance of the reciprocal eigenvalues all showed substantial variation. In the western stations, only the variance of the reciprocal eigenvalues exhibited substantial variation. Understandably, the same measures that were variable in the east often varied for all stations considered together. Thus, in general, there was a trend of decreasing variation in community structure and stability measures from the east to the west side of the river. This is not what would be expected if thermal pollution was high on the west side of the river. Also, as with rotifers and phytoplankton, most variation in the community appeared to be associated with the stability not community structure measures.

In Table D-8 the values of the various community structure and stability measures are given. Many of these results were related to the biology of Alosa spp., which includes the alewife, and other herring species. This was the most abundant group in the community often constituting 70 to 80% of the total community abundance at all stations and the group was particularly abundant at the eastern stations (92% at RDE). The sub-dominant species included the striped bass (Morone saxatilis) which was particularly numerous on the west side and constituted 11% of the total population while white perch (Morone americana) and Atlantic shad (Alosa sapidissima) were more evenly distributed at 6% and 3% respectively. Because of the dominance of the Alosa spp., all the diversity measure values were low, the mean time-depth diversity (H_T) accounted for only 50% of the total diversity and the within diversity component was fairly constant with slight increases for the inshore stations. The among-depth component (the total diversity minus the mean within spatial environments diversity, which for separate stations

would have applied only to depth) was non-zero only at the channel stations indicating that any heterogeneity in depth was related to the lower depths at the channel station. The time diversity and total diversity values were highest for the west channel station and at RDE. These results suggest that the eastern stations were more different than the stations supposedly undergoing the perturbation by the power plants. Dates and times were irregularly sampled, however, they have affected the separate date and time tables as well as the diversity index across time and date. Although not fully developed, the among-environment diversity measures appear to be useful indicators of bias in the sampling.

In terms of the niche breadth measures, the values for the relative community niche breadth ($\hat{B}/E$) were consistent for all station stratifications, as were the values of relative species niche breadth measures ($\overline{B_i}/\hat{B}$ and $\overline{B_i}/E$). The exception was for the measure $\hat{B}/E$ at the Roseton-Danskammer east station. This result is not surprising considering our results with other functional groups at that station.

The other community measures: $\overline{\%K_i}$, $\overline{\%K_i/(B_i/\hat{B})}$, and $\overline{D_i/K_i}$, α, fluctuated widely and without pattern. The α had a coefficient of variation of .4, which was higher at RDE and RDWCH. There were small changes when east and west stations were considered together. For example, density was higher on the average for the eastern stations than the western ones; while carrying capacity ($\overline{K_i}$) remained the same, $\overline{\alpha}$ and $\overline{\%K_i/(B_i/\hat{B})}$ decreased slightly and $\overline{D_i/K_i}$ was slightly greater at the channel stations. These are indications that the Alosa spp. used more of the environment at the eastern stations while the other species overlapped less on the western areas of the river off the plant.

In considering stability, the values of the determinant, min , H.M.$_\lambda$, and S^2_λ indicated higher stability at all-stations and RDE and RDECH than other station groups but S_λ and K_λ are lower for RDE and RDECH. Considering separate stations, the eastern stations, in general, and RDECH, in particular, have the greatest stability indicated by the determinant and the minimum, harmonic mean, variance and the kurtosis of the eigenvalues as well as all of the reciprocal eigenvalue measures.

b. Stratification by Date (Tables D-10 and D-11)

The next two tables (D-10 and D-11) give the stratification by date for the fish larvae community. The seasonal variation is large from May to July. This reflects the transitory nature of the fish larvae community. The coefficients of variation for dates are given in Table D-11. The coefficients of variation are high for diversity over date and for D, K, covariance of alpha (covα), the determinant of the alpha matrix, the variance of the eigenvalues, and the maximum, variance, and arithmetic mean of the reciprocal eigenvalues. This was the usual trend: the most variation was found in the stability measures, followed by $\overline{D_i/K_i}$ and then by other niche measures.

There were few indications that the fish larvae community was highly structured or exhibited any patterns by date. This table should probably be ignored in favor of the separate stratification for dates by time of day given on Tables D-16, D-17, and D-18. When the data were broken down by date on Table

D-10, Alosa spp. was usually the dominant species. On one date, June 7, the striped bass was more abundant than Alosa spp. but for this date all the samples were taken in the night. The diversity measures are low and inconsistent. There was variation in abundance; e.g., Alosa spp. varied by a factor of 2 in its relative percentage of the community. The mean depth diversity ($\bar{H}_d$) was not always greater than the mean time diversity ($\bar{H}_t$) for the fish larvae community.

The apparent lack of structure in the fish larvae community is undoubtedly related to the biology of the species which are seasonal and do not form an integrated unit of competing species. The values for relative community niche breadth ($\hat{B}/E$), and the relative species niche breadth ($\bar{B}_i/\hat{B}$) were not consistent. In general, the fish larvae community was not utilizing much of the available ecological space. The value of $\hat{B}/E$ was consistent for the June to July groupings. The values for $\overline{\%K_i}$ were not regular. The value for $\overline{\%K_i/(B_i/\hat{B})}$ was regular except for the lower values in May. The B'/N values were consistent except for the last two values in July, which were higher than at the beginning of the year. The mean values of alpha ($\bar{\alpha}$) were also not regular. Of the various stability measures the coefficients of variation; the mean alpha and the determinant of alpha; the minimum, range, variance, and harmonic mean of the eigenvalues; as well as the range, variance, and arithmetic mean of the reciprocal eigenvalues showed some indications of stability in the fish larvae community.

The fish larvae community exhibited some structure when enough space-time points were considered. An example was for all dates and all stations which exhibited enhanced stability values. For

The fish larvae community exhibited some structure when enough space-time points were considered. An example was for all dates and all stations which had enhanced stability values. For separate dates, there was little indication of stability. Only the skewness and kurtosis of the eigenvalues, and the covariance ($cov\bar{\alpha}$) and determinant, $|A|$, of the matrix for July, and the skewness and kurtosis of the eigenvalues for May 10 showed any increased stability over the values for the all dates and all stations.

c. Stratification by Depth (Tables D-12 and D-13)

In the next stratification (Tables D-12 and D-13) the fish larvae community is stratified by depth. Samples were taken at ten foot intervals from 0 to 40' at the various stations where these depths were possible. Values for various community measures by depth are given in Table D-12. The largest coefficients of variation by depth are associated with the covariance of alpha and the maximum and variance of the reciprocal lambda values. Generally, there was little variation by depth. As with rotifers, the depth stratifications showed more regularity than any other stratifications, the by-station stratification was the next most consistent one. This demonstrates that even with the fish larvae community there was far more variation by time of day and date than there was spatial heterogeneity. Alosa spp. was the most dominant species at all depths but it was most abundant at the surface. It was usually followed by striped bass which exhibited no depth preferences and white perch preferred depths of 20' and below. Density declined slightly but evenly by depth except for the 30' level which showed many differences, among them a relative increase in density particularly for species other than Alosa spp. This can

be partly attributed to the fact that depth was more biased for night samples, hence the relative decline in Alosa spp. at this depth may actually represent a diurnal behavioral pattern.

Diversity values were low because of the super-abundance of Alosa spp. The depth diversity value ($\overline{H}_d$) accounted for much of the total diversity measure. Diversity increased from the surface to the lower depths because Alosa spp. generally preferred the surface; however, there was a peak related to the among-station diversity at 30' where Alosa spp. were sparse. The among-diversity was actually lowest at the surface, contrary to expectation and experience with the rotifers. Within diversity was very low and the among time-date component high, but neither showed a great deal of pattern nor consistency.

The values of relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B}_i/\hat{B}$), $\overline{B}_i/E$, $\overline{B/E}$, niche overlap ($\overline{\alpha}$), percent carrying capacity ($\%K_i$), $\overline{\%K_i/(B_i/\hat{B})}$, competitive success ($\overline{D_i/K_i}$) and relative species breadth (B'/N) were consistent, although with relatively large ranges. The only exceptions were high $\overline{D_i/K_i}$ and B'/N values at 30' and an interesting decline in $\overline{\alpha}$ at 20' with corresponding high coefficients of variation over species. For all-depths, the values of $\overline{B}_i/\hat{B}$, $\overline{B}_i/E$, $\%K_i$ and $\overline{\alpha}$ decreased.

For the stability values, the greatest stability was found at the all-depths grouping. This is a familiar pattern. Stable values included those for the determinant of A; the minimum, range, variance, and harmonic mean of the eigenvalues; and the range, variance and arithmetic mean of the reciprocal eigenvalues. The 20 foot depth contour showed reduced stability with the minimum and harmonic mean of the eigenvalues as well as

the reciprocal eigenvalue measures which were constant over the other depths. The covariance of alpha and the kurtosis of the eigenvalues also indicated instability at the 40' level. The determinant indicated 30' level had greater stability associated with its other differences.

d. Stratification by Time of Day (Tables D-14 and D-15)

The fish larvae were stratified by time of day and the coefficients of variation for this are given in Table D-15. In general, there was more variation although there were not many coefficients of variation over .5. The higher degree of variation again showed some of the diurnal patterns in fish larvae biology, especially since many of the species are migratory. The measures that varied over the .5 cut-off value included total species diversity (H), mean depth diversity ($\bar{H}_d$), density, carrying capacity, minimum and maximum eigenvalue and variance of the reciprocal eigenvalues. Referring to Table D-14, there were few if any regularities but more patterns than the by-date tables. This stratification is biased as well, though not as much as the preceding one. The day category is missing for the last two dates while there were no sunset samples for both dates in June, which was a high population month, particularly for striped bass. There was only a slight rise in density from day to night and while Alosa spp., white perch, and cyprinids were more abundant in the day (84%, 12%, and 2% respectively), striped bass and Atlantic shad were more prevalent in the night. Alosa spp. density was constant and dominant. The sunset samples were quite sparse and of what was caught, 96% was Alosa spp.

All of the diversity values varied with time. They were lowest at sunset and almost four times higher at night. In general, many of the biological interactions occur at night when the among-date diversity component was non-zero. For sunset, the whole among-environment H was zero. In general, of course, diversity was low because of the super abundance of Alosa spp. Few measures were consistent. They included $\overline{B}_i/E$, %K, B'/N, and mean value of alpha, using the .15 range criterion value. Many other niche measures $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$, relative species niche breadth $(\overline{B}_i/\hat{B})$, relative community niche breadth (B/E) were variable. These results further indicated strong diurnal patterns in the fish larvae community. Between day and night, within and among-date diversity increased as did relative species niche breadth $(\overline{B}_i/B)$ and percent carrying capacity $(\overline{\%K}_i)$ while the other measures did not change much. The sunset values were more different, including low community niche breadth (B) while for the species, mostly Alosa spp, the value of B/E did not change. Values of $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ were also much lower for this category.

The most stable data stratification was related to the lowest community density, occurring at sunset. The values of the covariance of alpha; the determinant; the minimum, range, variance, and harmonic mean, skewness and kurtosis of the eigenvalues; and range, variance, and arithmetic mean of the reciprocal eigenvalues all indicated stability.

e. Two-Way Stratification Over Date and Time of Day (Tables D-16 to D-20)

The last set of niche value tables contain a two-way stratification of the fish larvae community by date and time of day.

Tables D-19 and D-20 contain the coefficients of variation for the date stratifications, by day (Table D-16), by sunset (Table D-17), and by night (Table D-18).

The coefficients of variation over dates for each time of day indicated a great deal of variation (Table D-19); this is consistent with the previous discussion. There appeared to be no obvious trends in comparing day, sunset, and night. Thus, there was a pattern of variation. Values that varied included: total diversity (H); mean-depth diversity ($\bar{H}_h$); carrying capacity (K); determinant of A; minimum lambda; and maximum, variance, and arithmetic mean of the reciprocal eigenvalues for daytime. The same values varied for sunset, with the addition of density, covariance of alpha, the skewness of the lambdas, and also deleting the arithmetic mean of the reciprocal lambda values. For night time, the total diversity (H), mean time-depth diversity ($\bar{H}_h$) and the coefficients of variation were lower, though they were not at the .5 level. The rest of the stability measures for night exhibited more variation as did the harmonic mean of the eigenvalues. Thus, there was a great deal of variation when the data were stratified in this manner. Stratification by all times of day for each date (Table D-20) also showed a substantial amount of variation in particular for:

May 10 - total diversity (H); mean time depth diversity ($\bar{H}_h$); density (D); carrying capacity (K); covariance of alpha (covα); minimum lambda (minλ); variance (S^2_λ); and skewness of the lambdas (Sλ); and maximum (max $1/\lambda$) variance ($S^2 1/\lambda$) of the reciprocal lambdas.

May 22 - total diversity, mean time-depth diversity, carrying capacity, covariance of alpha, determinant, minimum

lambda value, and variance of the reciprocal lambda values.

June 7 - this date was only sampled for one time of day.

June 19 - minimum and the harmonic mean of the lambdas, and the variance of the reciprocal lambda values.

July 2 - there were no coefficients of variation over .5 and this date had the least variation while June 19 had the next lowest variation.

July 17 - density, carrying capacity, covariance of the alpha, determinant of the matrix, minimum, and harmonic mean of the lambdas, and minimum, variance and arithmetic mean of the reciprocal lambda values.

July 31 - covariance of alpha, skewness of the lambdas, and the variance of the reciprocal lambdas.

All times and dates - total diversity, mean time depth diversity, density, carrying capacity, covariance of alpha, determinant, and minimum, variance and arithmetic mean of the reciprocal lambda values.

In general, however, the coefficients of variation were large, being lowest for the niche breadth measurements in this two-way stratification. Over time of day there were few similarities in pattern, however, the values did not change much overall as shown by the means in Table D-19. The most consistent measure was D_i/K_i while the diversity and stability values

were the most variable. The night-time stratification had higher diversity but a lower stability. In fact, referring to the first column on the Table D-22, all the community structure measures had coefficients of variation over the means for day, sunset, and night over date of .1 or under, except for diversity measure, density, carrying capacity, and mean value of alpha. This means that for these measures, the means for time of day over date were consistent while the niche values for time of day using all dates were different and fluctuated widely in comparison.

The day-time stratification showed the most pattern and regularity by date. Alosa spp. was abundant (99% on May 10). Density and diversity for all components were higher for the two middle dates in May and June than for the first and last ones in May and July. The rest of the measures were consistent for larvae except for seemingly random decreases in their values. $\overline{B_i/\hat{B}}$, $\overline{B_i/E}$, $\overline{B/E}$, and percent carrying capacity ($\overline{\%K_i}$) were all lower for all-dates and for the 22 of May than the other days while $\overline{D_i/K_i}$ decreased on June 19 and $\overline{\%K_i/(B_i/\hat{B})}$ on July 12.

The stability measures were highest on May 10 and July 25 the two outside dates, while June 19 was the lowest and all-dates values were only average. This was indicated by the determinant of alpha, minimum eigenvalue, the harmonic mean, and the skewness of the eigenvalues, and the reciprocal eigenvalue measures. There was some inconsistency in that all-dates had the lowest variance of the eigenvalues and the highest kurtosis.

The values at sunset showed less pattern. There were no samples for the middle month of June and there was more consistency within months than between. Density seemed highest towards the

middle of the year while diversity was generally higher. The most consistent community measures were $B_i/\hat{B}$, and $\hat{B}/E$ which had the coefficients of variation under .1. Community niche breadth ($\hat{B}$) was generally higher for the July dates than for May, $\overline{D_i/K_i}$ was lower for the middle dates and all measures dropped for the all-dates category, but these were the only clear patterns. The May 10th community was stable for many matrix measures including the harmonic mean (H.M.λ) of the eigenvalues, followed by July 31 values while all measures but skewness (Sλ) and kurtosis (Kλ) indicated the lowest stability for July 17.

Although the densities were higher and samples more numerous, the night stratification demonstrated as little pattern and consistency as the sunset values. There was no discernible pattern to diversity and there was more heterogeneity in species composition with striped bass being the dominant species on June 17 and white perch on July 17. This would explain the higher diversity for night-time on Table D-14. Density seemed to decrease through the year while $\overline{B}_i/\hat{B}$ and $\overline{B/E}$ were the most regular values. There was, however, a sharp increase in $\overline{B}_i/\hat{B}$ as well as percent carrying capacity ($\overline{\%K}_i$) and mean value of alpha ($\overline{\alpha}$) on July 17 which has shown several other differences. The stability measures were consistent in indicating the greatest stability on July 31, while the lowest stability was on July 17 or June 19 depending on the measure.

The mean niche values for each date showed more consistency and pattern although the improvement was not as much as for the time-of-day values (Table D-20). Mean environment and total diversity both increased through the year although they decreased on July 12. The niche breadth measures ($\hat{B}/E$, $\overline{B}_i/\hat{B}$,

$\overline{B_i/E}$, and $\overline{B_i/E_i}$) were consistent. Relative community niche breadth (B/E) showed a peak on June 17, but this date was the most biased since it had only night samples. The value of $\overline{B_i/\hat{B}}$ was spuriously high on July 17, this date has several other differences while $\overline{B_i/E_i}$ values were constant. Niche overlap was stable until it substantially increased in the last two months. These latter months were also biased in not having day-time samples. $\overline{D_i/K_i}$ values, regularly declined in the middle dates and were highest on the extreme dates. Percent carrying capacity ($\overline{\%K_i}$), and $\overline{\%K_i/(B_i/\hat{B})}$ values followed the pattern but with much less regularity. The stability measures: determinant, minimum eigenvalue, variance, and harmonic mean of the eigenvalues all regularly decreased in midsummer as did $\overline{D_i/K_i}$. The lowest stability values, however, were calculated for July 17. The stability patterns were similar for the various times of day when they were taken. All stratifications showed May 10 and July 13 to have high stability and July 17 to be low. Also, the all-dates grouping exhibited only average stability.

All other functional groups consistently demonstrated the greatest stability in the global case and had lower values for the more localized runs. This was not always the case with fish larvae, however, since the global values were often quite different and more variable than the individual dates or stations, etc. This could be a strong indication that because of their biology the fish larvae did not constitute an integrated community at least in terms of the available data. The lack of consistent properties is to be expected with a group of immature migrating species which are extremely seasonal and transitory no matter how many samples are taken. One data problem which may have contributed to this, however, is the taxonomy concerning the Alosa spp. group which may have been necessary for

visual identification but did not appear to be ecologically realistic. Also there were undoubtedly several species of macrozooplankton that would be active competitors of some of the fish larvae species; unfortunately, not even species-specific density data is available for this group. Thus, in leaving out an integrated component of a community, we cannot expect the leftover pieces to exhibit a high degree of integrity.

f. Niche Measures of the Dominant Species (Table D-21)

The results associated with the dominant species of fish larvae are given in Table D-21. For almost every factor listed, the coefficients of variation in terms of the niche value range exceeded the .15 criterion. The coefficients of variation indicated that the striped bass and, to a lesser degree, the white perch were extremely variable species, while Alosa spp. exhibited the least variation. This is understandable since Alosa spp. was a general grouping with several species lumped in it. Thus, species variation could be high while the group's variation would be less. Also, Alosa spp. exhibited higher $\overline{D_i/K_i}$ and $\overline{K_i/(B_i/\hat{B})}$ ratios, which indicated its general success in the ecosystem. These results are indicative of Alosa spp.'s high density. The striped bass had a larger $\overline{D_i/K_i}$ value in the western part of the river. Its $\hat{B}/E$ value was about the same as the other two species, but its relative species niche breadth $(\overline{B_i}/\hat{B})$ value was not as high as the value for Alosa spp. In general, striped bass did less well in the channel stations.

The community exhibited a much greater effect on Alosa spp. than did Alosa spp. on the other members of the community. For

striped bass and white perch the effects were somewhat equal. At the RDECH station, for some reason, community and species effects for all species listed dropped substantially. This was the station which showed an extremely high degree of stability in regard to its eigenvalue distribution parameters. In several ways, the white perch and striped bass are similar in niche characteristics, although the striped bass may not be doing quite as well and may also be slightly more variable than the white perch. This perhaps also indicates an instability in the system.

g. Summary of Fish Larvae Community Results (Table D-22)

(i) Overview of the consistent properties

Some of the trends in the fish larvae results were summarized in intext Table 13. For all dates and all stations the niche measures are the same. There are columns for the east and west stations, and then by time of day: day, sunset, and night. In one instance, the values in the rows were regular over all of the various stratifications. The east and west stations were consistent in values of relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B_i}/\hat{B}$), $\overline{D_i/K_i}$, and the mean value of alpha. A comparison of all dates to the various times of day, indicated that these stratifications are variable, and only the mean value of alpha exhibits any consistent trend whatsoever. All dates and the station stratifications are relatively consistent using the .15 cut-off with the exception of total diversity (H) and $\overline{\%K_i/(B_i/\hat{B})}$.

Table 13: Summary comparison of important niche measures for the fish larvae community by station and date

Niche Measure	All Stations All Dates	East Stations	West Stations	Day	Sunset	Night
$\hat{B}/E$	.38	.41	.34	.50	.22	.44
$\overline{B_i}/\hat{B}$	.26	.29	.34	.28	.46	.39
$\overline{\$K_i/B_i/\hat{B}}$	.92	.76	.94	1.10	.56	.85
$\overline{D_i/K_i}$	.43	.37	.36	.35	.20	.39
$\bar{\alpha}$	.16	.13	.25	.28	.19	.22
H	1.08	.79	1.30	.81	.29	1.26

(ii) Summary of statistical results

The fish larvae showed greater fluctuation and less pattern than any group so far encountered, particularly with respect to date and time. There were four obvious answers for this:

(a) Fish larvae are a relatively artificial classification of immature animals which are, by their biology, extremely transitory. Their populations are both seasonal and migratory, even on a diurnal basis, and the group represents some very diverse behavioral and feeding patterns which are largely unknown. Thus, that the fish larvae community was not as consistent, coherent, or structured as the others is not surprising.

(b) The taxonomy was such that several behaviorally and ecologically different species of herring were lumped together as one very erratic one - Alosa spp. Also, because Alosa spp. included several dominant species of fish in the area, this radically altered the discernible structure of the community. Alosa spp. was dominant at 79% overall and its fluctuations could not be balanced and while as a single species taxon, it was relatively stable, the whole community was highly variable because of it.

(c) Several major competitors which were sampled in the "macrozooplankton" collections were not included in the fish larvae matrix. The more general problem of delineating a community and not a sampling group is given in Section V.C.

(d) While there were fairly regular profiles of station and depth counted, the times of day for each date were randomly

chosen. Some profiles were split between late afternoon and every evening and categorized ambiguously as 'sunset'. Thus, the dates had widely differing numbers of samples and while they were fairly evenly represented by station and depth, there were dates with only night samples and some with only day samples. Unfortunately, the major variation was over date and time, not station and depth so that this created serious problems with bias in the by-dates stratification and somewhat less so for the by-time of day table.

Thus, the results show relative regularity over depth while there is somewhat more variation over stations, particularly on the east side of the river. The by-date and by-time tables are almost unusably incoherent, showing almost no consistent patterns. The two-way stratification over time and date also generated few patterns because it represented too many missing date-times. It was noticed, however, that the values over individual date-time categories bore little relationship to the values for each date collectively and each time of day on the previous tables. When the means for date and time over the two-way table were examined with their coefficients of variation, which appear on the ANOVA Table D-22, consistent properties appear, particularly for time of days, along with the usual lack of patterns. Some of these data are summarized in Table 14. The fact that the runs over combined data do not produce results consistent with the stratified runs and do not demonstrate the usual pattern of greater global stability than local stability is an indication that the fish larvae community did not have a great deal of integrity.

Due to the lumping together of dominants in the genus Alosa the diversity was in general extremely low, and coefficients of

Table 14: Summary comparison of statistical results for the fish larvae community

	BY STATION				BY DEPTH	BY DATE	BY TIME		BY TIME / DATE			
	ACC $\bar{x}$ (x)	CONTROL RDE+RDCH $\bar{x}$ (x)	EXPERIMENTAL RDU+RDCH $\bar{x}$ (x)	αt	$\bar{x}$ (x)	$\bar{x}$ (x)	$\bar{x}$ (x)		$\bar{x}$ (x)	TIME, DATE (x)(x)	TIME αE	DATE αF
species diversity N	1.01 (.36)	.75 (.36)	1.27 (.19)	.18	1.13 (.28)	.80 (.60)	.79 (.64)		.69 (.66)	(.41) (.61)	.17	.8016
B/E	.38 (.08)	.42 (.09)	.35 (.08)	.17	.41 (.16)	.53 (.24)	.39 (.35)		.60 (.17)	(.94) (.12)	.86	.63
B/B²	.37 (.13)	.36 (.26)	.38 (.04)	.81	.37 (.13)	.27 (.38)	.38 (.04)		.58 (.24)	(.99) (.03)	.84	.19
mean alpha $\bar{x}$	.24 (.41)	.21 (.66)	.27 (.29)	.65	.25 (.21)	.43 (.51)	.23 (.20)		.43 (.38)	(.16) (.32)	.56	.15
%K1/(B1B)	.85 (.11)	.80 (.06)	.90 (.13)	.46	.95 (.09)	.89 (.15)	.84 (.32)		.88 (.19)	(.96) (.19)	.69	.022
D1F	.80 (.22)	.73 (.39)	.87 (.02)	.74	.42 (.21)	.31 (.30)	.31 (.32)		.84 (.33)	(.12) (.21)	.58	.059
minimum λ	.33 (.74)	.50 (.57)	.17 (.39)	.36	.20 (.24)	.27 (.49)	.27 (.64)		.76 (.36)	(.94) (.74)	.099	.11
harmonic mean λ	.63 (.35)	.78 (.30)	.48 (.10)	.33	.26 (.11)	.56 (.38)	.62 (.25)		.49 (.52)	(.32) (.56)	.16	.513
variance λ	.49 (.59)	.36 (.10)	.61 (.28)	.56	.48 (.19)	.62 (.71)	.41 (.23)		.81 (.66)	(.35) (.51)	.22	.10

variation over species high. Thus, the within diversity is not accurate and probably neither is the among-time or date components. The most consistent community parameter was niche breadth, particularly $\overline{B_i/E_i}$, which was quite low compared to the values for other groups. Niche overlap was low and variable, further pointing to the lack of coherence with the larval group. Stability was reported as fairly high and consistent.

Diversity increased and density decreased with increasing depth, while the other measures including stability were regular. Alosa spp. was most prevalent at the surface, white perch was abundant in lower depths with peaks in diversity, and striped bass was evenly distributed over depths.

All the coefficients of variation were on the order of .2. The coefficients of variation were greater every time of day and the table showed little consistency or pattern. The coefficients of variation of the means for times of day over date were mostly under .1 and there were several clear patterns. Alosa spp. was higher in the day, followed by white perch which was replaced by striped bass in the night. Diversity increased from day to night (α_f = .2). The other measures, including density, were regular, rising only slightly in the night (most α_f = .8). The mean value of alpha ($\overline{\alpha}$) had the greatest rise from .35 to .47. Stability appeared slightly lower in the night, particularly if one takes the mean time of day values. These results indicate that community structure (as measured) is locally consistent over depth, over station with some exceptions, and over time with small variations.

The same thing was true of the by-dates table although not nearly to the same extent. There were still few measures which

remained consistent. The coefficients of variation were lower and there were more identifiable patterns. Diversity increased from .1 on May 10 to a high of 1.2 on July 17 (α_f = .002). Measures of niche breadth were the most consistent, all having coefficients of variation of about .2. Relative community niche breadth ($\hat{B}/E$) and $\overline{B_i}/\hat{B}$ were both .6 except relative community niche breadth ($\hat{B}/E$) was higher (.76) on June 17 and $\overline{B_i}/\hat{B}$ rose to .82 on July 17. $\overline{B_i/E_i}$ was the most consistent measure (α_f = .8). Niche overlap ($\overline{\alpha}$) was fairly constant with increases in the last two months (α_f = .2) while $\overline{D_i/K_i}$ decreased in mid-summer (α_f = .06). The other measures fluctuated without pattern having α_f under .1. Stability values decreased as did $\overline{D_i/K_i}$ in June and was also low on July 17.

By station, the differences were small, though often variable. In general, the eastern stations showed more variation, particularly with the peculiar RDE station, than the supposedly perturbed western stations. This is similar to the phytoplankton results where the RDE station was more unlike the controls than the experimental stations were. Species dominance was fairly consistent with Alosa spp. being higher at the east stations (control stations) and striped bass in the west (experimental stations). Mean time depth H was constant at .46 (α_f = .1), however, among and total diversity values were higher at the channel stations and higher in the west (α_t = .2). The average total diversity was 1.0(.4). Relative community niche breadth ($\hat{B}/E$) showed the opposite pattern (α_t = .2) but with very slight changes from .33 to .44. $\overline{B_i}/\hat{B}$ was .4(.15), $\overline{\alpha}$ was .24(.4), $\overline{\%K_i}$ = .3(.2), $\overline{D_i/K_i}$ = .35(.2), and $\overline{\%K_i/(B_i/\hat{B})}$ = .85(.1). They were all more or less consistent but with fluctuations of $\overline{B_i}/\hat{B}$ to .3 at RDECH and of $\overline{D_i/K_i}$ to .24 at RDE. There was an increase in density at both eastern stations (α_t = .2). Stability was notably higher at RDECH.

E. ADULT FISH COMMUNITY

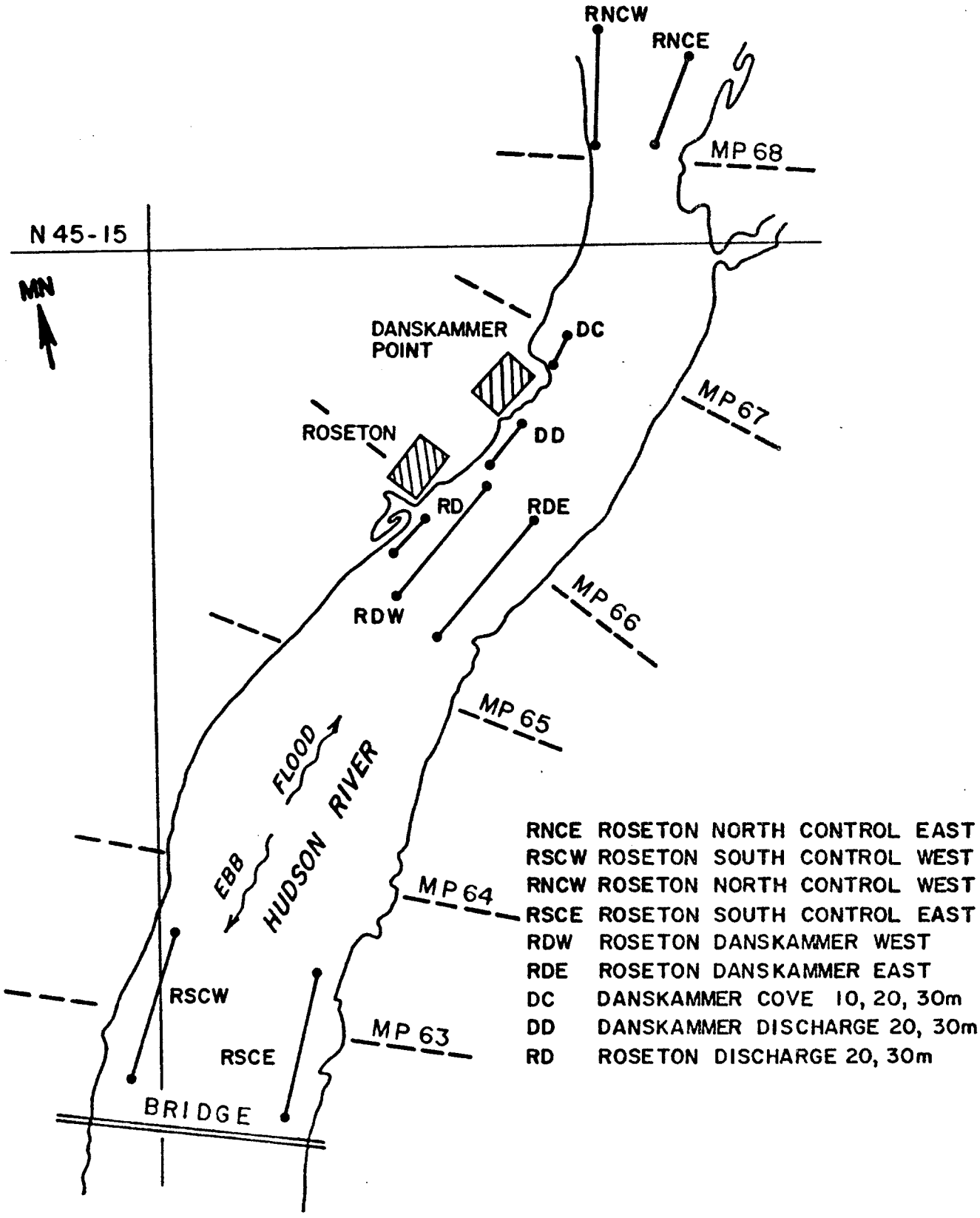
1. The Sampling Program and Selection of Stations (Tables E-1 and E-2)

The adult fish community around the Roseton/Danskammer point generating stations was analyzed using data collected by LMS from the trawl program carried out in the area from May through December 1973. These data appear in Appendix VI of the 1973 LMS report to CHG&E and are also discussed in Chapter VI of the same report. In addition to the trawl program, other fish collections using seines and trap nets were carried out in 1973. These samples were not considered because their differing selectivities and efficiencies rendered innumerable difficulties when comparing them to trawl samples. Since the trawls were employed at several stations, and were considered to be relatively unbiased, they were judged the most appropriate samples for niche analysis.

Fish were collected using an otter trawl, 30 ft wide by 5 ft tall with 1 inch square body mesh and a 1.5 ft cod end with a 1/4 inch square mesh liner. Normally, the trawls were towed at a station for 5 or 10 minutes either on the surface or on the bottom of the river. Tows were never across the river, but were always lengthwise along the river, and against the direction of the tide (or next tide). All captured fish were preserved in the field with 10% formalin and then were returned to the laboratory for identification. Length, weight, sex, and age were determined. Occasionally, a sample would yield no catch, for example, the net hung up early in the trawl or the sample would decay before analysis; all of these samples were omitted from the niche analysis.

Thirteen stations were sampled in 1973 and these are described in Figure 9 and Table E-1, which lists the stations giving name,

Figure 9. Map of Hudson River at Roseton and Danskammer Point Generating Stations illustrating the location of trawl sampling stations in 1973



abbreviation and location. Mile points and distances are given from the south-end to the north-end of the trawl where there is a nearby water quality station. Depth and chemical-physical parameters are also listed. All the sampling stations were in shallow areas (less than 30 ft in depth) and were identified by landmarks on shore. They generally followed a fixed depth contour.

Four stations were sampled as control stations: RNCE in the northeast by New Hamburg, RNCW in the northwest across the river starting north of Danskammer Cove, RSCE in the southeast starting at the Newburgh-Beacon bridge some distance offshore on a shallow shelf, and RSCW in the southwest close to the other shore. The north control stations were approximately one mile upstream from the plant, and the south controls were three miles downstream. Thus, these stations were taken to be the least affected by the plants and most representative of "normal" river conditions. Both the environmental and biological data appeared to substantiate this decision. Unfortunately, water quality parameters were not taken in conjunction with the fish trawls, nor even at the same stations or depths. Values for surface waters of both RNCE and RNCW were taken from station CH-1 in mid-river while CH-2 data were used for both south control stations.

The next two trawls were taken in the plant area on either side of the river. The RDE trawl on the east started at Chelsea and continued north to the cable. Because of bottom obstructions, only surface samples were taken and, perhaps because of the influence of Wappinger's Creek, catches here were extremely poor; water quality station CH-5 (Roseton-East) provided the water quality data used here. RDW, on the west was directly off the two plants between the discharge areas and well into the thermal plume. Associated water quality parameters were taken from CH-3 (Roseton-intake) which

was situated approximately midway along the trawl. This station is definitely experimental; however, the status of RDE is doubtful, since it was not apparently affected by the power plant, nor is it representative of the river.

The rest of the trawls were in the plant area and were of 5 minutes duration. The stations previously discussed constituted 10 minute trawls. Trawls were taken in Danskammer Cove (DC) (north of the Danskammer plant intake), along the 10, 20, and 30 ft depth contours (DC-10, DC-20, and DC-30). DC-20 and DC-30 were sampled surface and bottom but DC-10, because of its shallowness, was only sampled on the surface. This set of trawls started in the plume area, but as the rest of the cove sampled was not judged to be thermally affected by the plants, the control versus experimental nature of these stations was dubious. Chemical data came from station CH-2 (Danskammer-intake) which was at the plume end of the trawls. Stations DD-20 and DD-30 were taken at the 20 and 30 ft contours off the Danskammer point discharge and, correspondingly, RD-20 and RD-30 off the Roseton discharge. All of these were in the plume and constituted a more detailed version of the RDW trawl.

The schedule and results of the trawl sampling program are given in Table E-2 with stations across the top and dates down the page. Each entry in a column represents a trawl sample and the table shows the time and location of every sample taken. There were usually four trawls per date at a station, including surface and bottom trawls. Time of day was determined either by day or night, and by ebb or flood tide. In Table E-2, the first three letters of an entry indicate the classification of the trawl: D/N of day or night, S/B for surface or bottom trawl, and E/F for ebb or flood tide (occasionally H for high slack and L for low slack is used). Following this designation are the time of day and the duration (in

minutes) of the trawls. The other letters indicate any unusable results: N for no catch, H for hung net and R for rotten sample.

After May, samples were taken bi-weekly with the exception of some miscellaneous sampling carried out on a few dates for stomach analysis or fecundity studies. Two different programs were carried out on alternate two week periods. The first program sampled various river locations, expanding the 1971 and 1972 sampling programs. Specifically, the RNCE, RNCW, RSCE, RSCW, RDE, RDW, DC-10 and DC-20 stations were sampled on a diurnal basis so that there was a surface and a bottom trawl in the day and also in the night for each station, except RDE and DC-10 where no bottom trawls were taken. The second program involved stations located around the plants: DC-10, DC-20, DC-30, DD-20, DD-30, RD-20, and RD-30. These stations were sampled on a tidal basis so that there was a surface and bottom sample (only surface for DC-10) during an ebb tide and then during the flood tide. All samples were taken during the day.

As previously stated, the sampling program was not designed to be used for niche analysis, and was therefore inadequate in the following ways. In regard to placement of sampling stations, there is the problem that, in some cases, they did not correspond well to the water quality sampling stations. Some critical factors were not measured in conjunction with the trawls, such as temperature and salinity which have diurnal variations that are important for the interpretation of the results. Also, all of the stations were in shallow silt-bottom waters and none were taken in mid-channel where the bottom is more sandy and might support a different community of bottom-dwelling fish. It might be well to establish trawl stations corresponding to water quality stations, CH-1, CH-4 and CH-6, as well as fish larvae stations RDECH and RDWCH on either side of the channel in the plant area. This would give a better set of control stations.

As mentioned earlier, the Danskammer Cove stations are ambiguous with respect to thermal effects, and should be moved a little north out of the plume area, perhaps with the addition of a Danskammer Point station instead of DC-10 and DC-20. This would provide sampling of important spawning areas both affected and unaffected by the power plant. The RDE Roseton Danskammer station was not satisfactory. On the east side, because of bottom irregularities, and on the west, because of variable conditions, it is felt the RDE and RDW stations should be discarded in favor of 5 minute trawls which seem to produce as good a catch per effort and could be placed to make bottom trawls on the east side possible. The various contour sampling is not really necessary since it represents uneven replicate sampling.

It is unfortunate that sampling at all stations was not carried out at or around the same time, and under the same conditions. This caused difficulties in stratification and statistical analysis (because, for instance, of the bias toward day over night when both programs are considered together). It might have been better if, once a month, all the sampling were carried out in one week of fairly stable weather conditions using eight trawls per station: surface/bottom x day/night x ebb/flood. Also, if time permitted, runs on which the net hung, or perhaps where there was no catch, should be repeated, in order to reduce the number of missing samples.

2. The Species and Their Trophic Characterization (Tables E-3 and E-4)

As of 1973, 39 species of fish were known to exist in the river at the study site. Of these, twenty-eight species were collected in the trawl samples. Table E-3 contains a list by common and scientific names of the fish species found in the area. For example, Alosa

sp. are unidentified species of herring of the genus Alosa. The next two columns of Table E-3 contain various characteristics of the ecology of the fish species, including their habits and trophic preferences. Habitat was divided into "benthic-inshore" to include those fish which live and feed in or on the bottom mud or shallow areas, and "pelagic" to include those fish which live and feed in the water column. The feeding preferences were then listed as: other fish, insects (which include larvae and other non-insect anthropods such as crustaceans), plankton (which is microzooplankton and phytoplankton), macroscopic plants, and detritus or dead organic matter. These columns were then repeated for juvenile (young-of-the-year) fish which often have different feeding patterns then their adult counterparts. The next column describes the fish as resident and/or spawning, that is whether the fish stays year-round at the study site or is only seasonally present.

The last column indicates the status of a fish species in our analysis, classifying it as pelagic, benthic-inshore, not found, or too infrequent to use, that is, found in fewer than 10 samples. The benthic-inshore and pelagic designations indicate that the species was frequent and could be used in analysis. Species frequency criteria are discussed in more detail below. The American eel was not considered because of its ecological peculiarities. In all, there were 9 pelagic, 7 benthic-inshore, and 11 infrequent and absent species, of which, 7 pelagic and 6 benthic fish were ultimately used in the analysis. The ecology of these species and general results of the sampling program are discussed in the LMS 1973 report to CHG&E.

The frequency of occurrence or the number of samples in which each species was present is listed in Table E-4. The columns are 1) for all environments, 2) for all surface and then for all bottom trawls,

3) for all day and then for all night samples, 4) for combination; that is, S-D (surface trawls taken in the day), S-N (surface trawls taken in the night, 5) B-D (bottom trawls taken in the day), and B-N, (bottom trawls taken in the night, and then 6-12) by individual station. The final column on page 1 is for totals, that is, C (for control stations RNCE, RNCW, RSCE, and RSCW) and E for experimental stations (all those remaining stations).

On the second page of Table E-4 the columns are for the 23 separate dates on which samples were collected, and finally in the last column of page 2 (Table E-4) is the total number of dates on which a species occurred in a sample (excluding the dates for "fecundity"and "stomach"). The first row (no. of samples) indicates the number of trawls taken for that category, for instance, there were 23 trawls which turned up at least one blueback herring out of 112 trawls taken at the surface during the day. The number under each of the headings indicates the total number of trawls relevant to the heading criteria. For example, there were 112 trawls taken at the surface during the day. Of these, 23 contained blueback herring, 15 contained white perch, etc.

3. Stratification of the Data for Niche Analysis (Tables E-5 and E-7)

For several reasons listed below, only data from the original sampling program were used in the niche analysis. First, both experimental and control stations as well as both day and night trawls were included in the initial program whereas the second consisted only of control stations sampled in the day during ebb and flood tides. Analysis by LMS showed the tidal variation to be relatively insignificant as compared to the diurnal factor, therefore, it was decided to stratify across time using day/night but not

tide. Second, if both sets of data were used, the results would have been biased toward day samples at the control stations, especially DC-20. It would also have meant combining dates from the two programs and comparing stations which were not necessarily sampled under the same conditions. For the trawls of the first program, however, there were many "no catches" and "net hangs" in the summer and/or one date was almost all samples were missed. Also, in early spring when the sampling was initiated it was quite irregular. The first usable date, therefore, was in May; the next one was in August, followed by three more before the end of the year. The results are shown in Table E-5. Out of 325 trawls conducted, there were 214 good samples, of which only 89 fit into a regular pattern suitable for unbiased stratification.

There were enough samples in the data frame of each category to support 6 to 7 species in each community matrix. To meet this criterion given the selected data, only the species listed in Table E-3 as other than infrequent (that is, present in more than 10 samples, plus present on more than five dates) were used for analysis. This left the 7 pelagic and 6 benthic fish listed in Table E-6 to be analysed. Table E-7, page 1 gives a summary of the data which were coded for analysis: there were, 13 species, 6 stations, 5 dates, 2 times, and 2 depths. The rest of the table lists the stratifications which were run, following the usual order, by station, by date, by depth and then by time. The by-stations table presents each station separately, and then groups them by control (RNCE-RSCW), experimental (RDW, DC-20) and all stations. In the date stratification, runs were made on an August to December grouping to see if it was different from the May-December grouping but as the results were similar, their comparison was not included in the report. May results, however, appeared to be similar to the results of the fall data and these runs are not included. The time

stratification was simply a comparison between day and night trawls, and the depth stratification compared surface and bottom trawls. There were enough data to conduct two-way stratifications by both time and depth over all stations and dates; that is, day-surface versus day-bottom versus night-surface versus night-bottom and, as well, day-all-depths and night-all-depths comparisons.

Note that for the surface trawls, values of the benthic sub-community were not calculated. Benthic fish were understandably rare on the surface and even if present, were unlikely to be competing with each other or the pelagic fish. Therefore, surface benthic fish were deleted from the data, and no niche values were calculated for these categories. The all groups-surface column is then equal to the pelagic-surface column. Means and coefficients of variation for benthic fish were taken over the single element from the bottom trawls, while the pelagic mean was calculated from pelagic-surface added to pelagic-bottom. The all-groups mean was calculated over pelagic-surface and pelagic-bottom and inshore benthic bottom. On Table E-7, pages 3 and 4 are for the depth and time-depth stratifications.

4. Results by Density

a. Stratification by Station for All, Pelagic, and Benthic Inshore Groups (Tables E-8 to E-13)

Differences and similarities in community structure and stability values of the adult fish community are given in the all-group by station tables (E-8 - E-9). Fish, being a diverse group of animals with complex behavioral and life-history patterns, present some difficult problems in estimating their population in an accurate, unbiased, and efficient manner.

Because of the wide variations in size and location of the fish, the general conditions under which the samples are taken and even the animals' ability in avoiding capture, there is no one effective method for sampling all fish species in all environments. In fact, there is a definite bias against daytime surface trawls where most fish studies have found that fish can often avoid the sampling device. These devices have differing and largely unknown effectiveness. Trawls are fairly effective sampling devices for many species and they are applicable to the habitats in question, however, these samplers are biased in species selectivity.

The adult fish community has a comparatively large biomass per individual yet its populations are sparse in terms of sampling units, that is, the individual fish. Combined with the extremely heterogeneous spatial distribution and associated behavioral patterns (the tendency to school, migrate, etc.), it is difficult for any sampling method to capture adequate numbers of a fish consistently and to describe their abundance and distribution accurately. Fish catches are chancy, variable and often empty. In this study the most frequent species only occurred in 57 out of 84 samples. The second most frequent species was in only 28 samples. This sparcity of data had its effect on the results (large ranges of variation, generally low stability measures, and such effects as $\overline{B}_i/E$ being low while $\overline{B_i/E_i}$ was high).

In addition, the fish catches in the surface trawls were not as abundant as the bottom trawls especially in the day time and, in fact, many were empty. Therefore, stratifications across depth were slightly biased toward the bottom community which was

markedly different from the pelagic community in the top of the water column. Reference to Table E-5 shows that overall there were 34 surface samples to 55 bottom ones and only 14 surface-day samples. The only specific stations which showed a significant bottom to surface bias, however, were RNCW (10 to 3 samples, respectively) and DC-20 (9 to 3). The only troublesome dates were August 21 (only one sample for surface-day out of 16 total) and December 12 (one surface sample to 12 bottom samples). The coefficient of variation Table (E-9) showed several important patterns. It is interesting to note that $\overline{B}_i/E$ values are consistent while the other measures of niche breadth ($\hat{B}/E$ and $\overline{B}_i/\hat{B}$) are variable.

This trend in variation was repeated in the other fish stratifications and it illustrates that the newly developed measure $\overline{B_i/E_i}$ is more robust to sampling and more consistent with sparse data than the other measure of mean species niche breadth ($\overline{B}_i/E$). According to their coefficients of variation the mean time-depth H values for control stations were consistent but not for experimental stations. Also, D and K both decreased significantly at the experimental stations but the $\overline{D_i/K_i}$ ratio remained constant. In general, the other niche values were similar among control, experimental and all stations; however, the coefficients of variation were generally higher for the experimental stations than the control station.

Density fluctuated at a few stations (Table E-8). The major dominant was white perch at 39% of the total community. Not only was it an extremely abundant fish in the community but it was also important in that it was found in both the benthic and pelagic subcommunities. This particular species undergoes vertical migration as well as horizontal movements. It is

onshore at night and offshore in the deeper water during the day. As expected, many of its vertical and horizontal movements are correlated with its feeding peaks which occur at noon and midnight. Since it is a species that has the ability to follow its food and since the larger white perch can feed on other fishes in both communities, understanding the ecology of the white perch is important in regard to interpreting the results given below. Other dominants were Atlantic tomcod at 15% and brown bullhead at 16%. Aside from a slightly low density at RDW, the major difference in density and species composition is at RNCE where there was an extremely abundant brown bullhead population. The within-diversity was even and low, except at the experimental DI station. The total diversity was not as constant but this seemed to be associated more with numbers of samples and sampling bias.

Diversity followed the familiar pattern of decreasing from total H to mean depth H to mean time H to mean time-depth H. This indicates that there was a significant among-environments diversity component and that there was more diversity among the temporal factors than among the spatial ones. This is understandable for a station stratifications and was nearly always the case for them.

The within-environments diversity component, given by mean time-depth, is the average measure of the number and 'evenness' of species in a community over particular environments. The among-time component which is the total H minus the mean time H, measures the number and distribution of species over all the dates and time frames used. The among-depth component for particular stations is equal to the total H minus the mean depth H and it measures the 'flux' in species composition only across

depth since only one station is used. [Note that among diversity components are erroneous due to not weighting within components-DL]. Therefore, the among-time H is among more environments than the among-depth component and therefore, is greater. The among-environments H given by total H minus the within H is among times, dates, and depths and is the approximate sum of all the among components. The results by station show that the among-depth diversity component is lower and more variable than the among-times and dates component. Even for the diversity measures for station groups, there were more dates and times in the among time H than stations and dates in the among depth H. Only for the all-stations category where all environments by spatial and temporal factors are included, are the two among environment components equal. The among depth H is higher than for any of the individual stations although for some reason not quite as high as for the control station group. The by-date stratifications support these results by having greater among station and depth diversities than among time.

The measures: total H, relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B}_i/\hat{B}$), percent carrying capacity ($\overline{\%K_i}$), and $\overline{\%K_i/(B_i/\hat{B})}$ when comparing differences between the values seemed to indicate that station RNC is most similar to the Danskammer control station. DC-20 was one of the two most consistently aberrant stations. The south west control (RSCW), the southeast control (RSCE) and the experimental station (RDW) off the plant sites, were grouped leaving the northeast control station (RNCE) as having the greatest differences, usually in a direction opposite DC-20. There appears to be a biological difference at the RNCE station but the RNCW and DC-20 stations were described as being the most biased. The bottom samples could account for some of their similarities but probably none of their differences from the other stations.

The value of the relative community niche breadth ($\hat{B}/E$) was highest for the experimental stations, indicating that the experimental station communities were more efficient in utilizing the ecological space than were the fish communities at the control stations. The north and south control stations were similar in terms of diversity components but less so in regard to the niche breadth ratios especially $\hat{B}/E$. The value for relative community niche breadth ($\hat{B}/E$) was higher in the south control station; and $\overline{B}_i/\hat{B}$ was lower, indicating that the south communities were better at utilizing their ecological space, whereas the individual species per community were better adapted in the north control stations. When north control, south control, all control and all experimental stations were compared, several consistent measures were apparent including percent carrying capacity ($\overline{\%K_i}$), $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$, and the value of mean alpha.

The breakdown by separate stations showed a range of minor variation, probably due to the unavoidable sparsity of the fish samples. As usual, what differences were found among the groups of stations (previously discussed) turned out to be attributable to one or two stations within the groups rather than a general change across groups. The most consistently atypical stations were the experimental station (DC-20) and the control station (RNCE). The DC-20 station was taken along a 20 ft depth contour in Danskammer Cove which is probably a spawning and feeding ground for several species. In contrast, station RNCE may be a spawning ground for brown bullhead.

The measures of species niche breadth ($\overline{B}_i/E$ and $\overline{B_i/E_i}$) were relatively consistent so that as diversity decreased at RNCE, so did the community niche breadth. This caused the mean relative

community niche breadth to be high, indicating that most individuals used a high proportion of the available community niche space. This result also supports the fact that most of these species were also dominants. This pattern was reversed at the experimental station (DC-20) where the community niche breadth ($\hat{B}$) was high so that the community as a whole was using more of the available ecological space; that is, it was more prevalent in more of the sampled environments.

Density was highest at RNCE and DC-20, however, $\overline{D_i/K_i}$ values were consistent as were mean niche overlap (α), percent carrying capacity ($\overline{\%K_i}$) and $\overline{\%K_i/(B_i/\hat{B})}$ values except at RNCE.

The station, RNCE, in particular, seemed to have many peculiar characteristics and was dissimilar to other control and experimental stations. Thus, species abundances were uneven at station RNCE. The value for $\overline{\%K_i/(B_i/\hat{B})}$ was low also, indicating that, in general, species did not do well here, and percent carrying capacity was higher indicating that a few species dominated the community. The species breadth (B') value was low as was the value for habitat diversity (H'). The mean values of alpha were consistent over all separate stations stratifications. The covariance of alpha, and the variance of the eigenvalues indicated enhanced stability; for separate stations, however, most of the other stability measures did not substantiate this result. The covariance of alpha was twice as high for the north control stations as the south control stations and when considering all control stations versus all experimental stations the values were similar. Generally, there were no clear cut stability trends.

The remainder of the control stations, as well as station RDW were similar. For all stations considered, the $\overline{D_i/K_i}$ ratio, the

B'/N ratio, and the mean value of alpha were consistent. A comparison at the experimental stations showed that the diversity component was greatest at Danskammer Cove (DC-20) even though there were fewer environments sampled. The use of the environment by the community at DC-20 was twice as great as at Roseton-Danskammer West (RDW) and this was associated with the mean species use of the community which was somewhat lower. The mean species use per environment ($\overline{B_i}/E$) was slightly higher at DC-20 than at Roseton-Danskammer West (RDW). Values of percent carrying capacity ($\overline{\%K_i}$), $\overline{\%K_i/(B_i/\hat{B})}$, and $\overline{D_i/K_i}$ were similar for both stations as were the values of species breadth (B') and habitat diversity (H'). Mean alpha and its coefficient of variation were almost identical as was the covariance of the alpha. The corrected determinant, $|A|$, however, varied by a factor of ten. Stability measures at Roseton-Danskammer West (RDW) indicated that it exhibited the largest stability in terms of the determinant, $|A|$; range, variance, and harmonic mean, skewness and kurtosis of the eigenvalues; and the range and arithmetic mean of the reciprocal eigenvalues.

The stability of the fish community was generally low for all the individual stations as well as all station groups except for all-stations, repeating a consistent trend (concerning global versus local stability) found in the previous results. The measures except for skewness (S_λ) and kurtosis (K_λ) represented the stability for a particular station or area and likewise for a whole year versus a given date. This illustrates that there can be global stability in spite of considerable local instability. Thus, although there can be dynamic change or potential for serious perturbation in a limited set of environments, as one considers a larger portion of the ecosystem, it becomes more robust and changes or perturbations are

more likely to be dampened or absorbed. This is particularly understandable for fish whose use of specific areas in a region is quite specific and whose behavior may be far-ranging over a set of habitats. Because of this, the stability measures are insensitive to the numbers of samples and species in the data, and therefore, it is not valid to compare the values for different types of stratifications.

Another similarity between the fish and phytoplankton results by both density and biovolume, for at least all stations, the stability indications were greater for the sub-communities considered than for all groups. This is an apparent reversal of the trend of increasing stability with increasing amounts of data; however, it is probably a question of the definition of a community. It seems that as the community becomes larger, and the species less tightly related to one another the stability is relatively lower. Note that for phytoplankton the individual station values for all groups were higher than for each group because there were too many species considered for the number of samples and hence, even the corrected determinant was unreliable.

As mentioned, the covariance of alpha; the determinant; the minimum, harmonic mean and, variance of the eigenvalues; and the values for $1/\lambda$ all show the greatest stability for the all station group. All measures, except variance (S_λ), skewness (S_λ), and kurtosis (K_λ) demonstrated the second highest stability at the south control stations and the lowest at the north control stations. The south was more stable than the north and overall the control stations were more stable than the experimental stations. This latter result was not consistent, however, and was contradicted by the variance, skewness and kurtosis of the eigenvalues. Also, when means over separate

stations were considered (Table E-9), the mean value for experimental stations exhibited the greater stability although with more variation. All measures indicated the experimental station (RDW) was the most stable station while all but skewness (S_λ) and kurtosis (K_λ) had RNCE and DC-20 as the least stable. Skewness and kurtosis were highest at RSCW.

The apparent inconsistency among the various stability measures presented is as likely to be in our understanding of their interpretation as well as in any mathematical and/or sampling problem. As with the term community, stability is not well-defined and to say that a given measure increased or decreased is a gross simplification. We do not yet understand all the measures well enough to give a detailed interpretation in terms of the actual state of the system. In these results, we mostly rely on a few measures such as the harmonic mean and variance of the eigenvalues to show increases and decreases of stability defined as a tendency for a faster or slower response to a perturbation.

It is obvious that neither the control stations grouping or the experimental stations grouping were homogeneous. Stations RSCE, RSCW and RDW showed many properties in common while DC-20 and RNCW (which was the closest station to DC-20) also had several properties in common. Generally, in searching for patterns in these data, we have led concluded that many of the stations were not well chosen to illustrate the most significant differences and similarities in the fish community structure patterns.

Table E-11 gives the coefficients of variation for the adult pelagic fish by station. When the fish species were divided into pelagic and benthic inshore community groupings, more

trends were apparent in the pelagic fish community than in the benthic-inshore fish community. This was somewhat unexpected since trawls were usually less effective in open water, and the occurrence of pelagic fish in the bottom waters may cause discrepancies in some of the pelagic values, since the surface samples did not encompass the whole community.

Pelagic fish were one of the several groups in this study which illustrated the effects of being over-dominated by one species. The species composition was white perch 68%, blueback herring 10%, alewife 7%, and bay anchovy 6%. Later tables will show that most of the white perch were found on the bottom while most of the blueback herring, as well as the other herring species listed as dominant, were found mostly in surface trawls particularly during the day. Their overall density was also higher on the bottom indicating a large concentration of white perch on the bottom.

By-station density was lowest at the control station (RSCE) and the experimental station (RDW) while it was the highest at the other experimental station (DC-20), which mostly followed the fluctuations of white perch. RSCE showed decreases for all the dominant pelagic species listed on Table E-30a. The percent composition of white perch peaked at over 80% at control stations. Stations RNCE and RSCE exhibited a corresponding decrease in total diversity and consequently blueback herring and the alewife were displaced as second and third dominants at RNCE by the bay anchovy and the American shad and at DC-20 by the spottail shiner. There was a notable increase in the density of striped bass at the experimental station (RDW) although they were still only 6% of the community.

The separate groups, pelagic and inshore-benthic, exhibited more variation in the niche measures than did the all-groups. The only coefficients of variation for pelagic fish over all stations under .1 was $\overline{B_i/E_i}$ (Table E-11). In contrast, using the .5 criterion the only varying measures were the stability values. The coefficients of variation between control stations and experimental stations did not show much difference. $\overline{D_i/K_i}$, $\overline{\%K_i/(B_i/\hat{B})}$, and the stability measures exhibited less variation for experimental stations.

Comparisons of station groups by means or by the values on niche Table E-10, mostly followed the patterns of the all-group table. Within-environment diversity rose at the experimental stations while the among date and time component rose at the north control stations leaving the south control stations with the lowest total diversity. Relative community niche breadth ($\hat{B}/E$) increased steadily from north controls to south controls to experimentals; however, relative species niche breadth ($\overline{B_i}/\hat{B}$) was relatively constant. Niche overlap, percent carrying capacity ($\overline{\%K_i}$), and $\overline{\%K_i/(B_i/\hat{B})}$ all increased from south control stations to north controls with experimental station values intermediate. In particular, the means of percent carrying capacity ($\overline{\%K_i}$) and $\overline{\%K_i/(B_i/\hat{B})}$ for control stations versus experimental stations were similar. This trend was reversed for most of the stability measures with the north control stations showing considerable instability. The skewness (S_λ) and kurtosis (K_λ) were highest for the experimental groups indicating low stability.

It is interesting that there are greater differences between north controls and south controls than between control and experimental stations. In fact, the values for separate

stations show more similarity in some respects between the two east control stations and between the west controls than within the north and south groupings.

The diversity values showed several differences at the control stations while the experimental group was consistent. Total H and another diversity measure (B'/N) were lowest at RNCE and RSCE and highest at RNCW which is related to their first and second dominant species percent composition. This pattern was repeated by the among-date and time diversity which had a high peak at RNCW. The within-component was consistent except at DC-20 where it increased and the among H decreased producing no net change in total H.

The most interesting result was from the among-depth diversity component which seemed to fluctuate without pattern. For stations RNCW, RSCW, and RDW, it was positive and high while for RNCE, RSCE and DC-20 it was close to zero or negative. At the first three stations, however, where there is a significant among-depth component there were high percentages of surface fish, blueback herring or bay anchovy, while at the other stations the highest fish found at the surface was only about 7% of the density. This indicates that the differences in diversity were because, at the stations RNCE, RSCE, and DC-20, there were few fish found on the surface so that rather than a change in species there were simply no fish except at the bottom. Thus, there was no among-depth diversity. This result seems to have nothing to do with sampling since this was predicted to have an effect on stations RNCW and DC-20. It could be that all the western stations have a large surface population except DC-20 because of sampling while the eastern stations have few surface fish.

Diversity values for the control stations were lower than experimental station values, although both measures followed the trend of decreasing values from H to $\overline{H}_h$. The relative community niche breadth ($\hat{B}/E$) was higher for the experimental stations while the species use of the environment ($\overline{B}_i/\hat{B}$) was practically the same for control versus experimental stations. The values of $\overline{\%K}_i$, $\overline{\%K/(B_i/\hat{B})}$, $\overline{D_i/K_i}$ and H' were similar for both groups of stations, while B' was higher for the experimental stations.

The station (RNCE) exhibited some peculiarities. The relative community niche breadth ($\hat{B}/E$) was low, the associated relative species niche breadth ($\overline{B}_i/\hat{B}$) values were higher. The coefficient of variation for density was high, and the $\overline{\%K_i/(B_i/\hat{B})}$ ratio was low indicating that species generally did not do well. This is understandable since white perch dominated the station. The competitive success ratio ($\overline{D_i/K_i}$) was high for this station because of the success of white perch. This result was not as apparent at the RSCE station, however, even though white perch was also abundant here.

The experimental station DC-20 had an extremely high relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B}_i/\hat{B}$), $\overline{B}_i/E$, niche overlap ($\overline{\alpha}$), as well as the high density and mean environment diversity already mentioned. This indicates that most if not all species were more competitive and effective in using the environment. The measures $\overline{\%K}_i$, $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ were consistent here and at the remaining stations. Stability seemed to be essentially correlated with total diversity. The greatest stability was shown at RNCE and RSCE by the covariance of alpha; the determinant of A; and minimum, harmonic mean, variance and skewness of the eigenvalues and the reciprocal eigenvalues. The unstable stations were RNCW, RDW, and

DC-20 by all measures, however, there was disagreement as to which station was the least stable. The minimum eigenvalue (min_λ) and related criteria as well as the reciprocal values indicated RNCW was the least stable since its matrix had a zero eigenvalue caused by fewer environments than the number of species. Conversely, the variance of the eigenvalues, as well as skewness (S_λ) and kurtosis (K_λ) of the eigenvalues were highest at DC-20.

The inshore-benthic fish community might be expected to show more community structure than the pelagic fish community since this group contained most of the true resident species and the bottom samples were more complete than the surface trawls. Also, there was no depth factor since these fish were rarely found on the surface and those that were, were not considered to be competing in the community. This was not the case, however, with the benthic community which was quite variable both in terms of species composition and community structure. In terms of stations, the environmental conditions varied with the river bottom type while in terms of dates, the salt front intrusion had a longer-lasting effect on the bottom since the salt water tends to form a heavier layer at the bottom.

The benthic-inshore community contained most of the resident forms, however, the more numerous species were transient and thus contributed to the variability of the community. Benthic fish overlapped strongly with the pelagic fish such as white perch especially in the late fall. The dominant species of the community was also an anadromous fish, the Atlantic tomcod, which winters in the river and spawns in late fall through winter. Thus the trawls caught none of this species except in May and again in October to December reaching over 90% at these

times but only 37% overall. Another dominant marine fish was the hogchoker, a flounder. Although it appeared to be resident, the nighttime bottom trawl in November at the RSCE station collected a large number of them and they could have been brought in by the salt front. Although they averaged under 10% of the total catch they peaked at 60%.

Even the freshwater species showed great fluctuations in density. The brown bullhead was perhaps third in dominance, usually well under 10%, but for the daytime trawl in October at RSCE an extraodinarily high number (80%) of the species were captured. In fall, they became the overall dominant at 38%. The behavior of the white catfish was similar, but not as pronounced as the brown bullhead.

These two examples alone produced a great deal of variation, over date, over station, and even over time of day since one was in the day and one was in a night trawl. This may be an erroneous result; for instance, if most of the peak numbers were young, the actual change in biomass would be small. They had a considerable effect on the results; however, with the present data set, it is impossible to say where occurrences like these were prevalent or whether they had a correspondingly significant effect biologically.

The coefficient of variation in Table E-13 demonstrated the variable nature of the community. The only consistent measures were, as with the other fish groupings, $\overline{B_i/E_i}$ with a coefficient of variation of .2 and $\overline{D_i/K_i}$ with the same coefficients of variation. H' and B' also exhibited low variation. Measures which showed significant change of 50% from control to experimental stations were mean H, D, K, $\%\overline{K_i/(B_i/\bar{B})}$ and the stability measures.

Table E-12 presents the station breakdown of the community niche values. Overall, the species composition of the benthic-inshore dominants was brown bullhead 38%, Atlantic tomcod 37%, followed by the hogchoker at 17% and the white catfish at 4% along with several species of freshwater inshore fish such as gold fish. The Atlantic tomcod and hogchoker showed little or no station preference except for the hogchoker peak at RSCE (16%). The tomcod dominated most stations at 60-70%. The brown bullhead was found almost exclusively at the eastern stations and Danskammer Cove particularly at RNCE where there was 74%. Density was about 14 fish per 10 minute trawl, but rose to 48 and 29 at the two peak stations RNCE and RSCE respectively. RDW, the station nearest the plants, had a low density of a trawl as well as a fewer number of species that were all marine.

Diversity was constant and unaffected by the peak abundances. Total diversity was consistent except at two stations. There was a drop at RSCW in the among-environments component and a shift from within environment diversity (mean H_e) to among at both experimental stations as well as RNCE. Only at DC-20, however; was the increase in among diversity great enough to affect the total H. The diversity values for all-stations have a lower among-space H than the among-time H which is to be expected without the depth factor.

The community niche breadth ($\hat{B}$) was higher in the south control stations even though the number of environments was lower, but the values for $\bar{B}_i$ were relatively similar when comparing control and experimental stations. The value of the relative community niche breadth ($\hat{B}/E$) was higher in the south control stations, and extremely high in the experimental stations. The relative species niche breadth ($\bar{B}_i/\hat{B}$) had a higher value in

the north control stations over south control stations, and higher in the control stations when the control and experimental stations were compared. The mean species use of environment ($\bar{B}_i/E$) value remained consistent for all of the station groups except for the individual station stratifications.

For the individual stations, RNCE and DC-20 showed the greatest changes in community structure just as pelagic fish had. However, the other stations, notably RDW and RSCW, also showed differences. At RNCE, both relative community niche breadth ($\hat{B}/E$) and $\bar{B}_i/E$ decreased, relative species niche breadth ($\bar{B}_i/\hat{B}$) remained constant. This result parallels the decrease in mean environment diversity. At DC-20 there was a significant decline in relative species niche breadth ($\bar{B}_i/\hat{B}$) while relative community niche breadth ($\hat{B}/E$) and $\bar{B}_i/E$ diverged showing that species use at the environment was more specialized although more diverse than the among H suggests. At both RDW and RSCW) $\bar{B}_i/\hat{B}$ increased somewhat indicating more complete species utilization of the available community space. AT RSCW, however, the relative community niche breadth decreased while at RDW the mean relative species niche breadth increased.

Density was largest in the north control stations and lowest in the experimental stations because of the peak values. The $\overline{\%K_i}$ value was relatively constant for all but the individual station stratification where RSCW and RDW showed slight increases. The $\overline{\%K_i/(B_i/\hat{B})}$ ratio was greater for RNCE as well as the experimental stations, over the other stations. This indicated the unevenness in efficiency of a particular species in the experimental stations as compared to the control stations and is a common result in perturbed environments. While the $\overline{D_i/K_i}$ ratios were similar for north and south control stations and

control and experimental stations respectively, showing only a minor decrease at RSCW. The mean value of alpha was regular for most of the station comparisons. It increased only for RNCE and RDW. The coefficients of variation over the individual alpha values was quite high except at RDW. The rise at RNCE therefore was probably an effect of the brown bullhead peak which is a general effect that explains most of the other trends at RDW.

There was indication of instability at the DC-20 station and the RNCE station in terms of the covariance of alpha ($cov\alpha$), and determinant ($|A|$) as well as the other usual indications that stability was low at stations RNCW and RSCE in terms of the $range_\lambda$, S^2_λ, and $H.M._\lambda$, S_λ, K_λ, and range $1/\lambda$, $S^2 1/\lambda$ and arithmetic mean of the reciprocal eigenvalues.

b. <u>Stratification by Date for All, Pelagic and Benthic Inshore Groups (Tables E-14 to E-19)</u>

In the stratification by dates, it was not possible to use the data for the months of June and July, 1973. It was unfortunate that there were many unusable samples for this time period. Lacking these data prevented us from identifying any trends that might have been apparent had we had a complete temporal sequence from May to December. In general, there were fewer consistent properties in community structure and stability when the fish data were stratified by date as compared to the stratification by station. This is in agreement with most of what is known about north temperate aquatic systems, in that seasonal fluctuation variations in density and life history parameters are usually substantial. The date stratification included all dates and individual dates, May, August, October, November and December, being used.

In Table E-15 the coefficients of variation for all dates, over groups of fish, including pelagic and benthic inshore species, illustrated only a few noteworthy points. For diversity measures, the mean time-depth diversity ($\bar{H}_h$) was high. The within seasonal component of diversity ($\bar{H}_t$) was higher than the within station component of diversity ($\bar{H}_d$). In the discussion of the first Table E-8, this was explained as follows: the diversity within stations and depths is distributed across considerably more environments in this stratification than for the diversity within time which in this case is only across time of day.

The values of the relative community niche breadth ($\hat{B}/E$) and relative species breadth ($\bar{B}_i/\hat{B}$) were similar; the latter being only slightly larger than the former, while the value of the species niche breadth over E ($\bar{B}_i/E$), however, was less than half as much as with the previous stratifications. All of these measures had high coefficients of variation, of .3 or higher. As with the station stratifications, however, the $\overline{B_i/E_i}$ values were high and consistent, having a coefficient of variation of only .1. The measures of percent carrying capacity ($\overline{\%K_i}$), $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$ and habitat diversity (H') also had low variation as before. The only measures having a coefficients of variation over .5 were carrying capacity, $|A|$, minλ, H.M.λ, Sλ, max $1/\lambda$, $S^2 1/\lambda$, and mean of the reciprocal eigenvalue ($\overline{1/\lambda}$), however, there were no measures of less than .1.

The white perch was usually the most numerically abundant fish, although there were several seasonal shifts in species dominants (Table E-14). This is especially true because both benthic and pelagic inshore species were considered. The Atlantic tomcod was abundant only in May when it was dominant at 58% causing a

significant rise in density, and again in December when it was 29% of the fish caught after white perch at 50%. The peaks of benthic fish occurred in October when brown bullhead was barely dominant at 38% of the community density, and in November when the hogchoker was 24%, after white perch at 45%. The white perch reached its maximum dominance of 77% in August. Except for increases in May and October and a decrease in December, the overall density was constant. The value for species diversity was lowest for all groups in August, higher for October and November, and then decreased again in December. As expected, the all-dates grouping exhibited the highest diversity values. In regard to some of the other components of diversity, the values for the mean time-depth H ($\overline{H}_h$), the mean depth H, and mean time H were lowest in August. The mean time-depth H ($\overline{H}_h$) was significantly high in October while the among time depth diversity was highest in November, decreasing again in December.

Community structure values were either constant or they varied regularly except for the month of October which was the month of the brown bullhead peak when it exhibited some peculiar differences. That these same differences did not appear in the pelagic fish table but did for benthic fish, implies that they are due to the peak.

The relative community niche breadth ($\hat{B}/E$) was relatively constant for all of the months except October. The value for relative community niche breadth was lowest at this time of the year (October) while the individual species niche breadth ($\overline{B}_i/\hat{B}$) value was the highest. For the other dates, these two niche ratios were consistent. Thus, although the relative community niche breadth decreased considerably the $\overline{B}_i/E$ ratio was constant although it did rise somewhat in May and December.

Curiously, the value $\overline{B_i/E_i}$ dropped a little in October and was regular elsewhere, following the pattern of relative community niche breadth. The value for $\overline{\%K_i/(B_i/\hat{B})}$ was also low in October and slightly lower in November and December but $\overline{D_i/K_i}$ was consistent. Niche overlap was highest in May and December and lowest in November. The value for relative species breadth $(\overline{B_i}/E)$ and B'/N support the diversity values, being low in August and high in December.

The stability values also varied considerably. Usually the December values indicated enhanced stability over the other dates and all-dates particularly the values of $\min_\lambda$, range_λ, and H.M._λ, S_λ and K_λ of the eigenvalues and the range $1/\lambda$, $S^2 1/\lambda$ and arithmetric mean of the reciprocal eigenvalues $(\overline{1/\lambda})$. Except for S_λ and K_λ the same measures indicated August as the least stable month. The variance of the eigenvalues, on the other hand, showed a more familiar pattern, being lowest for all-dates and highest for October. The skewness and kurtosis of the eigenvalues were greatest in May. In general, overall indications of stability were slight and the adult fish community by date tended to be more unstable than its counterpart stratification by station. Although there were consistent properties in this community, other factors were not regular. In particular, the mean value of alpha underwent a two-fold variation with season.

In Table E-17 the coefficients of variation are given for the pelagic community stratified alone. In most cases, the coefficients of variation were higher than for all species. Several values were over .5 and the lowest was .15; however, in general they maintained their relative proportions. In this stratification, white perch constituted 68% of the community and blueback

herring was the second dominant species with only 10% of the total community density. Because of the predominance of white perch, most of the diversity values were low.

In general, the value of the relative community niche breadth ($\hat{B}/E$) was low and the relative species niche breadth ($\bar{B}_i/\hat{B}$) value was somewhat higher at .54 as compared to the value for all species. The mean $\overline{D_i/K_i}$ value was relatively large. The stability measures were notably higher and displayed lower coefficients of variation than for the all-species values.

In Table E-16, some more of the detailed patterning of temporal niche stratification by date is apparent. The density was regularly higher in the mid-summer months of August and October than in the early and late parts of the year, November and December. White perch dominated all months between 86% in August and 50% in October. In October there was a high proportion (18%) of the bay anchovy which became the second dominant. In December, there were only 3 different species in our data and the second dominant was the spottail shiner at 27%. Otherwise, the second most abundant species was the blueback herring at 10% overall.

Thus, the month of October showed differences in its diversity patterns although not with the community structure values or the stability values. In October all diversity components showed increases, and the time of day diversity value which was normally zero, was significant here. The total diversity dropped to its lowest value in August and December. When all dates were considered, the components of diversity related to station ($\bar{H}_d$), and season ($\bar{H}_t$) represented by month were equal.

For the niche breadth relationships, the value of relative community niche breadth ($\hat{B}/E$) was lowest in May, and was regular for the rest of the year. Also, the relative species niche breadth ($\overline{B}_i/\hat{B}$) value was highest at this time (.88), whereas for the other months of the year, it fluctuated between values of .35 and .53. Thus, these measures were not consistent. For May, the mean species niche breadth over environment ($\overline{B}_i/E$), however, was more consistent than the relative species niche breadth ($\overline{B}_i/\hat{B}$). The former measure varied from .25 in May and December to .15 in November while again $\overline{B_i/E_i}$ followed the relative community niche breadth ($\hat{B}/E$). Also similar to the all species table, values for all niche breadth measures were low for all-dates.

The density was greatest in August when white perch had the largest relative abundance. The $\overline{\%K_i/(B_i/\hat{B})}$ ratio was the lowest in May when species were less successful in exploiting their ecological space. This may be because conditions were not optimal for fish at this time of the year. For example, food organisms may be rare and so on. In contrast, the $\overline{D_i/K_i}$ ratio, or measure of competitive success in overlap, was the highest in May and December and mean niche overlap, the lowest. This result was further substantiated by the fact that there were fewer species occupying the environment at these times of the year and those present tended to have wider niches. The positive correlation between ecological overlap and density has been shown in other aquatic communities.

The values of species niche breadth (B' and B'/N) were lowest in August and were related to the dominance of white perch. The value for the B'/N ratio was low for November. The covariance of alpha was relatively constant from August to November and

lower in May and December. The determinant indicated lower stability in the summer. In August and October, the values of the determinant ($|A|$) were similar. The determinant values increased with time, yielding a trend of increased stability as the season passed. The highest stability measures were found in both May and December. For May, this included the eigenvalue range, variance and harmonic mean, as well as range, variance, and arithmetric mean of the reciprocal of the eigenvalue. For the month of December, the eigenvalue range, variance, harmonic mean, skewness and kurtosis of the eigenvalues and variance and arithmetric mean of the reciprocal eigenvalues showed increased stability.

In general, community structure and stability patterns for May and December were similar due to the fact that light and temperature as well as several other environmental factors were similar for these two times of the year. Consequently, several of the patterns can be delineated by comparing the extreme seasonal points of the data set as well as the month to month types of comparison.

The benthic inshore community is represented by niche value Table E-18 and coefficient of variation Table E-19. This fish group demonstrated greater variation than the others. Density fluctuates with coefficients of variation of .7 with no seasonal pattern evident. With an average of about 20 fish per trawl, May and October were high abundance periods at 38 and 34 while August and December were extremely low at 6 each. The species composition also fluctuated in the same manner. Two species were tied for overall first dominant at about 37% and the diversity was usually high although heavily-weighted on the among component. Each individual date was over-dominated by a

different species with a corresponding drop in the among environments H. In May and December the anadromous fish, Atlantic tomcod, dominated at about 90% although the total density was greater in May. Also in December, only 3 of the included species appeared so that the total H was the lowest found. In August and October, of the spawning fish, brown bullhead constituted 50% of the community although, again, the October density was greater than in August when only four species were captured. In November, the hogchoker was dominant at 60%.

All diversity measures were extremely variable. The within component was constant for the first three months but high in November and low in December. Only August and November had substantial among station-depth diversity while only August had a marked among time of day component. Thus, November and August have the highest total H while December had the lowest. Most of the community structure values were consistent except for the month of October. Comparing mean values over the fish groups, the benthic community exhibited somewhat higher niche breadth values, and mean overlap, but lower average $\overline{\%K_i/(B_i/\hat{B})}$, and diversity values. Like the pelagic fish, they showed higher $\overline{D_i/K_i}$ and stability values than the all-species grouping. The relative community niche breadth ($\hat{B}/E$) was similar and at its highest value for May and August, decreased in October, and then increased through November to December. This pattern was repeated with other niche values. $\overline{B_i}/\hat{B}$ varied inversely while $\overline{B_i}/E$ was similar to the relative community niche breadth ($\hat{B}/E$) but did not fluctuate as widely. $\overline{B_i/E_i}$ followed relative community niche breadth ($\hat{B}/E$) more closely, having significantly higher coefficients of variation over species for October. Although we do not have the June and July values to substantiate this result, the values seemed to suggest that the period from

May to August, the fish community uses about 67% of the available ecological space with each species using an average 50% of the community space. Then in October there was a perturbation, perhaps the salt front intrusion, which represented a major perturbation to the community. Niche breadth values dropped drastically, both for the community and species; however, the ratio of species niche breadth to the community niche breadth was higher. In fact one species, the brown bullhead, had a higher species niche breadth than the community niche breadth.

Many of the coefficients of variation were high for the October community, which indicated a great deal of variability in the behavior patterns and population dynamics of the individual species at that time of the year. October is also considered a transition time from summer to winter season and it may be that several unique events were happening in the life history of these species at this particular time of the year. Also, all values dropped from all-dates because of the variability of the individual species niches. That is, no one species has a relatively large niche over all dates and the whole community fluctuated over date and thus changes appeared small when viewed globally.

It was interesting that the value of $\overline{\%K_i}$ was regular (even including the October values) and that only in May was it especially high. $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ were somewhat consistent although with a high range. $\%K_i/(B_i/\hat{B})$ was high in May and August and slightly low with a high species coefficient of variation in October while $\overline{D_i/K_i}$ is low in May with small fluctuations in the last two months. The B'/N ratio was similar for August, November and December but again October was low as was May, and there were no other particular patterns with these data.

The mean value of alpha was low for December indicating that the species were not overlapping to any extent. Mean alpha was also low in October with a high coefficient of variation over species, particularly in May. The high spring overlaps have been previously observed in other aquatic communities (Lane, 1975). Often when food is becoming abundant, and when there are fewer species and lower population densities, it is possible for species to overlap to a higher degree than at other times of the year. The values of the determinants ($|A|$) were similar for the October and November overlap matrices and high for the December matrix. The high value illustrates the smaller overlap at this time of year.

For several of the stability measures, the October and November matrices exhibited similar properties. This was interesting since October seemed to exhibit different niche measures. Many of the stability measures for these two months and August showed an enhanced stability, including the values of $\overline{\alpha}$, the coefficients of variation for the mean value of alpha, the covariance of alpha, the eigenvalue range, and the reciprocal eigenvalue range. In general, however, the December values seemed to be more stable; including the values for determinant ($|A|$), the range, variance, and harmonic mean of the eigenvalues as well as the range, variance and arithmetic mean of the reciprocal eigenvalues. These results demonstrated that May was the least stable month, according to the variance of the eigenvalues, and that stability generally increased through the year.

c. Stratification by Depth for All, Pelagic and Benthic-Inshore Groups (Tables E-20 and E-21)

This section of the results discusses results in Tables E-20 and E-21. These tables contain the coefficients of variation for

the data on the adult fish community stratified by all depths for surface and bottom trawls, for all pelagic and benthic-inshore groups, for all-dates, stations and times. In Table E-20 and Table E-21, the fish community structure is delineated by depth. It can be seen from the coefficient of variation table that there is a fairly high degree of variation across depth considering that there are only two depths: surface and bottom. There was a high degree of variation over both depth and time of day for all, pelagic and inshore-benthic fish. Thus, the fish community structure did not appear to be locally consistent at a given date and station but displayed heterogeneity and specialization. This result was unlike plankton results and was more similar to fish larvae results. With fish larvae, however, consistent properties were found when the means across two-way stratifications were compared. Referring to the appropriate tables for fish, it can be seen that the same is true for fish but only for means across time. That the two-way stratification has so much more consistency than either of the one-way tables is an indication not only of the variation in these factors but of the considerable interaction between them. Thus, it would appear that according to their means, the fish community structure is regular over time but not depth. In any event, time and depth effects will be discussed in greater detail in regard to Tables E-24 to E-29.

The means and coefficients of variation in Table E-21 illustrate several of the basic trends in the variation patterns in the niche values for the stratifications by depths. Obviously, since inshore-benthic fish were only considered to be on the bottom, they do not appear in this coefficients of variation table over depth. Generally, the coefficients of variation for the diversity values are highest for the pelagic fish but low

overall. Although the diversity of the pelagic community from the bottom is low due to the over-abundance of white perch, the diversity of pelagic and inshore-benthic fish together is consistent over depth. The mean time-depth H's have comparable coefficients of variations. The mean depth H appears to follow the total H while the mean time H follows the mean environment H which is a consistent result. Niche breadth values have fairly low coefficients of variations for both all groups and pelagic fish. The rest of the community structure values, however, were quite variable. The variation of stability measures was slightly low although more so for all-species than pelagic groups.

Table E-20 gives some of the breakdown by depth and community groupings for the various results described above. The data stratification for all depths is from Tables E-8, E-10 and E-12 (as all-stations) and is included here for comparison. The benthic bottom species breakdown for all groups shows white perch as constituting 45% of the fish community. This indicated that this species was almost half of all fish individuals captured in the bottom samples. The species composition for surface trawls was: blueback herring (30%), alewife (24%), and bay anchovy (22%); while for bottom trawls: white perch is 45% while the benthic feeders, brown bullhead and Atlantic tomcod, are 19% and 11% respectively. The density for bottom trawls is three times that of surface trawls and approximately equally divided between pelagic and benthic feeders.

The surface trawls had a slightly higher total diversity value than the bottom trawls but a lower mean environment H. The lowest diversity in all components was exhibited by pelagic fish on the bottom which excluded most of the white perch. The

greatest differences were seen in the among components while the with-H was relatively constant. The among station H was understandably lower than the among date-time H except for bottom pelagic fish where the temporal diversity was zero.

The relative use of the species niche breadth ($\overline{B}_i/\hat{B}$) indicated benthic species were a little better at using their smaller community niche space, while bottom pelagic species were worse. Relative community niche breadth values were consistent for pelagic fish but slightly lower for inshore-benthic fish.

For other measures such as $\overline{\alpha}$, %K, $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ the inshore benthic community exhibited higher values. When the data was stratified by depth, however, the measures were not as consistent as they had been when all depths were considered simultaneously. Comparing surface-pelagic, bottom-pelagic, and inshore benthic values was difficult. The mean α was significantly greater for the surface pelagic fish; $\overline{\%K_i/(B_i/\hat{B})}$ was significantly lower for bottom pelagic, while $\overline{D_i/K_i}$ was significantly greater for the inshore benthic community. This in some way indicated that the introduction of depth as a data stratification causes more artificiality in the patterns that were observed, especially since the pelagic fish like the white perch were utilizing several depths successfully and there was probably a great deal of interplay between the surface and bottom waters for particular species of fish and none for others. Thus, this separation of fish communities into benthic and pelagic types may not be completely justified. We do not know enough about the ecology of most of these fish in these various circumstances to solve these problems completely; however, the two-way stratification will elucidate more of the interrelationships. The values of species breadth (B') and

species breadth over N were low for the pelagic fish. The mean value of alpha was consistent for the bottom all-groups, bottom pelagic, and benthic-inshore stratifications.

In regard to stability measures, the pelagic community on the bottom exhibited a greater stability in the depth stratification than in other data stratifications. This included the following measures: covariance of alpha; the corrected determinant; the range, variance, and arithmetric mean of the reciprocal eigenvalue. The benthic inshore community exhibited a greater stability in regard to the coefficient of variation of α, the mean value of alpha, and covariance of alphas. Thus, even though it would seem from the way the data were originally stratified that the pelagic bottom fishes are a subset left over from the surface water community, this is not true. This group does have an integrity which cannot be ignored, mainly because of the predominance of white perch. By most measures, especially the reciprocal eigenvalue values, the inshore benthic community was quite unstable; however, the variance, skewness, and kurtosis of the eigenvalues were low for this group.

d. Stratification By Time For All, Pelagic and Benthic Inshore Groups (Tables E-22 and E-23)

In the next Tables, E-22 and E-23, the data have been stratified by time of day. As with white perch, many of these fishes have a day-night distribution pattern or periodicity which will have a marked effect on community structure values in patterns that are observed based on time stratifications. For the adult fish of the Hudson River this is no exception. The sources of some of this variability could be seen better in the breakdown of the

day-night stratification in Table E-22. The percentage community abundance results illustrate that many of the fish were moving diurnally. For example, the white perch constitutes 76% of the pelagic community in the daytime, but only 53% of the pelagic community at night. The blueback herring is the second most abundant member of the day community, but in the night time, the alewife and bay anchovy constitute 17% and 14% of the community. In the daytime community for inshore-benthic species, the brown bullhead represented 55% of the community abundance, whereas in the night community, the Atlantic tomcod made up 50% and the brown bullhead only 14%. The hogchoker was the second most abundant benthic species at night with 26%, but represented only 10% of the community density in the daytime. When all groups were considered, the white perch was always the most numerically abundant fish. In the daytime, however, the brown bullhead was the second most abundant species whereas at night it was not even in the top four species since it was replaced by the Atlantic tomcod which composed 23% of the community density, and the hogchoker which composed 12%. For all times and all groups, the brown bullhead was the second most abundant species and the Atlantic tomcod was third.

The lowest coefficients of variation for the diversity measures were in the inshore-benthic community by day and night despite its changing species composition (Table E-23). The mean time-depth H was fairly regular for all species groups and thus the variation in the fish community appears in the among mean-time or mean-depth H for pelagic fish. For some of the values of the niche breadth measurements, the coefficients of variations were lowest for the pelagic community, in contrast to the diversity measures. The measures $\overline{B}_i/E$ and $\overline{B_i/E_i}$ were consistent for all species groups. The rest of the coefficients of variation were typical.

Comparing day and night values on Table E-20 produced rather confusing results. Again, the all-times values have been included for comparison. For all species, the within H and the among date H were similar but the among station-depth H and therefore total H was greater in the night. The inshore-benthic diversity components were close but the pelagic fish values showed neither similarity nor pattern.

Both relative community niche breadth ($\hat{B}/E$) and relative species niche breadth ($\overline{B}_i/\hat{B}$) were consistent except for inshore-benthic fish for one day-time. Relative community niche breadth ($\hat{B}/E$) decreased and relative species niche breadth ($\overline{B}_i/\hat{B}$) increased correspondingly. The benthic fish seemed to be more active at night which agreed with our knowledge of their biology. Many benthic-feeding fish are inshore during the day and only at night move out to deeper water where they can be caught by the bottom trawls. Also, in the Hudson River, it appears that they may be undergoing severe competitive pressure from the white perch which is more prevalent in bottom waters during the day. Values of $\overline{B}_i/E$ and $\overline{B_i/E_i}$ were generally consistent.

The rest of the community structure values, as with the depth stratification, showed no descernible patterns. Comparatively, $\overline{\alpha}$ had a high value for day-time pelagic fish while $\overline{\%K_i}$ and $\overline{\%K_i/(B_i/\hat{B})}$ were lowest for inshore benthic fish in the day-time and $\overline{D_i/K_i}$ was greatest for inshore benthic fish in the night. Again, we must refer to the two-way stratification over time and depth to obtain coherent results.

There is a clear trend towards greater stability in the night-time stratification demonstrated by all measures, including skewness (S_λ) and kurtosis (K_λ) of the eigenvalues, but not by

their variance. Also interesting is that the all-species stability is usually low or intermediate for fish reversing the trend found in the plankton stratifications.

If it had not been for the ubiquity and dominance of white perch in both communities, it is probable that several more patterns of community structure would have emerged. The white perch, however, constituted an important feedback loop between surface and bottom waters in the fish community. This would tend to blur community structure and stability patterns. Some of these could be quantified if white perch were removed from the matrices.

e. Two-Way Stratification By Time of Day and Depth For Surface and Bottom Trawls (Tables E-24 to E-29)

The last set of six Tables E-24 to E-29 constitute a grouping within themselves. Table E-24 involves a comparison of the adult fish community structure and stability values using a two-way stratification by time and depth, over all-depths and stations for all times, day, and night surface trawl data. E-25 is a counterpart table which involves bottom data only for all pelagic and benthic-inshore species and all groups of fish for all times, for day and for night. In Table E-24, no benthic fish were included because they were not abundant in surface trawls. Tables E-26, E-27, and E-28 include the coefficients of variation for Tables E-24 and E-25. Table E-26 includes the coefficients of variation over time for each depth and group, E-27 is taken over depth for day for each group, and stratification over depth for night for each group is given in E-28. Table E-29 includes means and coefficients of variations over depth and time.

As with the previous one-way stratifications by time and depth, the variation displayed by the all species-group was generally large over station and date. Thus, as a group becomes more localized to a given date and station, the community appears homogeneous in these environments as it was with the plankton communities. This is to be expected of more complex organisms which are more specialized in their utilization of space. Thus, whereas a given station and perhaps depth can be considered a whole community for phytoplankton, the fish community extends over all stations and both should be considered over time of day. On closer examination, it will be found that the fish community is consistent over time of day but significantly changes from surface to bottom. In this respect, the fish results were similar to those of fish larvae.

As with most of the stratifications, the lowest coefficients of variation were for $\overline{B_i/E_i}$ and $\overline{D_i/K_i}$. When comparing the various species groups on Table E-29, lower variances for inshore-benthic fish can be explained by the absence of the depth factor which proved to be the major source of variation. This is perhaps exemplified by the diversity components which are also low for all species. The niche breadth measures ($\hat{B}/E$ and $\overline{B_i/\hat{B}}$) exhibited high coefficients of variation for inshore benthic fish while pelagic fish were relatively regular. The trend is reversed again for $\bar{\alpha}$, $\overline{K_i/(B_i/\hat{B})}$ and S^2_λ, however, these measures are variable in the all species grouping.

As with fish larvae, the adult fish stratified over time and depth showed many more interesting results than the corresponding one-way stratifications. First, the means over time and depth showed clearer patterns than did the niche values stratified over time or depth. The coefficients of variation taken

over the means for each time and depth are given for all and pelagic fish on Tables E-31a-3 and E-31b-3. Comparing these values to the coefficients of variation over the niche values for each time and depth, it can be seen that for time, several new consistent properties are generated and other measures show a comparable degree of variation. For all-fish the coefficients of variation for D, H, and $\overline{D_i/K_i}$ went from .41 to .32, .14 to .11 and .11 to .16 respectively; however, the coefficients of variation of both relative community niche breadth ($\hat{B}/E$) and $\overline{B_i}/\hat{B}$ decreased from about .4 to under .1 while the mean value of alpha, $\overline{\%K_i}$, $\overline{\%K_i/(B_i/\hat{B})}$, H.M.$\lambda$, and S^2_λ changes from .3 for the niche values to .03 for the means, .13 to .08, .16 to .01, 1.0 to .6, and .5 to .15 respectively.

Thus, the adult fish community is essentially consistent over time. Further substantiation is given to this trend because when the pelagic fish community is considered alone, the results are even more definitive. For the niche measures, the coefficients of variations of H, D, K, $\overline{\alpha}$, covα, B', and all of the stability measures except $\max_\lambda$, $\min_\lambda$, and K_λ were well over an arbitrary cut-off of .25 while for the mean niche values only $\overline{H_t}$, D, K, and the reciprocal eigenvalue measures showed excessive variation. Almost all measures showed decreased variation over the means, the most notable being mean value of alpha, from .36 to .03. The coefficients of variation of relative community niche breadth went from 0 to .08 and $\overline{D_i/K_i}$ from .04 to .13.

For the benthic fish, there were no means over depth since they were only considered at the bottom depth; however, in Table E-23 the coefficients of variation over time of day for inshore benthic fish were under .25 except for relative community

niche breadth $\hat{B}/E$, $\overline{B_i}/\hat{B}$, K, and the stability measures. Thus, using the niche values stratified over time, coefficients of variation were ambiguous, sometimes high and sometimes relatively low and the means from the two-way stratification demonstrated of consistency in community structure over time of day.

The same comparison for depth, however, was different. Several measures substantially increased their variation when means over time were compared to the niche values calculated using the data for both times. In particular, those values which had shown the greatest decreases, ($\overline{\alpha}$ and the stability measures) now had the greatest increases for both all fish and pelagic fish. For all fish, values of H had low coefficients of variation of .02 over depth but the mean H's over each depth had coefficients of variation of .11. Also notable: $\overline{B_i}/\hat{B}$ went from .09 to .30, covariance of alpha from .23 to .61, harmonic mean of the eigenvalues from .36 to .90, and variance of the eigenvalues from .09 to .42. For pelagic fish, the $\overline{B_i}/\hat{B}$ coefficients of variation increased from .17 to .36, while the harmonic mean of the eigenvalues went from .6 to 1.3 while most of the remaining values changed little. The only cases of significant decrease from niche value variation to mean value variation were relative community niche breadth ($\hat{B}/E$), whose coefficients of variation went from .16 to 0 for all fish (from .11 to .16 for pelagic fish), $\overline{B_i/E_i}$ went from .07 to .02 for all fish and from .22 to .02 for pelagic species. These values represented the measures which have been consistent over all the other stratifications. Therefore, it appears that the fish community structure is different between surface and bottom, more so in fact, than for pelagic fish alone.

This latter result raises questions as to whether or not the previous division of the fish community into pelagic and benthic-inshore subgroups was artifical, which in fact, could have caused these results in the first place. Using consistency over time as a criterion, we compared the coefficients of variation of the day and night niche values for pelagic and benthic groups and for surface and bottom, and all species. On the whole, the latter had generally lower variation. For instance, the coefficient of variation for H was .3 and .08 for pelagic and benthic but .06 and .16 for surface and bottom. For relative community niche breadth, $(\hat{B}/E)$, a somewhat less conclusive .07 and .61 for surface and bottom. For $\overline{\alpha}$ it was .36 and .18 versus .04 and .17 and finally for the variance of the eigenvalues .5 and .9 were reduced to .1 and .3. There were no cases of drastic increases and the average of the coefficients of variations for surface and bottom groups was almost always less than for pelagic and benthic groups. These results imply that those fish which prefer the bottom waters and those that are found near the surface form coherent community groupings. Thus, habitat selection is more important than feeding behavior. This conclusion could also be due to our limited knowledge of the feeding habits of many of the Hudson River fish. In a surface bottom grouping, a problem arises because of fish species which are found in both surface and bottom trawls. Thus, we do not really know if the fish are competing in both areas and if so, in the same way. There is no precedent for placing the same species in two different competition matrices or for treating any obvious conflict that arises from this procedure.

It is also conceivable that the bottom group could be divided into inshore-benthic fish and bottom-pelagic fish. This division, however, seems to offer little advantage as the average

variation remained about the same and only spread the data more thinly. Diversity, H, had a coefficient of variation over time of .16 for the bottom values, but .08 and .53 for benthic and bottom pelagic. Coefficients of variation for $\overline{\alpha}$ went from .17 to .18 in both cases and the variance of the eigenvalues increased variation from .27 to .92 and .41 respectively.

Regarding specific trends, we refer first to Table E-26 over time of day. The pelagic surface fish showed by far the least variation. The only measures which had coefficients of variation over the usual .5 were the determinant ($|A|$), the minimum and harmonic mean of the eigenvalues and and the reciprocal eigenvalue measures. It is interesting that the variance of the eigenvalues was consistent and high while the harmonic mean of the eigenvalues was not low but regular. For the bottom trawls, the inshore benthic fish had a constant density and diversity but the bottom pelagic fish showed the most consistent community structure and stability values except for the variance of eigenvalues. This community also gave the greatest indications of stability. Tables E-27 and E-28 possessed few new results. As expected, the coefficients of variation were generally much higher, but there were few differences from day to night. Most of the obvious trends have been discussed in relation to Table E-27.

These results are reflected in the high diversity among times for surface fish and bottom-benthic fish, while it is low for bottom-pelagic fish, which was also noticed on Table E-20. The within diversity (mean time-depth H) decreased from surface-pelagic to inshore-benthic to bottom-pelagic, particularly in the day. The surface-pelagic fish and the inshore-benthic fish showed similarity in all their diversity components. The

among-date component was greater in all cases than the among station component. For the surface fish, the among-date H increased in the day while for benthic fish it increased in the night. The bottom pelagic fish among components were equal and much lower than for the other two groups. Both bottom groups, however, increased their among environment H in the night due to the migration and diffusion of 'surface' fish and 'bottom' fish while the surface among date H was highest in the day because of the seasonal influence. Total diversity followed the same pattern as the within component and was usually high.

Total density remained fairly constant at 12 fish per trawl on the surface but for bottom trawls the density decreased from 49 in the day to 27 in the night mostly due to the upward dispersal of white perch in the night while they are concentrated on the bottom in the day.

With regard to species dominants, the overall species composition is white perch 39%, brown bullhead 16%, Atlantic tomcod 15%, and hogchoker 7%, as mentioned before. When divided into surface/bottom and night/day, however, a great deal of heterogeneity appears. The surface trawls which captured only pelagic fish in any numbers, were quite different overall from day to night. During the day time, the surface waters were dominated by blueback herring 56% and American shad 22%, followed by the bay anchovy perch which also dominated the bottom trawls at 51% during the day. Another pelagic fish, the spottail shiner constituted 31.5% of the bottom-day catch.

At night, the herring moved offshore and down while the white perch was found nearer the surface. Thus, the surface trawls

were composed of alewife (41%) and bay anchovy (32%), which mostly came in with the salt front, and finally, white perch 11% and blueback herring (10%). In bottom trawls, white perch decreased to 33% while the spottail shiner was fairly even at 4% and blueback herring was 3%. Overall, pelagic fish dropped slightly in bottom trawls from day to night from 55% to 41%.

Some benthic species were subject to unusually high catches in certain trawls which caused considerable day-night differences. Overall, brown bullhead and Atlantic tomcod were 19% and 18% of bottom trawl catches followed by the hogchoker at 8%. For day-time trawls, it was brown bullhead 25%, Atlantic tomcod 12%, and hogchoker 5% while for the night-bottom trawls the order changed to Atlantic tomcod 29%, hogchoker 15% and brown bullhead 8%.

There were consistent community structure values over time of day for the two groups of pelagic fish on the surface and on the bottom. All measures except $\overline{D_i/K_i}$, relative community niche breadth ($\hat{B}/E$), $\overline{B}_i/E$, and D/K were consistent. Because of the inconsistency of the inshore-benthic fish data, there were many notable differences. This is what one would expect from given the results on Table E-22.

For the pelagic fish, the surface community seemed highly structured even though it had the smaller density and altered species composition from day to night. As mentioned, the diversity for the surface fish was higher in all components and it was also consistent. Although the relative community niche breadth ($\hat{B}/E$) was lower for the surface fish than the bottom pelagic species, the species niche breadth relative to E ($\overline{B}_i/E$)

was higher making the relative species niche breadth ($\overline{B_i/\hat{B}}$) and the niche overlap ($\overline{\alpha}$) much higher. Also, $\overline{\%K_i}$ and $\overline{\%K_i(B_i/\hat{B})}$ values were higher. When surface pelagic and bottom pelagic species are compared with day and night combined the surface values for $\overline{B_i}/E$, $\overline{B_i}/\hat{B}$, $\overline{\alpha}$, %K decrease from their separate day and night values. This indicates that while the fish are in the surface waters for both day and night, they are efficient in utilizing the environment and are overlapping heavily. There is little interaction between the day and night species. The bottom pelagic fish appear to be less successful since they are over dominated by white perch and face more competition from the benthic feeders.

The $\overline{D_i/K_i}$ ratio was equal for surface pelagic and bottom pelagic species but it did show interesting differences between day and night. For both groups, there were corresponding increases from day to night. Also, for some reason, the $\overline{D_i/K_i}$ value for surface pelagic fish was significantly greater when day and night were combined. Relative community niche breadth ($\hat{B}/E$) tended to drop slightly in the night as did total density.

The stability measures were as consistent as the rest but continued their puzzling trend of indicating that the more variable community structure was more stable. In any case, all stability measures except skewness and kurtosis of the eigenvalues displayed the greatest stability for bottom pelagic fish, thus giving daytime species an advantage.

The inshore-benthic community exhibited some very strange trends and was quite inconsistent. This is undoubtedly due to the peaks of brown bullhead and hogchoker which constitute much of the density in this group. In general, the inshore-benthic

niche values were in between those of the surface pelagic fish and the bottom pelagic fish except for the relative community niche breadth ($\hat{B}/E$) which was understandably lower and the $\overline{D_i/K_i}$ values which were considerably greater than for other pelagic groupings. The only measures consistent over time were diversity components which have been discussed. Relative community niche breadth ($\hat{B}/E$) increased dramatically in the night while $\overline{B}_i/E$ changed only slightly causing a drop in relative species niche breadth ($\overline{B}_i/\hat{B}$). Corresponding to the higher $\overline{B}_i/\hat{B}$ in the day were higher $\overline{\alpha}$, and $\overline{\%K_i}$ values. $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$, however, are both significantly higher in the night. This indicates, somewhat ambiguously, that the inshore benthic fish are considerably more active in the night, perhaps being restricted and outcompeted in the day by the higher concentrations of white perch. Interestingly, all the stability measures except $S\lambda$ and $K\lambda$ indicated the night community was more stable. The skewness and kurtosis of the eigenvalues were regular and were low for both day and night. Although less consistent than the pelagic fish (because of the peaks), the inshore-benthic community displayed some interesting trends.

f. Niche Measures of the Dominant Species (Table E-30)

Table E-30a contains the results for the dominant pelagic adult fish in the Hudson River. As with the larvae, the adults can also be characterized by extreme variation. Practically every niche measure exceeded the criterion of the .5 cut-off value for the range of the niche values. The white perch was slightly less variable in this regard than the other species. The coefficients of variation exhibited low values over stations for white perch as compared to the blueback herring, and to a lesser

degree, the striped bass. White perch was the least variable species followed by the alewife or Alosa spp. Both white perch and alewife had high $\overline{D_i/K_i}$ values and generally, all species had high $\overline{D_i/K_i}$ values except for the striped bass. Values for striped bass were lower and indicated that this species is not an efficient competitor with the other species. Striped bass also has lower density values, which indicates it was an inferior competitor. In terms of the $\overline{\%K_i/(B_i/\hat{B})}$ ratio, the value for striped bass was higher than the value for alewives and generally higher than the value for blueback herring, but not quite as high as the value for white perch which was probably the most efficient species in the pelagic adult-fish grouping. This indicated that other factors such as temperature and oxygen influenced the distribution patterns of the species. The striped bass had the highest $\bar{}$ followed by blueback herring. White perch and blueback herring had a higher species effect than community effect while for alewife and striped bass the effects were equal. There was a high degree of variation over station for these values but they generally retained the same interrelationship. Few consistent station trends appeared. RDW had reduced densities and $\overline{\%K_i/(B_i/\hat{B})}$ values for all species except striped bass.

Table E-30b gives a summary of the values of the common benthic inshore adult fish. This group, like its pelagic counterpart, was highly variable. The ranges most niche values were over the .15 criterion and most coefficients of variation were greater than .3. Several coefficients of variation, especially for the brown bullhead and the hogchoker, were over .5 and often over 1.0. These results indicated a highly variable community, more

so than other functional groups, except fish larvae. $\overline{D_i/K_i}$ values roughly followed D values and on the average $\overline{\%K_i/(B_i/\hat{B})}$ values were approximately equal. The $\overline{B_i/\hat{B}}$ values were greater than the values for $\overline{B_i/E_i}$. The effect of the community on the species dominants and the dominants' effect on the community were similar for the brown bullhead and less so for the hogchoker.

The alpha means ($\bar{\alpha}$) for Atlantic tomcod and hogchoker were about equal while those for brown bullhead were quite low. For all these species the average community effect was only slightly less than the average species effect; however, over stations the difference varied widely in both magnitude and direction. This indicated that the sampling was probably not adequate to completely characterize these species. In general, however, they have extremely variable dynamics within their ecological communities. Station trends were difficult to delineate; however, the peaks of hogchoker and brown bullhead were quite evident. Brown bullhead exhibited marked preferences for eastern stations and DC-20.

g. Summary of the Adult Fish Community Results (Table E-31)

(i) Overview of the consistent properties

Some of the major trends that have been discussed in the preceding section on results for the adult fish community are summarized below. The by-station and by-date results

Table 15: Summary comparison of important niche measures for the adult fish community

Niche Measure	Functional Group	All Stations or All Dates	By Station: Control Stations	By Station: Experimental Stations
$\hat{B}/E$	All species	.23	.20	.57
	Pelagic	.37	.33	.51
	Benthic	.17	.18	.51
$\overline{B_i}/\hat{B}$	All species	.33	.39	.25
	Pelagic	.28	.33	.36
	Benthic	.49	.53	.36
$\overline{\%K_i/B_i/\hat{B}}$	All species	.75	.73	.77
	Pelagic	.79	.81	.71
	Benthic	.79	.74	.95
$\overline{D_i/K_i}$	All species	.37	.35	.30
	Pelagic	.47	.45	.36
	Benthic	.53	.48	.54
	All species	.13	.17	.15
$\bar{\alpha}$	Pelagic	.19	.23	.25
	Benthic	.14	.16	.18
H	All species	2.76	2.69	2.62
	Pelagic	1.67	1.57	1.75
	Benthic	1.92	1.82	1.85

for all, pelagic, and benthic groups for six of the major niche ratios including total diversity (H), relative community niche breadth ($\hat{B}/E$), relative species niche breadth ($\overline{B_i}/\hat{B}$), $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$ and mean value of alpha are summarized in Table 15. Several consistent properties in the structure of the adult fish community are apparent. Variation was usually associated with the experimental stations. For example, with relative community niche breadth ($\hat{B}/E$) the regularities between all and control stations were found within the various species stratifications: all, pelagic or benthic species.

The experimental stations showed the greatest change and had higher relative community niche breadth ($\hat{B}/E$) values. For all and control stations the values of relative community niche breadth for benthic inshore species were lowest, followed by the all species values. The similarities of these values were not independent, because benthic species were included in the all groups stratification. The total diversity measure ($\overline{H_T}$) was consistent across rows, with the pelagic community having the lowest diversity, especially for the control stations. The all species value for diversity should be higher than the value for any sub-group, because diversity is directly proportional to the number of species included in the analysis. All stations and control stations were consistent across rows for the value of relative community niche breadth. The pattern of $\overline{B_i}/\hat{B}$ was the inverse of that for $\hat{B}/E$ indicating that $\overline{B_i}/E$ was almost consistent. Benthic values were considerably higher for all and control stations.

The $\overline{\%K_i/(B_i/\hat{B})}$ ratio was high for benthic species at the experimental stations which indicated that either environmental stresses and/or predation pressures were low, or food

was abundant; otherwise this measure was consistent. The competitive success ratio ($\overline{D_i/K_i}$), and the mean value of overlap ($\bar{\alpha}$) were consistent for all types of stratification for all, pelagic, and benthic species groups. In summary, since the fish community exhibited several consistent properties, it undoubtedly possessed a definitive community structure. The major variations in its integrity were associated with the niche breadth measures calculated from experimental station data. This indicated that the experimental stations were significantly different from the control stations. For example, usually the value of the relative community niche breadth ($\hat{B}/E$) at the experimental station was twice that of the control stations. This does not necessarily indicate that the effect of the perturbation on the community was bad, since as the relative community niche breadth ($\hat{B}/E$) greatly increased, the relative species niche breadth ($\bar{B}_i/\hat{B}$) subsequently decreased. This may be a positive rather than a deleterious effect on the fish community.

(i) Summary of statistical results

- Density results

Since only trawl data were used in the study the sampling was fairly unbiased environment-wise except as described below, but undoubtedly gave a biased view of species the community. The fish samples were unavoidably sparse in comparison with the other groups and therefore the clarity and consistency of the results are affected. Also, because the surface waters tend to be less populated than the bottom, the surface trawls were more sparse even for pelagic

fish than the bottom trawls and thus some bias was introduced. This bias, however, is inherent in the comunity structure and it suggests that even for pelagic fish there are separate bottom and surface communities. It is interesting that in all cases the most consistent measure was $\overline{B_i/E_i}$ (coefficient of variation around .2 which was designed to account for (sparsity in the data).

The overall species composition was white perch (39%), brown bullhead (16%), Atlantic tomcod (15%), and hogchoker (7%). White perch was found in large numbers at all stations and months and it usually dominated the community. This indicates only that there was a large stable population of white perch in the river. Other dominants or potential-dominant species may not have been as effectively sampled. The 1973 LMS report to CHGE indicated that blueback herring, spottail shiner, and striped bass were more dominant than shown when other surface sampling methods such as seines were used. Their results, however, still show that the area was preferred by bottom-dwellers and that the dominant species was white perch.

Benthic fish were mostly found in bottom trawls and not considered to be overlapping when found in surface trawls. In most communities, pelagic fish are rarely found in bottom trawls; however, in this area there were large numbers of white perch which prefer the bottom waters and they appeared to be overlapping heavily with some of the inshore-benthic fish. There are indications that the bottom/surface community stratification may have been a more consistent way to divide the overlapping fish. In terms of species composition and diversity there seemed to be separate surface-pelagic, bottom-pelagic, and inshore-benthic communities.

The following is a description of the dominant species trends referring to our figures for surface and bottom trawls and to the 1973 LMS report to CHGE which included all trawl, seine and trap net data. Out of the over 2400 fish sampled only, 14.6% were caught in surface trawls as opposed to 85.4% from bottom trawls; however, the relative populations of pelagic and inshore-benthic fish were about equal. 57% of fish caught were pelagic while the remaining 43% were of species were classed as inshore-benthic. When only bottom samples were considered, the comparison was closer: 51% to 49%.

The overall average density of surface trawls was 12 fish per 10 minute effort and it did not change from day to night although the species composition was different. Most of the species found in bottom trawls did not vary much diurnally except for the most abundant species, the white perch. Thus, the overall bottom trawl density decreased from 49 in the day to 27 at night. The surface fish seemed to be found in greatest numbers at RNCW and DC-20 while the bottom fish preferred DC-20 and, except for striped bass, avoided RDW.

The surface waters were dominated by various types of herring. All of these belong to the Alosa genus and are anadromous. (The alewife is considered separately below). The adults swim up the river in the spring only to spawn and the young move down river in the fall when they are mature enough to live in the coastal or beach waters. These species were more effectively sampled by seines and frame nets, particularly in mid-summer when only the small immature forms are present. Throughout the summer, Alosa spp. larvae consistently dominate the fish larvae community.

The dominant species when all types of nets were considered was the blueback herring, a pelagic feeder found mostly on the surface and particularly by seines. In trawls, they were found at an average density of about 5, mostly in day when they were 56% of surface trawls. At night, the fish moved further offshore and down to middle depths so that they constituted only 10% at the surface and 7% of bottom trawls. The adult herring were found in May and June. While the young appear from July to November, they form schools and migrate down river. The adults were 16% of the May catch but the young were not large enough to appear permanently in the trawls until November at 17%. Thus, they were only 5.6% of our trawl data although they were present in large numbers on the surface and inshore all summer.

The American shad were similar to herring in behavior as they were found mostly in day-time surface trawls at a density of about 3-11% of all surface trawls. They appear to have spawned earlier since few if any adults were caught and they were not abundant till the latter parts of the year. They preferred station RNCW.

The alewife constituted 24% of surface trawls, an average density of about 3. Although not as frequent as the blueback herring, this fish is larger and, in trawls from July to October, was more common. The young tended to stay inshore in the day, sometimes appearing in bottom trawls (.5%), but they were found in the offshore surface in schools during the night when they constituted 41% of surface trawls. Alewife usually spawn further upstream than most herring and their maximum density was at DC-20 and RNCW. The only other dominant pelagic fish was the bay anchovy

which appeared only in October at a density of about 4 (10%). Being a marine fish, it is likely that it came and went with the salt-front. It was caught in greatest numbers during the night and was maximum at station RNCW.

Most of the resident and resident-spawning fish were found in bottom trawls. Of the pelagic fish found in the trawl data, the bottom dwelling white perch were consistently dominant with an average density of 11.5 over the months sampled. This species is both a freshwater and coastal species. Although there was a resident population found year round constituting about 39% of the trawl catch, there was a summer peak from July to November when they were especially abundant at 77% in August of the total monthly fish catch. This was mostly due to the young-of-the-year which were found at near-shore stations feeding on herring larvae. They were found fairly evenly at all stations, highest at DC-20 with an average density of 16, and lowest at RDW where they were only 8. As mentioned, they live close to the bottom and make up 51% of the surface trawls in the day. In the night they move up and inshore, constituting 33% of bottom trawls and 11% of surface trawls.

The spottail shiner was a freshwater pelagic-feeding species that appeared prominently in the seine collections all year round but tended to be less abundant in trawl samples except in the beginning and end of the sampling period. Its population level fluctuated little and the average density in our data was 1.4 for all dates. This species prefers the bottom and shallow inshore areas such as station DC-20 where its average density was 4.5. It was 3.6% of bottom trawls for both day and night.

The final dominant pelagic feeder discussed is striped bass which is anadromous and like the spottail shiner was found mostly as young of the year by inshore-seine samples. This species does not appear to be resident in this part of the river but may be using it as a spawning ground. The young appear from July to November, declining sharply in December when they migrate downstream. The adults were found inshore in seines in May and June moving out to deeper waters in July and August. Consequently they peaked in our data in August at 1.8% corresponding to a density of .5 but were not found in several months. The fish was found in both surface and bottom trawls during the day but not at night. There was a preference for RDW, just off the plants, and after that for the south control stations.

The benthic feeders and inshore fish included most of the resident species but not the most abundant (white perch, etc.). In fact, the dominant benthic species was the Atlantic tomcod, an anadromous species which spawns in the winter. The adults were found in the trawl data in May at a density of 33 or 58%, and again in October to December at a lower density of about 4-5, which was 96% of the small December benthic population. Overall, this species constituted 15% of all trawl data and was even over stations although it was lowest at RDW. Like most benthic fish, there was usually no difference between day and night populations.

The brown bullhead is a fresh water resident with a normal density of about 9 or 15% of bottom trawl catch. It showed a strong preference for eastern stations and DC-20 but other variation was overshadowed by the October trawl at RNCE in

which the net seems to have been hung up judging from the large number of bullheads. This density value caused the brown bullhead to be 38% of the October catch for all species, 16% overall. In fact, its total density was greater than that of the Atlantic tomcod.

The third dominant was the hogchoker, a flounder which appeared to be resident with an average density about 1.5, less than 4% of most bottom trawls. There was a night-time bottom trawl in November, however, at RSCE which collected about 40 fish in a ten minute trawl so the overall percentage was 7%.

Other common species in the bottom trawls were the Atlantic sturgeon, white catfish, and goldfish. Species that were primarily caught in frame nets and seines were young herring, white perch, striped bass as well as shiners, darters, sunfish and the American eel. All these species came into the inshore zone, and many were resident species. The community in this area was extremely diverse and contributed greatly to the total fish biomass especially in the spring.

The by-dates tables showed a high degree of variation with little pattern. Because of the more or less anadromous nature of most of the dominants, and the size-selectivity of the trawls, a complex pattern emerged. From early spring until about June, the abundance by trawls was high because of the adults of the spawning species. Only in May was the sampling complete enough to use and the catch was Atlantic tomcod 58%, white perch 22%, and blueback herring 5%, with a total density of .39. After that, catches decreased with

mostly resident species appearing [white perch (77%) and brown bullhead 7% in August] when the total density was 25 until August to November when the young of the year were large enough to be captured in trawls. Simultaneously the salt front moves through the area importing more marine species. In November the adult fish community was composed of white perch (45%), hogchoker (24%), and blueback herring (10%), with a total density of 26. In December, the density fell to 15 as the young migrated down river leaving year-round residents and over-wintering fish: white perch 50%, Atlantic tomcod 29%, and spottail shiner 19%.

- Niche values for all groups

The following is a comparison of the fish groups among themselves and with other functional groups (Table 16). The fish values mostly resembled the fish larvae community which was variable and loosely-associated assemblage. For all measures, the fish groupings usually exhibited the high coefficients of variation over environments. Only the time of day grouping was consistent, particularly for pelagic fish. Bottom and surface samples represented quite different communities for pelagic fish while, of course, the benthic community was restricted to the bottom. Fish were more specialized in terms of their utilization of various station areas and had more complex seasonal patterns than the other groups. The most consistent measures were $\overline{B_i/E_i}$ and $\overline{D_i/K_i}$.

The among-environments diversity components were high unlike fish larvae (total among-environment H averaged over 1.0)

Table 16: Summary comparison of statistical results for the adult fish community

	By Station: All $\bar{x}$ (σ_x)	By Station: Control $\bar{x}$ (σ_x)	By Station: Experimental $\bar{x}$ (σ_x)	α_t	By Date $\bar{x}$ (σ_x)	By Depth $\bar{x}$ (σ_x)	By Time $\bar{x}$ (σ_x)	By Time/Depth $\bar{x}$ (σ_x)	Time (σ_x)	Depth (σ_x)	Time α_F	Depth α_F
ALL GROUPS												
H	2.34 (.10)	2.27 (.12)	2.47 (.04)	.26	1.95 (.26)	2.33 (.02)	2.68 (.14)	2.10 (.13)	(.11)	(.11)	.32	.36
$\bar{B}/E$	.44 (.48)	.37 (.46)	.59 (.47)	.49	.41 (.37)	.31 (.16)	.30 (.36)	.35 (.21)	(.08)	(0)	.67	1.00
$\bar{B}/\bar{B}$	.41 (.44)	.46 (.45)	.32 (.25)	.30	.48 (.46)	.39 (.09)	.35 (.36)	.47 (.29)	(.09)	(.30)	.74	.16
α	.20 (.11)	.21 (.11)	.19 (.11)	.40	.20 (.25)	.20 (.40)	.15 (.28)	.28 (.45)	(.03)	(.54)	1.00	.012
$\%K(B/\bar{B})$	.73 (.18)	.71 (.22)	.77 (.12)	.59	.70 (.17)	.78 (.21)	.69 (.16)	.75 (.18)	(.01)	(.21)	1.00	.040
D/K	.31 (.12)	.31 (.15)	.31 (.12)	1.00	.29 (.14)	.31 (.27)	.32 (.11)	.26 (.17)	(.16)	(.13)	.24	.37
minimum λ	.003 (1.43)	.001 (.42)	.005 (1.28)	.54	.06 (2.01)	.07 (.8)	.04 (1.22)	.02 (1.08)	(.44)	(.71)	.32	.41
harmonic mean λ	.02 (1.39)	.01 (.22)	.04 (1.23)	.54	.18 (1.51)	.30 (.36)	.23 (1.04)	.11 (.98)	(.64)	(.90)	.45	.26
variance λ	1.42 (.21)	1.49 (.20)	1.30 (.26)	.57	.48 (.28)	.70 (.09)	.84 (.45)	1.25 (.37)	(.15)	(.42)	.66	.0664
PELAGIC												
H	1.46 (.31)	1.35 (.40)	1.67 (.03)	.32	1.29 (.39)	1.52 (.78)	1.66 (.31)	1.36 (.53)	(.19)	(.61)	.70	.06
$\bar{B}/E$	.43 (.42)	.39 (.33)	.52 (.57)	.66	.40 (.21)	.37 (.11)	.39 (.07)	.39 (.16)	(.11)	(.16)	.45	.17
$\bar{B}/\bar{B}$	.45 (.31)	.47 (.36)	.41 (.24)	.61	.54 (.39)	.37 (.17)	.33 (.09)	.45 (.30)	(.06)	(.36)	.82	.015
α	.23 (.43)	.19 (.49)	.30 (.26)	.23	.20 (.37)	.19 (.50)	.26 (.36)	.25 (.62)	(.06)	(.74)	.43	.0057
$\%K(B/\bar{B})$	.69 (.27)	.68 (.35)	.71 (.03)	.82	.71 (.20)	.69 (.42)	.77 (.10)	.70 (.26)	(.04)	(.32)	.88	.013
D/K	.42 (.21)	.45 (.20)	.35 (0)	.11	.48 (.31)	.32 (.22)	.40 (.04)	.28 (.13)	(.17)	(.02)	.0042	.84
minimum λ	.06 (1.49)	.09 (.22)	.01 (0)	.24	.26 (1.13)	.34 (.95)	.10 (1.32)	.26 (1.13)	(.03)	(1.36)	1.00	.0015
harmonic mean λ	.21 (1.13)	.28 (.95)	.07 (.11)	.21	.47 (.83)	.63 (.58)	.28 (1.21)	.46 (1.06)	(.03)	(1.29)	1.00	.0025
variance λ	.95 (.58)	.74 (.72)	1.37 (.26)	.18	.57 (.76)	.44 (.96)	.89 (.54)	.89 (.96)	(.05)	(1.16)	1.00	.006
INSHORE BENTHIC												
H	1.32 (.20)	1.21 (.15)	1.54 (.20)	.39	.98 (.52)		1.27 (.08)					
$\bar{B}/E$	.41 (.34)	.35 (.38)	.52 (.11)	.09	.46 (.50)		.25 (.61)					
$\bar{B}/\bar{B}$	.69 (.31)	.72 (.21)	.63 (.61)	.80	.69 (.39)		.61 (.51)					
α	.34 (.54)	.28 (.35)	.45 (1.69)	.59	.23 (.78)		.16 (.18)					
$\%K(B/\bar{B})$	.73 (.26)	.61 (.16)	.95 (.03)	.003	.62 (.43)		.65 (.17)					
D/K	.42 (.16)	.40 (.20)	.46 (.15)	.44	.48 (.34)		.49 (.13)					
minimum λ	.12 (1.37)	.16 (1.24)	.05 (1.35)	.37	.22 (1.82)		.14 (1.21)					
harmonic mean λ	.26 (1.22)	.34 (1.12)	.12 (1.29)	.37	.33 (1.16)		.35 (.92)					
variance λ	1.07 (.57)	1.00 (.76)	1.20 (.21)	.66	.56 (.79)		.54 (.29)					

while the within-component was only about .5 which was similar to the value for larvae. Diversity was high for surface pelagic fish at 2.4 and low for bottom pelagic species. Diversity of the whole fish community does not change over depth. It is only slightly higher for benthic species, 1.9, than pelagic species. All diversity measures were about 30% greater for all-groups than either of the subgroups.

The niche breadth measures were also comparable to fish larvae, that is, low. For inshore-benthic fish, the relative community niche breadth ($\hat{B}/E$) was lower than for pelagic fish either bottom or surface (.2 versus .4 for either pelagic group or all pelagic fish), but the mean relative species niche breadth was higher (.5 versus .3 over all data). The $\overline{B_i/E_i}$ measure was usually high for fish as well as consistent, even though it decreased for fish larvae. This measure was lower when all data was compared with an individual station or date. Overall, $\overline{B_i/E_i}$ was high for bottom pelagic fish, lower for surface pelagic and lowest for benthic species, all pelagic, and all-groups.

Mean niche overlap ($\bar{\alpha}$) was low (.13) although it rose to .25 for pelagic fish on the surface, and with high coefficients of variation over species. Values of $\%K_i$, $\overline{\%K_i/(B_i/\hat{B})}$ and $\overline{D_i/K_i}$ all decreased for pelagic fish on the bottom and were similar for surface pelagic and inshore-benthic except for $\overline{D_i/K_i}$ which was higher for inshore-benthic species.

$\overline{\%K_i}$ was .3 and it decreased to .2 for bottom pelagic species although for individual stations and dates, it rose to .5 for inshore-benthic species. $\overline{\%K_i/(B_i/\hat{B})}$ showed interesting patterns over space and time, and it was about .75

for all groupings of species except bottom pelagic fish for which it was .5. $\overline{D_i/K_i}$ was .3, .4, and .5 respectively for bottom pelagic, surface pelagic and all pelagic groupings but it decreased to .4 for all species. These results indicate that the pelagic fish community sampled by the bottom trawls had high competitive pressure, which is further substantiated by the low $\overline{B}_i/\hat{B}$ and H values. Thus, while density increased for this group it was attributed to the prevalence of white perch at the subsequent expense of the total community. Because of this, the benthic fish were forced to compete at a much higher level than other groups.

Both percent carrying capacity ($\overline{\%K}_i$) and $\overline{D_i/K_i}$ values dropped slightly for all-groups and were comparable to fish larvae. In contrast, $\overline{\%K_i(B_i/\hat{B})}$ was lower for both fish larvae and rotifers and with a generally higher coefficient of variation over species. It is interesting, particularly from the point of view of the sampling, that as with larvae, the individual station and date values and their means were often higher and more consistent than the values over all the data. The one-way stratification over time and depth demonstrated few patterns; however, when the means over the two-way stratification for each time and depth were compared, time of day showed many consistent properties, particularly for pelagic and all groups, and although $\overline{B_i/E_i}$ and $\overline{D_i/K_i}$ values appeared constant for depth, there seemed to be more pattern.

The stability measures indicated that as a whole the fish were sensitive and considering all of the data, the benthic-inshore community was considerably more unstable than the

pelagic fish which were stable in bottom samples. This result was not consistent locally, however, and the average measures between pelagic and benthic communities were not different. As with phytoplankton, the all-groups values demonstrated lower or occasionally intermediate stability as compared to the sub-groups. This is probably because all species together constitute a less-cohesive community.

For all groups, when the one-way stratifications were considered, depth showed low variation in H, $\hat{B}/E$, $\overline{B}_i/\hat{B}$ and the stability measures while time stratifications produced low values of H, $\overline{B}_i/E$, and $\overline{D_i/K_i}$. The two-way stratification over both time and depth however, exhibited consistent properties by time of day and changes by depth. The ANOVA values tended to support this result.

Over time of day the only consistent changes were: a night increase in among date-station diversity from 1.1 to 1.4 (α_f =.3 for total H), a small increase in $\overline{D_i/K_i}$ from .25 to .3 (α_f =.24) and a rise in stability which was not considered significant (α_f =.5 for H.M.λ). All other α_f's were over .7 and there were several values of 1.0. There was a daytime decrease in $\hat{B}/E$ ($\overline{B}_i/E$ constant) and a slight rise in $\overline{\alpha}$ (both on the bottom only and not significant overall).

Over depth there were almost no consistent properties. Within-group diversity rose but among H was constant (α_f = .36 for total H). There was more diurnal variation in $\hat{B}/E$ and $\overline{\alpha}$, but the bottom surprisingly exhibited no differences in $\hat{B}/E$ (α_f =1), while $\overline{B}_i/\hat{B}$ decreased from an average of .56 to .36 on the bottom (α_f =.2), $\overline{\alpha}$ from .38

to .22 (α_f =.01), $\overline{\%K/(B/\hat{B})}$ from .85 to .63 (α_f =.04) and $\overline{D_i/K_i}$ only decreased slightly from .28 to .23 (α_f =.4). Stability generally increased on the bottom (α_f =.3) for H.M.λ and .06 for var λ.

By dates, the only consistent properties were $\overline{B_i/E_i}$ at .22(.12) and $\overline{D_i/K_i}$ at .29(.14). Total diversity was 1.95 (.26) ranging from 1.36 in August to 2.59 in October. The within component was more even at about .8 except for the two months just mentioned. The among components were highest in October and November when most of the young of the year were found. In terms of community structure values, most of the differences were in October. $\hat{B}/E$ fell from .41(.4) overall to .15 and $\overline{B_i}/\hat{B}$ rose from .48(.5) to .86 while $\overline{B_i}/E$ remained fairly constant at .17(.25), being greatest in May and December and $\bar{\alpha}$ was relatively constant at .20(.25). Even $\overline{B_i/E_i}$ dropped from .7(.1) to .6 and $\overline{\%K_i/(B_i/\hat{B})}$ fell from .70(.2) to .51 with a high species coefficients of variation. $\overline{D_i/K_i}$ was constant as mentioned and did not change. May showed high $\bar{\alpha}$, .27 and $\overline{\%K_i/(B_i/\hat{B})}$ .83. Stability was lowest in August and October and highest, according to H.M. λ, in December.

There were few differences across station groups. Between control and experimental stations, however, the within diversity component rose from .8 to 1.1 while the among component decreased from 1.9 to 1.6. Thus, there was no overall change in H. Relative community niche breadth ($\hat{B}/E$) rose from north-control station (.2) to south control stations (.4) and was highest for experimental stations (.6) while mean relative species niche breadth reversed the trend (.6, .3, and .25 respectively) indicating little change in

the $\overline{B_i/E}$ measure. Density, percent carrying capacity ($\overline{\%K_i}$), and $\overline{\%K_i/(B_i/\hat{B})}$ were all slightly higher at the north control stations compared to the south with the experimental station group intermediate.

Consideration of separate stations illustrated that most of the differences were centered around the experimental stations RDW and DC-20 (which were not similar) and the northeast control station, RNCE. Total diversity had an overall coefficient of variation of .1; however, the within component rose from an average .9 to 1.4 at DC-20 (α_f = .001) while the among component decreased from an overall average of 1.4 to around 1.1 at both RNCE and DC-20. Most of the changes in community structure values took place at these two stations and because averages over both control stations and experimental stations were affected, the t-tests were not useful. Density rose at both RNCE and DC-20 but for relative community niche breadth ($\hat{B}/E$), .4 (.5) overall, decreased at RNCE to .2 and rose at DC-20 to .8 (α_t =.1). $\overline{\%K_i}$ and $\overline{\%K_i/(B_i/\hat{B})}$ increased to .4 and decreased to .5 respectively at RNCE from their averages of .3(.2) and .7(.2) with $\bar{\alpha}$ and $\overline{D_i/K_i}$ constant at .3(.1) and .2(.1). Stability was highest for RDW and slightly lower at RNCE and DC-20. There was a high covariance of alpha at RNCE while RSCW had a high kurtosis of alpha.

- Niche values for pelagic fish

The pelagic fish exhibited the same trends but with more consistency than for all groups or for the inshore-benthic fish. The bottom trawls and surface trawls had different species compositions and different community structure

values but both usually followed the same diurnal pattern which was usually consistent.

The few differences across time of day included an increase in the among environment H from day to night. By the time-of-day table, H increased from .8 to 1.4. During the day the surface and bottom communities were separate; however, during the night the two populations overlap to a greater degree. Also, $\overline{D_i/K_i}$ increases in the night time for both surface and bottom fish from .25 to .3(α_f =.004). On the bottom, only within-H increased in the night while density and stability decreased and on the surface $\hat{B}/E$ and $\overline{B_i/E_i}$ decreased.

By depth, the community changed completely. Diversity, relative species niche breadth, $(\overline{B_i/\hat{B}})$ niche overlap, $\overline{K_i/(B_i/\hat{B})}$ all decreased while stability increased. Only relative community niche breadth $(\hat{B}/E)$, $\overline{B_i/E_i}$ and $\overline{D_i/K_i}$ remained relatively constant. Diversity declined in all components and the total H went from a surface 2.4 to .7 on the bottom (α_f =.06). Relative community niche breadth $(\hat{B}/E)$ was fairly constant at .4 except for a small drop at the surface for night to only .3 (α_f =.2). In contrast, B/E decreased regularly for the bottom community so $\overline{B_i/\hat{B}}$ went from about .56 to .34 (α_f =.02). $\overline{\alpha}$ similarly decreased from .38 to .11 (α_f =.005), although it had varied over time of day. Stability, however, was much greater for the bottom community (α_f = .01).

Since they were dominated by a mainly resident species, the pelagic fish community reached a maximum density in August and a minimum density with fewer species in May and December.

Diversity showed little pattern. Total H was 1.29(.4) and was low in all components in August and December and maximum in October. The rest of the niche values exhibited the same pattern as density. Relative community niche breadth ($\hat{B}/E$) decreased from .43(.4) to .28 while $\overline{B}_i/\hat{B}$ increased from .45(.3) to .88. $\overline{B}_i/E$ increased from .20(.2) to .25, $\overline{\%K_i/(B_i/\bar{B})}$ was .69(.3) decreasing to .51 in May. $\overline{D_i/K_i}$ was .42(.2) and it increased to .71 in May and .56 in December. $\bar{\alpha}$ dropped from .23(.4) to .11 in May and .19 in December. Stability was high in May and December, and low in August and October.

By stations there was little variation in the most dominant species, white perch, which was the second dominant at RSCW and RDW where blueback herring was first dominant and at RNCW, the bay anchovy. At the other stations, RNCE, RSCE and DC-20, the among depth diversity was zero indicating there was a low surface population. At RNCE and RSCE white perch was more dominant than at the other stations and it caused a decline in total diversity from 1.7 to 0.9. At DC-20 there was also a large concentration of spottail shiner which caused an increase in the within diversity from .5 to .9 as well as the overall density. The highest total diversity was 2.0 at RNCW where the among diversity components were all high. The highest concentration of striped bass was at RDW although it was only 6%.

The community structure values were consistent, though with high non-significant fluctuations, except at RNCE and DC-20. At the control station, RNCE, relative community niche breadth ($\hat{B}/E$) decreased from .4(.4) to .2, while $\overline{B}_i/\hat{B}$ increased from .4(.3) to .7. Thus, the decline in community

niche breadth ($\hat{B}/E$) was not associated with a drop in species niche breadth ($\overline{B}_i/\hat{B}$) but rather with the decrease in community diversity. Niche overlap decreased from .23(.4) to .08, $\overline{\%K_i/(B_i/\hat{B})}$ decreased from .7(.3) to .4 and $\overline{D_i/K_i}$ increased from .4(.2) to .6, indicating, respectively, assymmetry in overlap patterns.

The other aberrant station, DC-20 showed the opposite effect. Relative community niche breadth ($\hat{B}/E$) rose to .7 (α_t =.1) while species niche breadth ($\overline{B}_i/\hat{B}$) was constant at (α_t =.8) and there was a general rise in species niche breadth. Niche overlap rose slightly to .35 while the other measures were constant ($\alpha_t \geq .9$). These results (with the overall higher density, carrying capacity ($\overline{K}_i$) and diversity) illustrate a similar but generally efficient community. Similarly, RNCW had the highest total diversity of 2.0 because of high among-components, as well as the second highest density and niche overlap which was .3 and the highest $\overline{\%K_i/(B_i/\hat{B})}$ value of 1.0. Both this station and DC-20, however, had many missing samples so that this similarity between them is suspect. Stability was highest for the two eastern control stations, RNCE and RSCE, where there were high concentrations of white perch.

There was a clear decrease in stability between the experimental station and the control station groups, except for RNCW (α_t =.2 for the minimum, maximum, variance and the harmonic mean of the eigenvalues).

- Niche values for inshore-benthic fish

Although containing most of the resident species, this group was extremely variable. It neither contained the most dominant resident nor was the real dominant species of this group (Atlantic tomcod) a resident. These fish were perhaps more prone to station preferences based on bottom type and there were indications that they overlapped strongly with the white perch which varied diurnally. Most of the variation, however, comes from two peak densities for a couple species in different environments which affected the results.

There was no depth factor and the stratification by time of day showed a relatively high degree of variation. From day to night, total H went from 1.7 to 1.9 although the within H was constant. Relative community niche breadth ($\hat{B}/E$) went from .14 to .35, $\overline{B_i}/\hat{B}$ from .83 to .39 so that $\overline{B_i}/E$ was constant. $\overline{\alpha}$ and percent carrying capacity ($\overline{\%K_i}$) were also constant but $\overline{\%K_i/(B_i/\hat{B})}$ rose from .57 to .73 and $\overline{D_i/K_i}$ from .44 to .53 indicating more success in the night when the abundance of white perch was less. Stability was also greater in the night.

By date, there was also a lot of variation, particularly as in the all-species group in the month of October which was the month of the salt front intrusion and of the peak of brown bullhead. Density followed the pattern described for all-species. Total H was 1.0(.6) and fluctuated widely. The only difference in the within component was a decrease from .6 to .3 in December. November exhibited the maximum diversity. Relative community niche breadth ($\hat{B}/E$) was

.46(.5) being lowest, .13 in October and generally less in the later part of the year. $\overline{B_i/E}$ showed the same pattern, but $\overline{B_i/\hat{B}}$ increased from .69(.4) to 1.13 in October. $\overline{\alpha}$ and $\overline{\%K_i/(B_i/\hat{B})}$ decreased throughout the year: $\overline{\alpha}$ changed from .5 in May to .03 in December and $\overline{\%K_i/(B_i/\hat{B})}$ from 1.03 to .45. Both values notably decreased in October as well. $\overline{D_i/K_i}$ was .48(.3) except for a decrease to .24 in May and an increase to .67 in December. $\overline{B_i/E_i}$ (as usual) was most consistent at .78(.12). Stability was lowest in May and highest in December. The patterns of inshore benthic and pelagic communities are nearly inverse to each other and combine to produce a decrease in October when all-species are considered. This is perhaps the main indication that the two groups are affecting each other.

The benthic or bottom-feeding fish included extremely high density values for the dominant species which were associated with the natural variation by date and by location. Thus, this group exhibited coefficients of variation over station that were comparable to the pelagic fish values as well as large fluctuations in species composition and density.

With regard to changes over groups of stations, there was a decrease in average density at the experimental stations compared to control stations from 28 to 12 which corresponded with a shift in diversity components from within to among (opposite to pelagic fish) while total H was relatively constant at 1.9. This value was slightly higher than for pelagic species. Also there was an increase in $\hat{B}/E$ from .2 to .5 and an increase in $\overline{\%K_i/(B_i/\hat{B})}$ from .79 to .95. The other measures were fairly constant over time while the

stability measures and $\hat{B}/E$ showed more variation between north and south control groups.

As before, lowest coefficients of variation were $\overline{B_i/E_i}$, .75(.17) and .42 (.18). The niche breadth pattern was the same for the inshore benthic community as for pelagic fish, as was the value for relative community niche breadth. The value for $\overline{B}_i/\hat{B}$ was higher, however, at .5 overall. There was little if any similarity in pattern with diversity, niche overlap and the other measures although their average values were all comparable. Percent carrying capacity ($\overline{\%K_i}$) was generally correlated with $\overline{\alpha}$.

Measures such as $\overline{B}_i/E$, $\overline{B}_i/E_i$ and $\overline{\alpha}$, were notably lower for all stations than any individual station or grouping. This was an effect noticed for all-species but not pelagic fish. This indicates that, unlike pelagic fish in the benthic communities, competition is more localized and fish do not overlap much with those in other areas.

Considering the individual stations, we see that the only stations which are consistently similar are the controls, RNCW and RSCW. The wide fluctuation in density, 26(.6), appears to be mainly a result of the peaks of brown bullhead and hogchoker at RNCE and RSCE. However, the density and number of species caught was very low, only 9, at RDW. Total diversity was an even 1.3(.2) except at RSCW where a low among-component decreased to 1.0 and DC-20 where there was a high among component (1.7). The mean H, however, decreased from about .8 to about .3 at both experimental stations (α_t =.09) and at RNCE while the among component correspondingly increased from .5 to .9 except at DC-20 where it was 1.5.

RSCW was the least perturbed station. As well as possessing a low among H, relative community niche breadth ($\hat{B}/E$) was low .27 and $\overline{B_i}/\hat{B}$ high, .95. $\overline{\alpha}$ was slightly higher at .32 and $\overline{D_i/K_i}$ low at .31 but there was no change in $\%\overline{K_i/(B_i/\hat{B})}$. The RNCW station was similar to the experimental station RDW. Both stations exhibited a shift to among diversity and higher values for $\overline{\alpha}$ and $\%\overline{K_i/(B_i/\hat{B})}$. While RNCW had a general decrease in relative community niche breadth decreased to .20 and $\overline{B_i}/\hat{B}$ remained constant. RDW showed a high $\overline{B_i}/E$ value resulting in an increased $\overline{B_i}/\hat{B}$ to .40. Finally, DC-20 had a high among H and high relative community niche breadth ($\hat{B}/E$) of .56. This caused a low value of $\overline{B_i}/\hat{B}$ of .36 and a high $\%\overline{K_i/(B_i/\hat{B})}$ value of 97. Thus, there was a significant rise in $\%\overline{K_i/(B_i/\hat{B})}$ at the experimental stations alone (α_f =.003) while $\overline{D_i/K_i}$ remained regular. Stations RSCW, RNCE and DC-20 demonstrated low stability while RSCE had the highest values.

SECTION V

DISCUSSION

V. DISCUSSION

A. GENERAL SUMMARY OF RESULTS

1. Introduction

The previous discussion of results has been a detailed examination of community structure and stability of four functional groups of organisms in a dynamic estuarine environment, which is undergoing a variety of perturbations. In documenting community structure and stability, we have used Levins' niche analysis, which provides a set of gross or macroscopic descriptors of community structure and stability.

In applying this analysis to the Hudson River ecosystem, we have had varying degrees of success with three of the major validation criteria: first, regularity in which we attempt to show a pattern chiefly through demonstrating consistent properties in the niche values and their associated statistics for different types of data stratifications. (See also Lane and Wright 1977.) Validation of the second criterion, predictability is not yet complete; nor is the third, understanding. There are three major reasons why the second and third criteria are not completely validated. First, too many functional groups are missing in the analysis. The groups that were included in this study are assorted ones. Missing groups include the rest of the microzooplankton, the macrozooplankton, and the benthos. These components are strongly interrelated to the groups analyzed in this study. Also, most of the sampling designs that were used were inadequate for this analysis, and consequently many different types of artifacts and biases were present in the results. The original data collection programs were not designed

for niche analysis. These data represent better than average evaluation of community density patterns in comparison to many other thermal pollution studies. Consequently, it may be more desirable to use a slightly better than average data set, then to use an optimum one which would in a pragmatic sense be impossible to obtain on a routine basis. This particular study was experimental. For routine analysis, several stratifications could be deleted and the remaining portion automated to facilitate use of the analysis.

Third, there was no loop diagram used as an overall starting point. We did not initially know enough to construct such a diagram for the Hudson River. In the future, continued use of niche analysis will be greatly hampered, especially in regard to the third validation criteria of understanding, and to a lesser degree predictability and regularity without loop analysis. Lane and Wright (1977) discuss one loop diagram for the Hudson River.

There was regularity in several of the community stratifications, especially for the plankton communities. Besides being able to demonstrate community structure and stability for several communities, we were also able to show many possible effects of the power plant on these communities and to advance several hypotheses to explain what might be happening in the system. Unfortunately, although we could advance many hypotheses we could not test them because of the inadequacies in the data set. Therefore, the most important contribution of this study is to present (by example) a methodology for evaluation of natural communities using field data. In many ways, the report represents a how-to-do-it manual, (given the warnings in Chapter I) and some ecological results have been generated. Undoubtedly the approach could be greatly enhanced with more research and development, however, it is a viable one in its present state.

We should also emphasize that the particular definitions and usages of community structure and stability measures have unique attributes in relation to how we have used them. Orians (1974) has discussed several definitions of stability. Undoubtedly, ecological stability measures and methods of evaluation need to be developed more independently of physics and associated mathematical stability than they have been in the past. As we will summarize later, some of our stability results go counter to ecological theory, and others agree with it. Neither the theory and its related mathematics, nor the ecological understanding is developed enough for many of these difficulties to be resolved at the present time. When we state a community is more or less stable when represented by a given data stratification compared to another one, we evaluate stability only in regard to niche analysis which only incompletely and imperfectly models the natural world. Niche analysis, at present, although more complete than many other community analyses, has many inadequacies. As we learn more about community structure and stability, all of these measures may be discarded and/or substituted by new ones. Consequently, the analysis itself and in particular this application of it, are only working, transient models in an interesting and difficult period of evaluating, and understanding community structure and stability.

In the previous results section, we summarized each of the subcommunities for four functional groups, including thirteen sub-groups, of organisms and as much as possible, we conducted all possible data stratifications. In the following section, we will briefly summarize each community and then concentrate our comparison of the thirteen sub-groups using niche values and stability measures that were calculated over all possible stratifications. Thus, for each sub-group we are using all the available data to calculate one set of community structure and stability values. While this particular

type of comparison tends to blur much of the interesting ecological detail it does provide a more convenient handle for comparing differences in the communities. Besides comparing the thirteen groups individually, we will also concentrate on two biological divisions: 1) plants versus animals and 2) plankton versus fish.

In the following section of the discussion (Part B), we will summarize many of the station differences especially since these results were the most useful in delineating the effect of power plants. We will also discuss the stability measures since the focus of the report is evaluation of thermal perturbation, and the ability of the system to resist the perturbation. To a lesser degree, we also attempt to compare perturbation effects to the natural variation of the system.

Finally, in the third section of the discussion (Part C) we will present some paradoxes, explanations, and hypotheses. Clearly, based on what we have presented in this report, a great deal of additional progress is guaranteed with more research, development and improved sampling regimes. Parts D and E summarize sources of error and general recommendations for application of niche analysis.

2. Some General Remarks

Some general remarks are in order so that we do not forget some of the basic properties of the system which is being evaluated. Despite all of the sampling problems and the inadequacies of the theory, it should be remembered the river was probably heavily perturbed and polluted before the power plant was in operation. In general, the thirteen sub-communities all show some evidence of a

history of pollution, since most of the communities have one to three dominant species that tended to dominate the general community patterns.

In regard to the potential perturbations, knowledge of the power plant effects is rudimentary and in regard to other types of perturbation we know practically nothing. Obviously, several of these such as sewage inputs, industrial wastes, etc., have been long term perturbations and the species, in particular, the dominant plankton species, may have had an evolutionary time span in relation to their generation time to adapt to these stresses. Undoubtedly, many of the perturbations will affect the ecological network at different places and even in opposite directions (Lane and Levins 1977). Consequently, at different stations even when the same species are present, their functional relationships may produce marked differences in the qualitative structure of the ecological networks. It is doubtful that the networks at individual stations are similar, since particular stations are quite unique. Therefore, although all species can be at all stations, the relative abundance patterns in space and time are quite different. We can also argue the network differences based on known complexities for the fish populations. Consequently, there are many qualitative and quantitative phenomena simultaneously producing the complicated community structure and stability patterns observed in nature. Also, in this particular part of the river, the salt front intrusion makes the area an ecotone. This natural perturbation creates an impoverishment of species in one sense and in another, the intrusion adds much complexity to the system. The niche values documented this result.

In comparing the various groups of organisms, it has also become obvious that as the trophic status increases, from primary producers

to the second degree carnivores that it becomes more difficult to find consistent properties. In general, there is more variation in community structure measures for higher trophic levels. This is because of three reasons. First, species on higher trophic levels have more complicated biology. For example, their behavior patterns are more complex. Their life history dynamics also become complicated and many time lags are introduced into the system. For example, phytoplankton species can go extinct locally, or can adapt quickly due to their generation time. In contrast, fish species can subsist on a minimal diet for a long time when resources are low without showing related density effects, although they would eventually use up their food storage reserves, become thinner and die. Many of these latter effects would not be easily seen in terms of density-distribution data. Time lags greatly complicate the ecological dynamics and are not adequately treated by niche analysis.

Second, there are many difficulties in sampling higher trophic levels. Sampling fish is never easy. While the sampling in many ways was good in this study, we would expect, for example, communities of pelagic or large fish (that could only be captured with gill nets) would complicate the identification of consistent properties and other community structure patterns. Undoubtedly, the particular fish species that were used in this study, however, if collected with a better sampling design, could be more successfully treated with niche analysis than we have done.

Third, it is difficult to determine what constitutes a set of overlapping species and an appropriate habitat definition for many groups of organisms on higher trophic levels.

In summary, the analysis has been increasingly verified with each new result we have obtained in terms of 1) documenting other types

of perturbation such as the salt front, and 2) identifying many community structure patterns and in substantiating the known biology of individual species.

3. The Plant Community

The phytoplankton community as was discussed in the results section was consistent over most data stratifications. The diatoms and the greens had similar community structure patterns, while the bluegreens were the most different group especially in fall. Of the station comparisons, sets of all stations, and control stations were most similar and the set of experimental stations was the most different. Date stratification showed that in the summer there was more variability and that generally, stratification over date was more variable than stratification by station. The bluegreens possessed a set of community structure values that indicated that they were unbalanced. A species group can be abundant in an ecosystem but be in a poor position in terms of functional relations in the ecological network. Levins (1975c) has shown how a species can do everything right in terms of Darwinian fitness and yet select itself to extinction. It was interesting that usually one experimental station (in terms of the community structure and stability values) differed but not all of them did. Much of the variation in the experimental stations came from the large abundance of the bluegreen species, Oscillatoria. In general, niche values of all stations exhibited greater consistency in the fall. The bluegreen effects were most pronounced in the summer stratification which agrees with the known biology of the bluegreen groups. The diatoms were to be relatively uniform although there were blooms of Melosira sp. and Navicula sp. at the DI station. The greens were not abundant but exhibited many consistent properties in their community structure patterns. We will discuss this result in more detail

below. It is interesting, as well, that the RSCW station was more like DI than any of the others. With a large decrease in diversity at DI because of the bluegreen and diatom blooms, there emerged a pattern of global community structure with considerable instability at DI. At the unusual RDE station, the bluegreens were replaced by the greens. Many patterns were unique at this station; we did not have enough information to resolve the nature of its peculiarity.

In terms of the bio-volume stratifications, the consistent properties were quite interesting. The medium-sized community was generally the most structured. Unfortunately Oscillatoria was classified as a small species and the small group was generally more like the large group in which Oscillatoria should have been classified. The small and medium groups had the most differences in the summer, and the medium group generally did better in the fall. The large group was regular over station, but changed over date. This was a problem because of the errors in the LMS data transfer in regard to the density of Amphiprora sp. The small group generally exhibited the most instability and the weakest community structure because of the presence of Oscillatoria sp. Stratifications for the fall period exhibited more inconsistent properties than summer communities because of the erratic behavior of Oscillatoria sp. in the summer. Many of these results are summarized in intext Table 17 where the niche values have been calculated for all the data for each particular group: bluegreens, greens, diatoms, all phytoplankton species, all biovolume species, and small, medium and large groups.

In terms of number of species, each subgroup had approximately the same number except for the two larger all-species groups. In terms of percentage of the first dominant species, the bluegreens and small phytoplankton were dominated by Oscillatoria sp. and the large

Table 17
Summary comparison of the phytoplankton functional groups.

	Blue	Green	Diatom	Phyto	Biovol	Small	Medium	Large
E	41	42	42	42	42	42	42	42
N # species	7	9	6	22	18	6	6	6
1st dom.sp	85	21	48	64	47	78	27	57
H	.94	3.04	1.78	2.03	2.66	1.12	2.48	1.87
$\bar{H}_h$	.85	2.06	1.58	2.12	2.22	1.22	1.85	1.33
$H-\bar{H}_h$	.10	.98	.19	-.09	.45	-.10	.63	.54
$\hat{B}/E$	.43	.61	.73	.50	.45	.52	.79	.35
$\bar{B}_i/\hat{B}$	.68(.6)	.66(.4)	.78(.3)	.82(.5)	1.06(.4)	1.13(.2)	.59(.4)	1.02(.3)
$\overline{B_i/E_i}$	.50(.2)	.59(.2)	.62(.2)	.57(.2)	.62(.2)	.64(.1)	.58(.2)	.65(.2)
$\bar{\alpha}$	.44(.3)	.56(.3)	.75(.2)	.49(.3)	.52(.5)	.64(.2)	.50(.6)	.41(.6)
$\%\bar{K}_i/\bar{D}_i$	.52(.6)	.61(.3)	.76(.3)	.54(.4)	.57(.5)	.74(.1)	.57(.4)	.45(.6)
$\overline{D_i/K_i}$	.19(1.6)	.21(.6)	.20(1.0)	.07(2.0)	.12(1.7)	.20(1.7)	.30(.3)	.33(.9)
$\overline{\%K_i/(B_i/\hat{B})}$	.81(.3)	.98(.2)	1(.1)	.72(.3)	.57(.6)	.68(.3)	1.02(.12)	.52(.9)
cov. α	-.001	.009	-.023	.006	.02	.001	.014	.05
det. α	.05	.001	.002	.75-11	.45-9	.009	.035	.05
min λ	.18	.13	.07	.02	.02	.07	.16	.15
max. λ	3.5	5.4	4.6	11.0	9.9	4.2	3.5	3.1
H.M. λ	.46	.31	.19	.13	.13	.24	.39	.40
$S^2\lambda$	1.35	2.87	3.21	5.39	5.32	2.43	1.60	1.29
$S\lambda$	1.74	2.31	1.74	3.91	3.41	1.72	1.48	1.31
$K\lambda$	4.52	6.63	4.12	17.4	13.52	4.07	3.56	3.19
B'_i	1.38	7.58	2.76	2.02	3.81	1.58	5.21	2.67
H'	3.01	3.42	3.56	3.25	3.27	3.29	3.60	3.08

group by Amphiprora. Therefore, since these two dominant species and in particular, Amphiprora, only occurred in one or two samples at high densities, they tend to dominate and skew some of the results. In terms of diversity, it decreased at these points where there were blooms of Oscillatoria sp. and Amphiprora sp. Diversity was also much lower within environments for blue-green, diatoms, small and large species as expected because of these bloom phenomena.

The greens, biovolume, small and large groups had large among-components and these indicated a more variable community structure pattern. The relative community niche breadth was highest with green, diatoms and medium species, which were probably the three best adapted communities. The large species exhibited small B/E values. In terms of the relative species niche breadth, $(\bar{B}_i/\hat{B})$, the biovolume, small, large, and to a lesser degree all phytoplankton had the largest values, although all values were relatively high. When the mean value of species niche breadth over environments is taken, however, we see that many of the effects average out so this measure was one of the two consistent measures in the total set of niche values for phytoplankton groups. In general, these values are high as well as being consistent. Consequently, there are significant differences in those groups dominated by bloom-type species versus those communities that have more uniformly-distributed species. Bloom-type species tend to contribute to the high values of relative species niche breadth $(\bar{B}_i/\hat{B})$ and low values of relative community niche breadth $(\hat{B}/E)$ while the non-bloom communities tend to be more uniform in regard to these measures.

The mean value of alpha $(\bar{\alpha})$ was high especially for the non-bloom communities. Larger species, e.g., bluegreens, tended to overlap less and likewise, diatoms and greens overlapped more. In terms of $\overline{D_i/K_i}$, the measure of competitive success, the phytoplankton bio-

volume groups were low and there was generally more cooccurrences within a group than among groups. This is expected since in interspecific competition phenomena, members within a group possess more similar ecological requirements than does the total set of species. In terms of the $\overline{\%K_i/(B_i/\hat{B})}$ ratio, the values were generally high while the smallest values were for biovolume, small, and large algal groups.

The determinant ($|A|$) was high for the medium group indicating enhanced stability. It was much less stable for the phytoplankton biovolume groups, the blue-green and large groups were the next most stable communities. This indicates that there is not as much stability in a global sense for the larger groupings of phytoplankton. Global used in this report means data stratifications involving more than 1 station. In terms of the minimum eigenvalue, the bluegreens, greens, medium, and large groups were the most stable. With the maximum eigenvalues again these followed the above result in terms of enhanced stability, and also the diatoms and small groups exhibited slightly more stability. In regard to the harmonic mean ($H.M._\lambda$), the bluegreens, greens, medium and large groups were the most stable. A source of instability was observed in the greens in terms of the variance of the eigenvalues. The skewness (S_λ) and kurtosis (K_λ) measures for the bluegreens, diatoms, and large groups showed the most stability, the small group was more stable in regard to skewness, while the medium group was more stable in regard to kurtosis.

The species breadth was greatest for the greens and medium group, predicted from the uniformity of the community discussed above. The habitat diversity (H') values were similar. This measure is also related to $\overline{B}/E$ and it represents the only type of consistent property for the total community, since B' was related to the diversity

which did fluctuate by a factor of 3. It is interesting that while the greens and the medium group were most stable, the bluegreen and the large species also exhibited a great deal of stability. This indicated then that our stability measures take account of more than one set of criteria (biomass, relative abundance, frequency) in delineating stability. This will be discussed more in part B, but the result is related to the relative degrees of biomass the species possess.

4. The Animal Communities

We will first discuss the separate animal groups before comparing the phytoplankton results with those for rotifers, fish larvae, and adult fish. The rotifer community exhibited a large number of consistent properties. It possessed a highly-structured group of species, and even though there was more variation in July and August, there was simultaneously more stability. Deviations at station DI were indicated, and in general, there was less variation by station than for phytoplankton. Although the RDE station was different from DI for phytoplankton, the two stations were more alike for rotifers. There were several measures that were different at DI and in general, there was a reduced stability at DI. The RSCW station often showed trends in the opposite directions, from the former two stations.

The larvae, in contrast, were not consistent and several reasons were given for this result. First, they are immature and transitory nature, carry yolk sacs and may not be feeding, and in general, they possess diverse biologies. Second, their taxonomy was unsuitable because Alosa spp. (which accounted for 79% of the community) was constituted of several species. Third, there are several competitors which were not included in the larval matrix, but which would

be found in macrozooplankton, microzooplankton and benthic samples. Consequently, the larval species in the matrix probably represented only a partial community. Fourth, the dates were different for number of samples in regard to time of day. Thus, there was irregularity in the sampling design which generated rather problems especially in regard to the missing samples. There was less global integrity and more local structure for fish larvae. Stability was generally high and sometimes the community structure was consistent over depth and station. As with the phytoplankton community, station RDE was different from the DI station and in general, there were several apparent species-specific habitat preferences. For example, Alosa spp. had higher densities in the eastern part of the river while striped bass were more dense in the western part of the river.

There was not one adult fish species that used the total area. The white perch constituted 39% of the total fish community, however, only 15% were caught in the surface. Of the overall community density, 57% were pelagic and 43% inshore bethic. Even when pelagic fish were caught in the deeper waters the ratio stayed similar at 51% to 49%. As with larvae and to a lesser degree rotifers, distinct diurnal patterns were associated with the more complicated behavioral adaptations and strategies of the species. In general, these patterns represented large day-night-bottom differences for the fish community. There was a large coefficient of variation over stations which was related to these behavioral flexibilities that the species exhibited. The benthic group was the most unstable. There was less global stability for all groups. The most different station was the RDW station although it did exhibit higher stability. The RNCE station was similar to the RDW station, however, because both of these latter stations had many missing samples, their similarity may rest upon mathematical artifacts. The t-test were

generally not useful in trying to elucidate this problem. With pelagic fish, there were many local station variations. The white perch was abundant at DC-20 while the striped bass was numerous at RDW and the southern control stations.

5. A Comparison of All Communities

In the following intext Table 18 the niche values using all data are given for the phytoplankton by density and biovolume, rotifer, larvae, all fish and pelagic and benthic fish sub-groups. Consequently, the following discussion centers on looking at similarities and differences in this table. We are using two main lines of comparison. The first one is between the phytoplankton by density and by biovolume versus all of the animal groups. In other words the algae and animals represent two different trophic categories: autotrophs versus heterotrophs. Consequently, we would expect some similarities in niche values within each trophic category. Second, the plankton and fish groups also represent natural divisions in that the individual fish larvae and adults are characterized by more behavioral flexibility than the planktonic group. The rotifers, although they can be carnivorous, are usually consuming small organic particulate matter and thus represent a different life style than the fish. Therefore, it is reasonable to suspect that plankton versus fish may be another natural grouping.

The rotifers and fish larvae were sampled much more extensively than the other groups, and to a lesser degree the all-fish and pelagic sub-group. The phytoplankton by density and biovolume were sampled the least. Thus, it is expected that the rotifers and fish larvae would have the best community characterization using the multivariate principle of representing a given set of variables by a larger number of cases. Generally, the larger number of cases per variable, the better the characterization.

Table 18
Summary comparison of all functional groups of organisms

	Phto	Biovol	Rotifers	Larvae	Fish	Pelagic	Benthic
E	42	42	143	186	84	81	45
N	22	18	8	6	13	7	6
%	64	47	37	79	39	68	38
H	2.03	2.66	2.58	1.08	2.76	1.67	1.92
$\bar{H}_h$	2.12	2.22	1.51	.45	.88	.50	.55
$H-\bar{H}_h$	-.09	.45	1.07	.63	1.87	1.17	1.37
$\hat{B}/E$	.50	.45	.68	.38	.23	.37	.17
$\bar{B}_i/\hat{B}$	.82(.5)	1.06(.4)	.38(.5)	.26(1.2)	.33(.8)	.28(.7)	.49(.7)
$\overline{B_i/E_i}$	.57(.2)	.62(.2)	.50(.2)	.28(.9)	.35(.5)	.39(.3)	.30(.6)
$\bar{\alpha}$	.49(.3)	.52(.5)	.31(.7)	.16(1.3)	.13(2.2)	.19(1.4)	.14(2.1)
$\overline{\%K_i}$	.54(.4)	.57(.5)	.38(.5)	.24(1.3)	.19(1.1)	.23(1.0)	.30(.6)
$\overline{D_i/K_i}$	.07(2)	.12(1.7)	.30(.5)	.43(.8)	.37(.6)	.47(.6)	.53(.7)
$\overline{\%K_i/(B_i/\hat{B})}$	.72(.3)	.57(.6)	1.01(.1)	.92(.3)	.75(1.1)	.79(.3)	.79(.9)
cov. α	.006	.02	.018	-.003	.030	.027	.072
det. α	.75E-11	.4E-9	.090	.752	.004	.234	.034
min. λ	.02	.02	.28	.68	.03	.23	.03
max. λ	11	9.9	3.18	1.65	2.62	2.22	1.97
H.M. λ	.13	.13	.60	.92	.25	.64	.15
$S^2\lambda$	5.39	5.32	.92	.13	.61	.43	.55
$S\lambda$	3.91	3.41	1.67	1.02	.81	.78	.02
$K\lambda$	17.4	13.52	4.46	2.82	2.67	2.70	1.71
B_i'	2.02	3.81	4.72	1.55	4.60	2.06	3.21
H'	3.25	3.27	4.74	4.54	3.64	3.76	2.76

In terms of number of species, the natural division was between the plants and animals. Phytoplankton usually had two to three times more species than did the animals. In terms of percent dominance, the first dominant species of the phytoplankton by density was large and the biovolume, fish larvae and inshore-benthic groups had the smallest percentage for the 1st dominant. Some of the preceding results were reflected in diversity: the fish larvae and the pelagic fish had the lowest diversity values. Niche values of phytoplankton by biovolume, rotifers, and all fish were quite similar. The inshore-benthic group had a low diversity value which was unexpected given the 38% for the first dominant species. For within diversity, there was a natural division between the plants and animals and this measure possessed a low value for larvae as well as for pelagic and inshore benthic fish species. In terms of among-diversity, it was high for rotifers and fish and generally low for larvae and much lower for phytoplankton. The relative community niche breadth ($\hat{B}/E$) was mostly broken into plankton versus fish groups. On a community level these two modes of existence were more important than were trophic stratifications. Relative community niche breadth, ($\hat{B}/E$), was highest for the rotifers and values for the larvae and pelagic fish were about equal. The phytoplankton by density and biovolume were similar and the all-fish and inshore benthic groups were also similar. There are several sub-divisions for this measure. The relative species niche breadth ($\bar{B}_i/\hat{B}$) exhibited a division between the plants and the animals. The larvae and pelagic fish had the lowest values and the plankton ($\bar{B}_i/\hat{B}$) was about 1.5 to 2 times greater than the fish. The value of $\hat{B}/E$ for plankton was about 1.5 to 2 times greater than the fish.

The mean value of alpha for the plankton was much higher which is probably an important function of the scale of time and space that

was used to characterize each community. The sampling programs were undoubtedly more adequate and appropriate for plankton than for the fish species. The mean value of alpha ($\bar{\alpha}$), however, divided the phytoplankton into a category, separate from the rotifers, and then the fish groups. For several measures, the values were consistent over larvae and adult fish. The phytoplankton values of $\overline{\%K_i}$ were much higher, the rotifers lower and the fish values were lowest and variable. The $\overline{D_i/K_i}$ ratio was low for the phytoplankton and higher for the animals, especially the benthic fishes. The $\overline{\%K_i/(B_i/B)}$ values for the rotifers and larvae were different and the values in general were high, although lower for phytoplankton, especially by biovolume.

The determinant ($|A|$) values were larger for animal communities than for plants. The larvae and pelagic fish indicated enhanced stability, and the determinant was unexpectedly high for the larvae. The larvae also exhibited a larger minimum eigenvalue which indicates enhanced stability, with rotifers and pelagic fish being the next most stable groups. The maximum eigenvalue also indicated a plant versus animal division, in which the animals were more stable. For the harmonic mean, the rotifer, larvae, and pelagic groups showed the most stability while the all-fish and the inshore-benthic fish were the least stable. The values of variance (S_λ^2), skewness and kurtosis of the eigenvalues were different for plant versus animal groupings. Generally, the animal communities exhibited higher stability than did the phytoplankton community. With species breadth there was no particular trend but essentially the best was the rotifer group, followed by fish, then biovolume, algae and benthic fish. In terms of habitat diversity (H'), the rotifers and larvae did better and the benthic fish were the least successful.

In summary, the rotifer community is probably highly structured. We have found from many other studies that zooplankton possess a high degree of community structure and integrity using this analysis, and in general, the results of this study substantiated previous results. The pelagic fishes also had good stability measures. The benthic fishes were probably the least-overall consistent community. In conclusion, the niche patterns of the different organism groupings behave differently, but usually the marked differences are between the plants and the animals. Occasionally rotifers and fish larvae exhibited particular similarities in their community structure patterns, or for some measures, fish were separate from the plankton groups.

After detailed application of niche analysis, it is obvious that a number of measures are necessary to characterize the relative abundance patterns of groups of species in natural communities. The fact that we see a great deal of variation in these overall community values indicates that niche measures can assume a large range of values and probably more significance should be attached to consistent patterns than we have stressed previously.

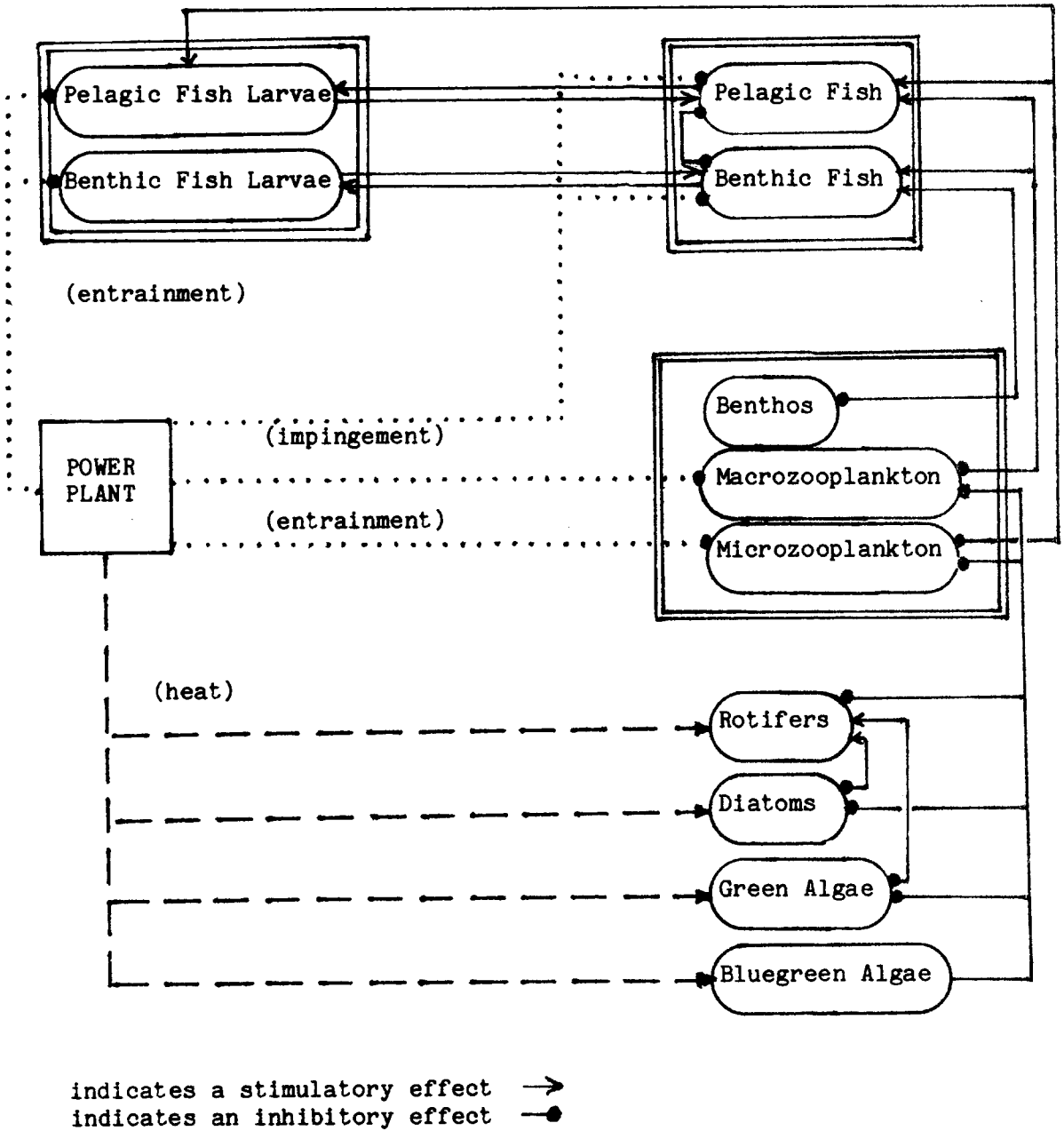
B. EVALUATION OF THE EFFECTS OF THE ROSETON AND DANSKAMMER POWER STATIONS ON THE FOUR FUNCTIONAL GROUPS OF ORGANISMS

1. Introduction

In this section, we are going to consider the effects of the thermal plants on these various distribution patterns of natural community. By using a loop diagram it will become more obvious why we obtained the results presented in V A.

Figure 10 gives a hypothetical loop diagram for the effect of the Danskammer power plant on the communities of various aquatic organisms. The loop diagram is understandably incomplete because we had no information on benthos, macrozooplankton, and the rest of the microzooplankton. As can be seen by the loop structure, this is particularly unfortunate since these groups form an integral part of the qualitative structure between the fish and the plankton groups. Power plants affect aquatic communities mainly in three ways. First, through heated effluents which influence all trophic levels. Increased temperature can be expected to greatly increase turnover rates of the phytoplankton, to provide a more favorable environment for bluegreen algae, to hasten microzooplankton reproduction and development, to increase rates of detrital production and microbial activity. The second major effect is the entrainment or impingement of the zooplankton and fish, especially the immature forms of fish larvae. (Third, toxic materials can be released in wastewaters; this perturbation is not considered here). In this particular diagram, we have four different entrainment and impingement effects and two heat effects entering the network. The relation of temperature to diatoms and green algae is ambiguous. Certainly some species would be helped and some species would be harmed, within each major sub-group. In a system such as this, there are eleven variables which undoubtedly should be expanded if we knew more about the missing groups. In its simplest form, the system is amazingly complex. Even given the present level of analysis we have completed on the separate stations around the power plant, it is not expected that the loop structures would be identical for all stations. This fact has resulted in many of the differences in the community niche values that we have observed while the species lists remain the same.

Figure 10: Hypothetical (and oversimplified) loop diagram of effect of Danskammer power plant on the Hudson River ecosystem



At the present time, the theory is incomplete, as was discussed in the previous section. We have not yet begun to incorporate and interpret niche values in terms of loop structures. This is one of the next steps that should be done. Given that we could do that, then the calculations made on the loop structure would probably explain not only the main pathways of the effect but the generation of consistent patterns. In this particular diagram, for example, to go from the power plant perturbation through heat to the various components to pelagic fish, would entail several thousand pathways. To go through entrainment to bluegreens, for example, would also entail several thousand pathways. Thus, to resolve the main pathways of the network is not a simple exercise, and often the results of a loop analysis are non-obvious. (Lane and Levins 1977). See Lane and Wright (1977) for results of loop analysis modeling for a power plant perturbation.

2. Community Structure and Thermal Perturbation

In the following discussion of this section, we will refer back to Figure 9 to illustrate particular points. Heat can cause subtle shifts in species of a community or the quantitative relationships of the various species. It can also speed up growth rates and other factors that would tend to accentuate certain pathways in the community, and other ones would become less important. Essentially an effective loop diagram rests on the assumption that the various links are in some kind of a temporal coordination with each other (Levins 1975c). Thus, the heat would act directly on the physiology of many species, so that their reactions to competition would either be improved or hampered and temporal relationships would be altered. Also expected, are certain seasonal effects in tolerance levels (as well as overall physiology) and behavior patterns that are more susceptible to heat than at other times of the year. In some

situations, heat will act as a buffering agent taking out much of the seasonal variability in temperature for the system. The thermal variation of the plant was much less than that of the natural temperature cycle in the north temperate zone. These particular organisms, however, have evolved for tens of thousands of years to adapt to this particular climatic cycle and not to a power plant type of heat variation. Unfortunately the sampling program was not optimal to discern thermal effects for the experimental or control stations.

For a power plant, both types of perturbations (the mechanical action versus temperature), act essentially through what could be considered natural pathways. For example, temperature is a normal perturbation that these communities have adapted to with normal seasonal variation. All the organisms involved have many thermal adaptations. In addition, power plants can be considered to act as a superpredator predating on many of the smaller organisms as they enter the intake water. Thus, impingement and entrainment mimic the mode of action typical to a predation effect in a community. Although these processes are quite different than the actual biological type of predation, they could be expected to affect the network in natural ways. This is quite different, for example, from the effect of a pesticide or toxic pollutant that enters the community and becomes concentrated in particular parts of the food web thus affecting various physiological processes in abnormal ways.

In demonstrating that there could be effects of the power plant at Roseton-Danskammer point, the most relevant calculations are those related to the station stratifications. If there is an effect of the plant, we would expect sampling stations for the various communities that are closer to the power plant to be more affected than stations

that are farther away. Indeed while the sampling design was not optimal for elucidating differences between experimental and control stations, it did include control and experimental stations to attempt to delineate some of the differences that might be occurring due to the plant. The stations effects that we have been able to find are summarized in the intext Table No. 18 which represents all the combined effects of both types of perturbation (heat and mechanical). With niche analysis, it is possible to discern there is a difference in stations but without more research and development (loop analysis), we cannot say whether it is due to impingement and entrainment, or due to the thermal effects.

In intext Table No. 19 we list the individual station niche values for some of the more critical measures including: density, diversity, relative community niche breadth, relative species niche breadth, mean value of alpha, $\overline{\%K_i/(B_i/\hat{B})}$, competitive success ratio $\overline{D_i/K_i}$, the harmonic mean and variance of the eigenvalues. In the first two columns, the mean and standard deviation of the typical or median values are given with an appropriate range of variation, then each of the individual stations are listed. Whenever they deviate from the median values, deviations are indicated. Finally, the mean over stations is given. This particular system of notation is similar to that when we used a critical cut-off value of .15. In this case, however, the critical cut-off value has become a custom-made value for the various niche values so that in some regards it is better, although a less uniform criterion. The coefficient of variation is not very sensitive to extreme values, while the .15 criteria is perhaps too sensitive to extreme values.

TABLE 19

Summary comparison of community structure and stability values by stations using median values

	Typical or Median Values		Departure from Median Value								Mean (C.V.) over stations
			RNCE	RNCW	RSCE	RSCW	RDE	RI	DI		
BLUEGREENS											
D	.9 E7	± .1E7					.3E7		.95E7		.7E7 (.3)
H	.9	± .1	.8	1.0		.6	1.0	.7	.5		.8 (.25)
$\bar{B}/E$	.4	±				.5			.6	$\bar{B}, \hat{B}$ high	.46 (.2)
$B_i/\hat{B}$	.9	± .2									1.0 (.15)
$\bar{\alpha}$	.6	± .07				.8			.9		.7 (.2)
$\overline{\sum K_i (B_i/\hat{B})}$	.7	± .04				.9 (.2)			1.0 (.1)		.8 (.1)
D_i/K_i	.2						.34	.24	.25		.21 (.15)
H.M λ	.04	± .02	.001			.00027		.02	.003		.02 (.14)
Variance λ	.2	± .5	2.9			3.6			3.4		2.6 (.5)
GREENS											
D	.5E6	± .1					.7E6		.6E6		.5E6 (.2)
H	2.6	± .11				2.3	2.3 (lower among)		1.7 (both lower)		2.4 (.1)
$\bar{B}/E$	.6	± .07					.7			$\bar{B}$ high	.6 (.1)
$B_i/\hat{B}$	.85	± .09					$\bar{B}, \hat{B}$ high		1.0	$\hat{B}$ same	.9 (.1)
$\bar{\alpha}$	.7	± .13				.6					.7 (.1)
$\overline{\sum K_i (B_i/\hat{B})}$	.97					.8 (.5)			.9 (.4)		.9 (.07)
D_i/K_i	.2	± .02				.29 (.8)	.27 (.2)		.3 (.8)		.24 (.2)
H.M λ	.02	± .01				.06		.0009	.04		.03 (.8)
Variance λ	3.5	± .03	4.0			2.1	2.2	3.6	2.4		3.0 (.25)
DIATOMS											
D	.9E6	± .1							.12E7		.95E6 (.1)
H	1.8	± .08					1.5 (low within)		1.5 (no sig. among)		1.7 (.1)
$\bar{B}/E$	.7	± .09					.85	.6 (slightly low species B)		$\bar{B}$ high	.75 (.1)
$B_i/\hat{B}$	.95	± .06							1.1	$\hat{B}$ same	.9 (.1)
$\bar{\alpha}$	.5	± .06									.8 (.05)
$\overline{\sum K_i (B_i/\hat{B})}$	1.0	± .06							.85		1.0 (.07)
D_i/K_i	.2	± .04					.24		.3		.21 (.2)
H.M λ	.01	± .01							.1E-4		.01 (1.4)
Variance λ	3.5	± .7							2.4		3.5 (.16)

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Summary comparison of community structure and stability values by stations using median values

	Typical or Median Values		Departure from Median Value								Mean (c.v.) over stations	
			RNCE	RNCW	RSCE	RSCW	RDE	RI	DI			
PHYTOPLANKTON												
D	.9E7	±.1					.5E7		.11E8		.9E7 (.2)	
H	1.7	±.24				slightly low within	2.5 (both high)		1.5 (low within)		1.8 (.2)	
$\hat{B}/\epsilon$	.5	±.09					.6 } $\hat{B}, \bar{B}$ high		.7 } $\hat{B}, \bar{B}$ high		.54 (.2)	
$B_i/\hat{B}$	1.0	±.2									1.0 (.15)	
$\bar{\alpha}$	.6	±.05							.7 (K high)		.6 (.1)	
$\%K_i/(B_i/\hat{B})$	.7	±.03				.8			.85		.7 (.1)	
D_i/K_i	.07	±.015					.1	.08	.1		.08 (.2)	
H.M λ	.4	±.25	.9 } +				1.4 } +		1.0 } +		.7 (.6)	}
Variance λ	7.75	±.4	6.7 }				5.7 }		6.0 }		7.0 (.1)	}
ROTIFERS												
D	.4E4	±.1				.76E4 (.7)			.12E5 (1.1)		.9E4 (.15)	
H	2.5	±.07		2.6 (slightly high overall)		2.6 (shift to among)	2.4 (shifted within)		2.2 (shift to within)		2.5 (.06)	
$\hat{B}/\epsilon$	.75	±.04			.6	.6		.65			.7 (.1)	
$\bar{B}_i/\hat{B}$	.4	±.06					.46	.45	.54		.4 (.1)	
$\bar{\alpha}$	.3	±.04					.4		.5 (K high)		.4 (.2)	
$\%K_i/(B_i/\hat{B})$	1.0	±.1						.9			1.0 (.04)	
D_i/K_i	.3	±.03					.2		.2 (.9)		.3 (.2)	
H.M λ	.35	±.06				+5 } +	.2 } −		.07 } −		.3 (.5)	}
Variance λ	1.2	±.1				.9 }	1.5 }		2.2 }		1.3 (.3)	}
						RDE	RDECH	RDWCH	RDW			
FISH LARVAE												
D	775	±20						500 (1.4)	640		675 (.2)	
(within + among) H	1.0	±.1				.6 (no among)		1.4 (high among)			1.0 (.4)	
$\hat{B}/\epsilon$	.36	±.03				.4 } $\hat{B}$ and $\bar{B}$ high	.3 (1) } species $\hat{B}$ low uneven $\bar{B}$ same				.4 (.1)	
$\bar{B}_i/\hat{B}$	.4	±.03					1 (1.6)		.2		.4 (.15)	
$\bar{\alpha}$	.3	±.02						1.0			.24 (.4)	
$\%K_i/(B_i/\hat{B})$	.8	±.04				.24					.85 (.1)	
D_i/K_i	.4	±.04					.94 } +				.35 (.2)	
H.M λ	.5	±.11					.08 }				.6 (.4)	}
Variance λ	.6	±.13									.5 (.6)	}

TABLE 19 (con'd)

Summary comparison of community structure and stability values by stations using median values

	1 Typical or Median Value	2 RNCE	3 RNCW	4 RSCE	5 RSCW	6 RDW	7 DC-20	8 Mean (c.v.) over stations	11 All	12 Surface	13 Bottom
				Departure from Median Value							
Pelagic Fish											
D	20 ± 1	17(2) 15/6	13/7	12(2) 16/6	14/7	13 12/7	24 11/7	18 (.26)	17 (1.7)	12 (.8)	21 (2.3)
H	1.6 ± .1	.9 (lower among)	2.0 (higher among)	1.0 (lower overall)			(shift to within)	1.5 (.3)	1.7 (.7) (.2)	2.4 (.7) (.7)	.7 (.4) (.3)
$\hat{B}/\epsilon$	.4 ± .13	.2 $\hat{B}$ low		.5 $\hat{B}$, $\bar{B}$		.3 $\hat{B}$ slightly low	.7 $\hat{B}$, $\bar{B}$	.4 (.4)	.4	.34	.4
$\bar{B}_i/\hat{B}$	.4 ± .08	.7 $\bar{B}$ same		slightly high		.5 $\bar{B}$ same	high	.45 (.3)	.3 (.7)	.4 (.7)	.3 (.9)
α	.2 ± .04	.08(3) (K same)	.3 %K same		(%K low slightly)	(%K high slightly)	.35 %K same	.23 (.4)	.19 (1.4)	.25 (1.2)	.12 (1.4)
$\%K_i/(B_i/\hat{B})$	.7 ± .14	.4 (1.4)	1.0 (.3)		.6			.7 (.3)	.8 (.3)	.9 (.4)	.5 (.6)
D_i/K_i	.4 ± .05	.6 (.6)				.35	.35	.4 (.2)	.5 (.6)	.4 (.6)	.3 (1.2)
H.M λ	.4 ± .25		.0006 −	.6 +	.15	.06 −	.07 −	.2 (1.1)	.6	.4	.9
Var. λ	.4 ± .06		1.5		.7	1.1	1.6	.95 (.6)	.4	.7	.14
Benthic Fish											
D	14 ± 1	48 10/5	7/5	29 7/5	8/6	9.8 5/3	8/6	21 (.7)			
H	1.3 ± .14	1.2 (shift to among)			1.0 (lower among)	(shift to among)	1.75 (shift to high among)	1.3 (.2)			
$\hat{B}/\epsilon$	.5 ± .06	.2 $\hat{B}$, $\bar{B}$			.3 $\hat{B}$ low	$\hat{B}$ same	$\hat{B}$ same	.4 (.3)			
$\bar{B}_i/\hat{B}$	.65 ± .04	low c.v. low			.95 $\bar{B}$ same	.9 $\bar{B}$ high	$\bar{B}$ low	.7 (.3)			
α	.2 ± .03	.4		low c.v.	.3 %K high	.7 (.4) %K high	high c.v.	.34 (.5)			
$\%K_i/(B_i/\hat{B})$	.55 ± .07	.7				.9 (.4)	1.0	.7 (.3)			
D_i/K_i	.4 ± .07		.5		.3		.5	.4 (.2)			
H.M λ	.6 ± .2	.005 −		+	.03 −	.2 −	.01 −	.3 (1.2)			
Variance λ	.4 ± .06	1.9			1.3	1.9	1.0	1.1 (.6)			
All Fish											
D	30 ± 5	45				15		29 (.4)			
H	2.3 ± .12	2.0 (low among)	2.6 (high among)				2.15 (shift to high within)	2.3 (.1)			
$\hat{B}/\epsilon$	.4 ± .03	.15 $\hat{B}$ low slightly	.6 $\hat{B}$ high				.8 $\hat{B}$ high	.4 (.5)			
$\bar{B}_i/\hat{B}$	.4 ± .04	.75 $\bar{B}$ low	.3 $\bar{B}$ same				.3 (.7) $\bar{B}$ slightly high	.4 (.4)			
α	.2 ± .03	(%K slightly high c.v. high)						.2 (.1)			
$\%K_i/(B_i/\hat{B})$	.7 ± .01	.5 (1.0)	.9				.8	.7 (.2)			
D_i/K_i	.3 ± .04	.36						.3 (.1)			
H.M λ	.01 ± .001	.006 −				.07 +	.005 −	.02 (1.4)			
Variance λ	1.4 ± .15	1.9			1.5	1.1	1.5	1.4 (.2)			

For the first group, bluegreens, the most different station was the Danskammer Intake (DI) which would in effect be the station most affected by the power plant. Roseton Intake (RI) was also affected in every case in a similar way as DI, and the Roseton south control west station (RSCW) was also affected in a similar way with values like those of Danskammer Intake. Roseton-Danskammer East station (RDE) exhibited lower densities, while its diversity value was higher, as was $\overline{B}$, and the community niche breadth ($\hat{B}$) remained the same. The $\overline{D_i/K_i}$ ratio also remained the same as with RI and DI. Consequently, for bluegreens the Danskammer Intake (DI) station was the most different. Both the Roseton Intake (RI) and Roseton south control west (RSCW) station exhibited many identical differences to Danskammer Intake (DI). The RDE station possessed only one measure that was similar and two that were different than DI. The relative species niche breadth ($\overline{B}_i/\hat{B}$) and the relative community niche breadth ($\hat{B}/E$) were constant at the experimental stations and they inversely varied at the control stations as did the harmonic mean ($H.M._\lambda$).

For the green algal community, all niche measures except the $\overline{\%K_i/(B_i/\hat{B})}$ ratios, resulted in DI station being different from the others. The RSCW station exhibited some typical variation of about the same level of magnitude and the same qualitative type as that for the bluegreens, that is, the same community measures were affected. Also, for the RDE station the green algae were affected more in a similar way than were the bluegreen algae. Bluegreens exhibited variation at the RDE station and this may indicate why particular aspects of community structure were more like the rest of the control stations than the experimental stations.

In terms of diatoms, the DI station showed several differences. The RDE station showed a few differences although diversity was similar, and $\overline{D_i/K_i}$ was somewhat similar although it was between the typical

and median value and that of DI. Diatoms at RSCW were not as effective and were similar to other control stations. Thus, for phytoplankton groups, DI is by far the most different station, RI is slightly different, RSCW is different for bluegreens and greens, and RDE is also a different station but in different ways than for the other stations.

The phytoplankton as a group are given in the next page of the table, and the DI station is consistently different. The RI is only slightly different in regard to the $\overline{D_i/K_i}$ ratio. The RSCW station is not very different, while the RDE station showed quite a few differences although they were not at all similar to the types of differences at the DI station except with regard to niche breadth and $\overline{D_i/K_i}$ and to a lesser degree the harmonic mean and variance of the eigenvalues. Thus, the effects of the RDE stations were somewhat similar to those of the DI station, but not identical. In regard to overall seasonal patterns, the most different stations were those for diversity which were inversely related at the control and experimental stations, the relative species niche breadth $(\overline{B_i/\hat{B}})$, the community niche breadth $(\hat{B}/E)$ which also varied and especially the harmonic mean of the eigenvalues. Thus, there were some significant date differences with control and experimental stations.

For the rotifer community, the most different station was DI. The Roseton control stations (RNCW and RSCW) were only different in terms of diversity which was slightly higher over all and the RSCE and RSCW stations had slightly lower community niche breadth $(\hat{B}/E)$. The Roseton south control west (RSCW) station again was quite effective in similar ways, except for the stability measures as was DI. Most niche values over all stations over date, were not consistent over date, although the rotifer community generally had more

consistent properties than any of the others. Several individual niche measures varied over species.

The fish larvae were more difficult to characterize because the four stations are different from the plankton stations. The fish larvae community was sampled with four transects rather than the seven individual stations. The western stations which we would expect to be the most affected by the thermal plant, in fact did not show much variation. Each station showed two or three major differences across the river and there was no particular pattern except that density was lower nearer the stations, which is what might be expected if the plant were cropping off a certain percentage of the larvae. The diversity was higher in the western channel station, whereas it was lower in the west, at RSCW which was a poor place for fish species to be. There also were few adult fish at this station. The niche breadth measures were different in the eastern station and the stability measures were different at the RDE channel station. The temporal patterns and the changes in niche values were more consistent than they had been for rotifers, despite the general levels of increased variation.

On the third page of the table, the pelagic fishes are given. Different stations were also used. The first four stations are considered as controls and the last two as experimental stations (RDW and DC-20). In general, fish did not show many patterns in temporal stratifications, however, there were more differences among stations. The fish were abundant at specific stations but no single species was abundant at all stations. This is indicated on this table in that the community structure appears to be quite different from station to station. The differences in fish dynamics alone would necessitate the construction of different loop structures to model these stations. With more research and development,

these effects could be more clearly demonstrated, but it is fairly obvious that substantial station differences are present. The most differences appeared, however, to be related to the pelagic fish at the RDW and DC-20 stations in contrast to the community at the Roseton north control west (RNWC) station. This is a different result from some of the other animal groups. Also different was the Roseton north control east (RNCE) station as well as the Roseton north control west (RNCW), especially the northern control station on the east which agrees with some of the results we have had with other groups at the RDE station.

In the next intext Table, 20, many of the foregoing results are summarized for each station. At the Roseton north control east (RNCE) station, bluegreens were unstable while phytoplankton, in general, exhibited a higher degree of stability. The pelagic fish in this area showed the effects of over-domination of the white perch and in general, there were poorer conditions for the other fish. These results were reflected in the niche patterns. There was a low among-diversity, community niche breadth as well as the $\overline{\%K_i/(B_i/\hat{B})}$ ratio. The higher $\overline{D_i/K_i}$ values were also found because of this over-domination of white perch and in general, there were high coefficients of variation over species. There was a great shift to among diversity, higher density, lower overall niche breadth, and higher overlap and $\overline{\%K_i/(B_i/\hat{B})}$ ratios, with a concurrent decrease in stability. For all fish there was a higher density, unevenly low niche breadth, and $\overline{\%K_i/(B_i/\hat{B})}$ was low with a high coefficient of variation. $\overline{D_i/K_i}$ was higher with a lower consistency.

The Roseton north control west (RNCW) station had a slightly higher among-diversity for bluegreens and rotifers. There was a high among-diversity, high alpha and $\overline{\%K_i/(B_i/\hat{B})}$ values, somewhat lower

TABLE 20

Qualitative summary of community structure by station for all functional groups.

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI
BLUEGREENS	Low stability	Slightly high among H		Similar to DI Low among H Slightly high $\bar{B}$ and $\overline{\%K_i(B_i/\bar{B})}$ High $\bar{\alpha}$ and $\overline{\%K_i(B_i/\bar{B})}$ Low stability	Low density High within H $\bar{B}/\hat{B}$ and $\overline{D_i/K_i}$ high	Slightly low density Slightly low diversity Slightly high $\overline{D_i/K_i}$	Very good conditions High density Low diversity Niche breadth high ($\bar{\alpha}$, $\overline{\%K_i(B_i/\bar{B})}$), $\overline{D_i/K_i}$ high. Stability low.
GREENS				Lower within H Lower K High stability	High density Lower among H Higher $\bar{B}$ and $\overline{D_i/K_i}$	Low stability	Low diversity High $\bar{B}/\hat{B}$ High $\overline{D_i/K_i}$ High Stability
DIATOMS					Low within H High niche breadth		Good conditions High density no among H High $\bar{B}/\hat{B}$ Low $\overline{\%K_i(B_i/\bar{B})}$, High $\overline{D_i/K_i}$ Low Stability
PHYTOPLANKTON	High stability			Somewhat similar to DI Slightly low within H Slightly high $\overline{\%K_i(B_i/\bar{B})}$	Low density High diversity High niche breadth Higher $\overline{D_i/K_i}$ High stability	$\overline{D_i/K_i}$ slightly high	High density Low within H High niche breadth ($\bar{\alpha}$, $\overline{\%K_i(B_i/\bar{B})}$), $\overline{D_i/K_i}$, all higher High stability
ROTIFERS		Slightly high H	Slightly low $\hat{B}$	Poorest conditions Low density Shift to among H diversity Slightly low $\hat{B}$ High stability	Better conditions (similar to DI 20) Lower among H Higher $\bar{B}$ with more overlap while $\hat{B}$ same Lower $\overline{D_i/K_i}$ Low stability	Slightly low $\hat{B}$	Good conditions High density Low among H Higher $\bar{B}$ and $\bar{\alpha}$ Lower $\overline{D_i/K_i}$ Low stability

TABLE 20 (con't)

Qualitative summary of community structure by station for all functional groups.

	RNCE	RNCW	RSCE	RSCW	RDE	RDECH	RDWCH	RDW	DC20
FISH LARVAE					Good conditions No among H High $\bar{B}$ and $\bar{B}$ Low $\overline{D_i/K_i}$	Species B and $\bar{a}$ unevenly low Stability high	Low density High among H High $\%K_i(B_i/\bar{B})$	Low density Low $\bar{a}$	
PELAGIC FISH	shows effects of over domination of White Perch. IN general poor conditions for the other fish Low among H Low community niche breadth ($\bar{B}$) Low $\%K_i(B_i/\bar{B})$, higher D_i/K_i. High c.v. over species Somewhat lower density	Good conditions High among H Higher $\bar{a}$ and $\%K_i(B_i/\bar{B})$ Low stability	Slightly perturbed: Low overall density Lower diversity but generally higher niche breadth. Fairly high stability	$\%K$ and stability slightly low			Somewhat similar to RNCE and RSCE Low overall density with exception of Striped bass $\bar{B}$ slightly low $\%K$ slightly high Fairly low stability	Very good success High density High overall niche breadth High niche overlap Fairly low stability	
BENTHIC FISH	Peak of Brown Bullhead. Shift to among H High density Low overall niche breadth High overlap and $\%K_i(B_i/\bar{B})$ Low stability	Good success (D_i/K_i)	Peak of Hogchoker High density High stability	High % of Tomcod Low among H Low community niche breadth ($\bar{B}$) $\bar{a}$, and $\%R$ high Low $\overline{D_i/K_i}$ Low stability			Low overall density Shift to among H $\bar{B}$ same, but species Breadth ($\bar{B}$) higher, with more overlap $\%K_i(B_i/\bar{B})$ high. Good conditions.	Species uneven High among H Lower within H Species breadth ($\bar{B}$) low High $\%K_i(B_i/\bar{B})$ and D_i/K_i High c.v. over species Low stability	
ALL FISH	High density Low among H Unevenly low B's $\%K_i(B_i/\bar{B})$ low - c.v. high $\overline{D_i/K_i}$ higher Low stability	Good conditions High among H High community niche breadth ($\bar{B}$) High $\%K_i(B_i/\bar{B})$					Low density High stability	Fairly good conditions High within H Lower among H Unevenly high B's High $\%K_i(B_i/\bar{B})$ Low stability	

stability for the pelagic fish. The benthic fish were successful as indicated by their high $\overline{D_i/K_i}$ ratios. Fish exhibited high among diversity, community niche breadth and $\overline{\%K_i/(B_i/\hat{B})}$ values.

The Roseton south control east (RSCE) station differed only slightly in having lower community niche breadth for rotifers. For the pelagic fish, RSCE was a slightly perturbed area. There were lower overall density and diversity values, but generally higher niche breadths with high stability for the pelagic fish. For benthic fish, it was the peak area of the hogchoker which gave higher density and stability values to this group. The Roseton south control west station (RSCW) was similar to DI for the bluegreens, although it exhibited a low among-diversity, and slightly higher mean species niche breadth and community niche breadth, mean value of alpha, and $\overline{\%K_i/(B_i/\hat{B})}$ and, as for the bluegreens, stability was lower. For green algae, it possessed rather lower within diversity and K values with higher stability values. For phytoplankton, in general, RSCW was somewhat similar to DI with a slightly lower within diversity and higher $\overline{\%K_i/(B_i/\hat{B})}$ values. Rotifers exhibited a low density, a shift to among diversity, slightly lower community niche breadth, and higher stability. For the pelagic fish, $\overline{\%K_i}$ and stability were slightly lower, and for the benthic fish (since there was a high percentage of tomcod) there was a lower among-diversity, lower relative community niche breadth ($\hat{B}/E$), alpha and $\overline{\%K_i}$ were higher, with a low $\overline{D_i/K_i}$ and stability values.

In regard to the (peculiar) RDE station, blue-greens had a low density, high within-diversity, and the relative species niche breadth ($\overline{B_i/\hat{B}}$) and $\overline{D_i/K_i}$ ratios were high. For green algae there was a higher density, lower among-diversity, higher community niche breadth ($\hat{B}/E$) and $\overline{D_i/K_i}$. For diatoms, there was a low

within-diversity and a higher niche breadth. In general, phytoplankton exhibited a lower density with higher diversity, niche breadth, $\overline{D_i/K_i}$, and stability values. For rotifers, station RDE was similar to DC-20. There was a lower among-diversity and a higher mean niche breadth with more overlap while the community niche breadth remained the same. In addition, there were lower $\overline{D_i/K_i}$ ratios, and stability values. For fish larvae, there were good conditions here as well as for rotifers and phytoplankton. There was a high community niche breadth and mean niche breadth with a lower $\overline{D_i/K_i}$ ratio. The eastern channel station for the fish larvae had a high stability, but an uneven alpha and B values which are mathematically related. The western channel station had a low density, a high among-diversity and a high percent carrying capacity ($\overline{\%K_i}$) over relative niche breadth ratio.

At the Roseton-intake (RI) there was a slightly lower density, lower diversity, and higher $\overline{D_i/K_i}$ values for bluegreens, and greens exhibited lower stability. Phytoplankton possessed slightly higher $\overline{D_i/K_i}$ ratios. For rotifers, the niche breadth was lower at RDW. For pelagic fish, RDW was somewhat similar to the northern and southern control east stations. There was a lower overall density with the exception of striped bass which did well in this part of the river. The community niche breadth was lower, and $\overline{\%K_i}$ higher although there were fairly low stability indications for pelagic fish. Benthic fish possessed the lowest overall density and a shift to among-H diversity components. The community niche breadth was the same, but the species breadth (B') was higher. In general, there was little overlap and $\%K_i/\overline{(B_i/\hat{B})}$ was higher which indicated higher utilization efficiencies for benthic fish. This we might expect if heat influenced (and improved) their food supply. All fish exhibited a relatively lower density and higher stability in this part of the river.

The DI station was the most thermally affected for the plankton and fish larvae groups and DC-20 for adult fish. These stations showed the most differences as would be expected if they were affected by the power plants. For bluegreens, there were good conditions (higher values of density, niche breadths, alpha, $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$ while stability and diversity were lower). This result was directly related to the superdominance of Oscillatoria sp. For greens, there was a lower diversity but a high relative species niche breadth $(\overline{B_i/\hat{B}})$, $\overline{D_i/K_i}$, and generally higher stability. Diatoms exhibited a high density, less among-diversity, higher relative species niche breadth $(\overline{B_i/\hat{B}})$ lower $\overline{\%K_i/(B_i/\hat{B})}$, lower stability and higher $\overline{D_i/K_i}$ ratios. For the all-phytoplankton, the density was higher but within-diversity values were lower. Values for niche breadth, alpha $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$, and stability were all higher. It is expected that from the heat effect in the loop structure the algae would be improved and also in regard to the fact that some of the predators, or predators of predators, were cropped off, the algae might be less subject to predation pressure.

For the rotifers, there were generally good conditions at Danskammer intake (DI). There was higher density and low among-diversity, higher mean value of species niche breadth and $\overline{\alpha}$, and lower $\overline{D_i/K_i}$ and stability values. For fish larvae, the closest station was the RDW station which had a lower density and lower overlap value as we would expect if the plant were substantially cropping off fish larvae. Pelagic fish exhibited a high density, niche breadth, a niche overlap, but fairly low stability values. For benthic fish, the species were relatively uneven in their niche characteristics. There was a high among-diversity but a lower within-diversity. Species breadth was lower while $\overline{D_i/K_i}$ and $\overline{\%K_i/(B_i/\hat{B})}$ were higher. There was generally a high coefficient of variation over species and a lower stability.

In summary, the community structure comparisons of the various station illustrate that the DI station is different from the others. Hall (1975) has shown a large percentage of the river near the plant and much of the total river flow passes through power plants in a given time period. Consequently, we would expect that the Hudson River power plant at Danskammer point would significantly influence local communities of organisms. Even though DI was sometimes sampled differently, in all probability, many of these effects represent changes in community structure that are real and probably can be related to the power plant itself. The RDE station is also notably different. We will discuss this paradox in Section C.

3. Community Stability and Thermal Perturbation

In the final summary of stability values, a qualitative designation system is used to indicate increased or decreased stability for separate stations as well as combinations of all, control and experimental stations (Table 21). Parentheses indicate that the measure is slightly more stable or unstable depending on the sign, while circled values indicate the most unstable, or conversely, the most stable conditions. There are seven general trends: plus and minus with and without parentheses, plus and minus circled, as well as a blank which would indicate just average stability. The measures are based on harmonic mean of the eigenvalues, and the arithmetic mean and variance of the reciprocal eigenvalues. In the last column of the table the harmonic mean ($H.M._{\lambda}$) and variance (S^2_{λ}) of the eigenvalues with their coefficients of variation are given in parentheses for each of the 13 subcommunities.

The mean reciprocal eigenvalue is probably the most reasonable and consistent measure but it is difficult to use and identify consistent patterns because of its high range of variation. Since the harmonic

Key-
−/+ unstable / stable
(−)/(+) more unstable / stable
⊖/⊕ most unstable / stable

TABLE 21
Qualitative summary of community stability by station for all functional groups.

	RNCE	RNCW	RSCE	RSCW	RDE	RI	DI	ALL	CONTROL	EXPERIMENTAL	Dominant Eigenvalue VAR. λ [mean (C.V.)]
PHYTOPLANKTON	+		(−)		⊕	⊖	+			(−)	.68 (.6) .70 (.1)
BLUEGREENS	−			⊖	⊕		−			−	.02 (1.4) 2.6 (.5)
GREENS	+			⊕	(+)	⊖	+			−	.03 (.8) 3.0 (.03)
DIATOMS	⊕	+		(−)			⊖			−	.01 (1.4) 3.5 (.2)
BIOVOLUMES								+			.4 (.3) 6.9 (.2)
SMALL										−	.1 (.6) 3.3 (.3)
MEDIUM										−	.1 (.4) 2.1 (.1)
LARGE										−	.2 (.4) 1.6 (.01)
ROTIFERS				⊕	−	(−)	⊖			−	.32 (.5) 1.3 (.3)
FISH LARVAE				RDE	RDECH ⊕	RDWCH	RDW ⊖			−	.63 (.4) .49 (.6)
FISH	−		(−)			⊕	⊖	+		−	.02 (1.4) 1.4 (.2)
PELAGIC	+	⊖	⊕			−	−	+			.21 (1.1) .95 (.6)
BENTHIC	⊖	+	⊕	−			−	+		−	.26 (1.2) 1.1 (.6)

mean is inversely proportional to the mean reciprocal eigenvalue, H.M.$_\lambda$ is a good and simple measure for comparisons across station. The variance of the lambdas and especially the kurtosis and skewness as shown by the phytoplankton results is sensitive to the number of species and the number of environments. Thus, these measures are not as good for comparisons where sampling differences are great. Also, since they are mathematically related, there is a correlation from which the differences must be distinguished. Because of these theoretical problems, therefore, they cannot be used in isolation, but rather the patterns among them must be examined, also taking account of the differences in E and N. When these measures are understood better, however, they should give a more detailed picture of stability then does the harmonic mean of the eigenvalues. Since they are probably not dependent on the absolute value of the eigenvalue, or minimum eigenvalue, they are probably less dependent on biomass and may be the best measures to compare station groups as well as to compare stability of cross-functional groups. Note that since the arithmetic mean of the lambdas is one, the square root of the variance equals a standard deviation of the lambdas or the coefficient of variation of the lambdas.

The intext Table 20 shows the most stable communities were the diatoms at the Roseton north control east station (RNCE), the greens at the Roseton south control west (RSCW) station, and the rotifers at the Roseton south control west (RSCW) station, the all phytoplankton and bluegreens at RDE, and the fish larvae at RDE, and the adult fish at RI. The fish larvae were very unstable at RDW near the plant which is what we would expect if impingement and entrainment were significant. Also, the fish had negative stability in this area, but increased stability in the western part of the channel. This is possible because they were hurt by impingement in the more inshore areas but helped by the addition of heat through

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the food resource pathways slightly farther out on the western side of the river. In regard to the north control stations, generally, the western station was unstable for the pelagic fish and the eastern stations for the benthic fish. This also indicates the Wappinger's Creek inflow is not good for the benthic community in general. The Roseton south control east (RSCE) station was the least affected of any station, stability was good for both the pelagic and benthic communities, although, considered as whole, the station was slightly unstable. The bluegreens were less stable at the north control east station, the south control western station, and the Danskammer-Intake. This latter result was because of the large bloom of Oscillatoria sp. in that area. Most all of the experimental stations were generally unstable, especially for all phytoplankton.

C. SOME PARADOXES AND SPECULATIONS

1. Ecological Versus Mathematical Artifacts

In this section, we handle only a few of the paradoxes. Some of the unexpected results may be due to mathematical artifacts or biological peculiarities. Unfortunately, most of the data are not adequate to resolve these questions. Undoubtedly in the stability results there are several new ideas for development of ecological theory. First, in terms of trying to delineate mathematical versus ecological artifacts, there were some general results. For example, there was greater variation in stability measures. This comes about because of the range of values that eigenvalues can assume. Consequently, this mathematical reality generated concepts of ecological instability when in fact these results were due to the mathematics. Second, several of these measures are correlated in various ways. For example, a rise in the $\overline{D_i/K_i}$ ratio will often mean that $\overline{\%K_i/(B_i/\hat{B})}$ is getting smaller. This is an obvious correlation.

A less obvious correlation involves the skewness of the eigenvalues that increase when the minimum eigenvalue increases, or when the reciprocal maximum (max $1/\lambda$) eigenvalue increases and the kurtosis of the eigenvalues decreases. These are just two of the many mathematical relationships in the niche measures. Several correlations are non-obvious and remain to be discovered. Third, the statistics and sampling theory are incomplete at this time, and it is often difficult to delineate artifacts from real results.

2. What is Ecological Success?

This is an extremely interesting question, which has no ready answer (Lane and Wright 1977). Every species present on the earth can be considered successful in the sense that to persist through a perilous evolutionary history is to succeed. Many of the results that we obtained in this study center on this central question of defining ecological success. In terms of community structure values, it is tempting to assume an increase in mean alpha, diversity, $\overline{\%K_i/(B_i/\hat{B})}$, $\overline{D_i/K_i}$, relative species niche breadth $(\overline{B_i/\hat{B}})$, and relative community niche breadth $(\hat{B}/E)$ are indications of less variable community structure.

In this set of data (at only one point in the river and for only four functional groups of organisms), there was a considerable array of possible combinations of niche values. It is possible, if we knew enough about the network diagram, that particular aspects of community structure for particular groups will appear unstable yet, enhancing the overall ecosystem. Species can operate at suboptimal levels in their ecological networks and even select themselves to extinction (Levins, 1975d). For example, $\overline{\%K_i/(B_i/\hat{B})}$ of the phytoplankton may be more variable, so that $\overline{D_i/K_i}$ of the zooplankton

is a more stable measure. If we knew enough about ecosystems, their stability and instability, the consistency and variability of various measures would become more obvious. There is no ecological theory available that predict that particular measures of a group should converge or diverge from particular values, that their variability should be at some level or that particular measures should be ecologically (not mathematically) correlated. That these measures will have particular values or can have certain probabilities and predictabilities attached to them, is undoubtedly a development for the future. Thus, value judgments concerning niche values are basically subjective at the present time.

3. To Be or Not to Be Stable

We have used the term stability extremely loosely. Orians (1974) indicates there are several ways to look at stability. Holling (1973) has also emphasized particular definitions of stability. Numerous discussions of stability can be found in the Siam volume (Levin 1975) and the proceedings of the First International Congress of Ecology. In all, no one is sure what stability is and only vague notions exist denoting it as a desirable component of natural communities.

Throughout this study, we have only measured some components of community structure and stability and these measurements have been differentially accurate and precise. Some of our approximation formulae are better than others. The difficulty is that so much of the application of these measures is experimental at present, and it is difficult to evaluate and delineate which measures are the most statisfactory ones.

If we assume that we are measuring real components of community structure and stability, then several paradoxes have arisen. It is

clear from the results in this study that the concepts and ideas, as well as a cloud of metaphor that surround stability have to be elucidated. A great deal of development is needed.

In this study, mathematical theory from the physicists and mathematicians has been used to develop a set of criteria that indicate enhanced stability. In terms of the biology, certain of our communities (or data stratifications) that we believe to be quite unstable show enhanced stability. The reason we believe this is true is that the play-off of various components or sources of stability come from different places, through different network pathways and in some instances, these pathways work against each other and in other instances work with each other. Thus, what appear as conflicts in the final results are probably related to the fact that "stability" is actually more than one type of ecosystem property. While certain variables will approach stability through enhanced biomass, others will approach stability through fast turnover rate or some peculiar physiological or behavioral characteristics. Consequently, for example, when we had increased stability with the fish larvae, this indicates some aspects of particular functions that they are playing in the community at that time, but not necessarily that their overall system is more stable. The true effects of stabilizing one part or subcomponent of an ecological system in relation to the rest can probably only be delineated through loop analysis or some variation thereof. Consequently, in this study, all we can do is speculate as to several things that may be happening with these measures. Unfortunately, because we did not have the middle groups of organisms validation for several hypotheses and predictions was impossible.

This explains why particular blooms can appear stable when in biological reality we know they are not so for very long. This is

not to say that the other members of the community are affected by the bloom, it just indicates that with enhanced biomass, there are certain types of stability that can be contributed to a community even under bloom conditions. It is also related to the playoff between relative abundance and biomass. One or more of the eigenvalues and their respective vectors are mostly concerned with measuring biomass in a community. Consequently, when one species becomes very dominant, for example, during bloom conditions, the system then can be mathematically more stable due to this particular component, while it becomes more unstable in terms of other components that depend more on relative abundance patterns. Thus, in terms of "ecological success" there are certain components of stability that may appear to be desirable in a mathematical sense yet are not in an ecological sense. Thus, we need to sort out ecological stability components and anchor them in terms of species biology and community structure. Part of the resolution of this problem will come from taking particular value judgments on what we consider ecologically desirable. How do we delineate, for example, when the large biomass in an oak hickory forest is desirable and when a bloom of bluegreen algae is not?

How do we delineate these systems which are in one sense mathematically, and in another sense functionally very similar at an instance but very different over the long term? Probably this can be resolved with loop analysis, and also since loop analysis centers on temporal relationships it may be possible to work on the play-off of space versus time for resolving some of these questions. A dominant bloom species differs more in temporal relationships with its community than does an oak hickory forest, but at an instant some of its spatial characteristics do not.

In regard to the second stability problem, global versus local stability, we found in particular situations that the community was stable globally, but not stable locally (plankton). In another situation, this trend was reversed. For example, the adult fish appeared to be locally more stable and globally more unstable. These results are probably closely tied to the problems in sampling designs. Usually species could exist at any station that was sampled. The fish, however, were more restricted in that no one fish species did well at all stations, although several species were highly successful in a local sense. The habitat requirements of fish are more specialized and their behavior is such that they can restrict their habitats by choice. Much of the choice that a plankter has is a passive one, either survive or go extinct and while plankton possess an impressive array of adaptations, they do not possess much behavioral flexibility.

In regard to sampling problems, often times there were not enough environments in the local sense to characterize the distribution of the species. This was especially true for the phytoplankton. Thus, because the number of cases in the global calculations increased, it is undoubtedly true that much of the global stability came from the fact that on a larger scale, there was a better ecological characterization of the species than for local environments. For example, in phytoplankton, the forty-two environments were used to construct global patterns while only six or seven data points were available per station.

In analyzing stability phenomenon there is probably a play-off of four factors: biomass, evenness and frequency distribution, turnover rates and time functions, and variability. Resilience, rate of return and persistence are nonlinear combinations of these factors.

The mathematics and our ecological understanding are presently inadequate, as to how we should best relate these various stability components to the measures that we can quantify. For example, in terms of variability, the variance of D affects the variance of K. Stability will increase with increased variance and density. The other indications of stability are directly related to $\overline{D_i/K_i}$ and the strength of this relationship proportional to the variance of the K's. Consequently, if the K's are more even and less variable we can be much more predictive in our stability interpretations. Likewise, the variance (S^2_λ) and minimum eigenvalue, which is a significant measure of stability, depends on the variance of K. In general, our results have also shown that complexity does lead to instability given our particular determinants of stability. Usually the largest eigenvalue varies the most. Its percent variation (in comparison to the other variables) and how the variations correlate with each other are important. For example, if N is constant, then the largest eigenvalue is correlated with biomass. Perhaps a more basic question is: Are the eigenvalues a good measure of stability? We will not be able to resolve this problem completely until we can resolve the variability of $\overline{D_i/K_i}$ times r ratio (Lane, Lauff and Levins, 1975). Presently we only have enough data to do this for Gull Lake plankton.

For river wide phenomena, the variation in D decreases and there is decreased stability across species for a given environment. If the variance in K decreases, there is increased stability. The play-off between variation and species in one environment, and variation of species across environments is not the same and does not contribute in the same way to stability measures. Many of the sampling problems will be damped out globally and this fact also probably accounted for the enhanced global stability of the phytoplankton. This is another reason why our global versus local stability results

are not completely consistent and explainable. In terms of blooms, if one environment experiences a bloom on one day, stability can increase. There is more variability across species and density at one station leading to this enhanced stability. Or, there can be more variation at one station over time that can decrease stability, so that we have again the play-off of species density versus temporal consistency in regard to interpreting the stabilitiy measures. In these situations it is not always clear how the variance in K will change. With more species, generally global stabiliity decreases because of the increased possibility of disjunct sets of sub-communities in local environments. Consequently, in a bloom, the local community can be more stable during the period of the bloom but generally more unstable over the long run. Thus, many refinements in stability measures are needed both for the evaluation of local and global stability and the delineation of transient stability from what we might term regular stability.

A third and significant paradox related to these stability measures is that they are sometimes negatively correlated with what we consider to be community structure characteristics. Part of this problem is due to mathematical artifacts and sampling inadequacies, and another portion is related to our inadequate knowledge and understanding of community structure and stability. It is possible that what we define as mathematical stability may be inconsistent with what we think of as biological or ecological stability. Or it may be that integrity and stability are not synonomous. It is going to take considerable development to explain this paradox that arose with many of the results.

4. Perturbations and the Ecological Network

It is also necessary, with all the paradoxes mentioned above, that we be aware of how and where particular perturbations enter the

ecological network and affect the niche patterns. Are the perturbations natural or unnatural in the the sense of speeding or slowing existing pathways or in creating or destroying other pathways? For example, we discussed the problems of trying to delineate the impingement and entrainment perturbations, the thermal perturbation, the salt front intrusion, the Wappinger's Creek inflow phenomenon, and countless other types of perturbations that are present but unknown in the Hudson River. Hopefully, most of these unknown perturbations that are occurring sufficiently either downstream or upstream to affect most of the stations in a similar manner.

There was also another interesting result -- the interaction between station and date. This can be seen by examination of the phytoplankton data. Unfortunately, there were not enough data to construct two-way stratification from which interaction effects could be calculated. What this means is that the different stations had different species sequences over time and at a given date the stations were different. Again if we hypothesize that there is a thermal perturbation that acts through the normal temperature pathway, this would affect some stations by distinguishing them from the other in a seasonal sense. This is an extremely interesting result, if it could be further documented, or evaluated in a more quantifiable way. Thus, if temperature speeds or slows particular seasonal results, the interaction term should facilitate the documentation of this result.

D. SOURCES OF ERROR AND BASES FOR GUARDED CONCLUSIONS[1]

Throughout this study, there have been many sources of error and other associated problems contributing to the tentative nature

[1]This section integrates with $\overline{V}$ C and $\overline{V}$ E and the three sections should be read as a unit.

of the study's conclusions. Some of these problems are sources of error in the more traditional sense; including the type of samples used, errors in the laboratory processing of samples, numerical errors in transcribing data points, etc. Another set of problems is associated with the fact that the theory is not complete. Yet a third set of problems is the fact that there was not time or financial support available to finish the study in the best possible way given the present state of the theory and technology. These sources of error and problems related to these three general categories are discussed below.

1. Sampling

a. Field Sampling

The sampling program used in this study was not planned in advance for the application of niche analysis. Therefore, many of the problems in trying to use these data centered about this general problem of lack of prior planning. Thus, many samples that were taken were not usable. This was especially true for the adult fish. Also, the sampling design in both a spatial sense and a temporal sense was not always appropriate or adequate, thus, many needed samples were not collected and their loss is irreparable. Finally, several of the laboratory analyses, in particular, identification and enumeration of organisms were inadequate.

Since many of the niche measures are summed over environments the definition of environment becomes critical. When we began this study there were no firm criteria to separate experimental from control stations, nor even adequate descriptions of the actual sampling stations used. We have attempted a beginning

of this problem of defining an environment in this study. Also when the environmental characteristics of each station were listed from the available information, it became obvious that many of the stations were not as appropriate as they should have been. In future studies, a list of definitive characteristics ($\bar{X}$ and SD) should be generated for each station, especially in relation to the major questions to be answered and hypotheses to be tested. Stations should be selected in regard to some definite pre-established criteria.

In particular, the stations involved in the present study were not adequately delineated in regard to the thermal perturbation, yet, this was the main parameter of interest. We had expected a company that was previously based solely on engineering expertise to have good measurements of the thermal plume and general river characteristics. In contrast, there was not much data available on the plume or its relation to the biology of the river species for 1973. Consequently, this lack of information made characterizing experimental versus control stations difficult. Many of the stations were taken only with a general reference to the thermal plume when a more detailed selection of stations could have been made on the plume characteristics that were known, however incompletely. Also, every time a set of samples is collected, associated light and temperature measurements should also be taken. Consequently, in interpreting results we had to group sample results and physical-chemical information together that were taken at vastly different stations and time periods than those of prime concern in regard to the biological community. Thus, often the environments from which the biological samples were taken were not adequately characterized even in regard to simple parameters such as temperature, which is relatively easy to measure in the field and yet of major interest to this study.

In general, as with the particular problem of the physical measures, sample collections were not well coordinated. Thus, it was difficult drawing some of the types of comparisons that would have been desirable between and among functional groups or sub-functional groups such as the thirteen categories used in this study. Thus, in order to complete a successful niche analysis for an ecosystem, sample coordination is probably as critical as the initial sampling design per functional group.

In addition, there were more general problems of sampling frequencies in space and time. Because of mathematical difficulties (to be discussed below) more environments should have been sampled. The statistical theory is at present incomplete and the optimum number of environments is yet to be determined but generally the data in this study were too sparse, both in terms of calculating the niche measures and the statistics to test significance among the resultant values. Essentially there were not enough data points to characterize the distribution patterns of the rare species as well as the abundant ones. This problem leads to the generation of additional mathematical artifacts in ranking species in selected environments in an attempt to use as much data as possible for niche analysis.

We have discussed several of the spatial implications in defining the environment (h) used in niche analysis. Temporal considerations are also important and sampling design should be based on at least general estimates of species turnover times.

b. Biological Considerations

Niche analysis is centered around resource or indirect competition where species do not compete by interfering with each

other but rather by their indirect use of a dwindling food supply or resource of some type. Much of the development of niche theory is based on a one dimensional concept, however, we know in nature that usually two or more niche dimensions are operating.

The basic assumption, inherent in the analysis, is that the intensity of overlap is directly proportional to the probability that individuals of the two species will meet in attempting to utilize a limiting resource. The probability of co-occurrence formula can be applied only to habitat selectors with validity, that is, species which alleviate competition by using different spatial-temporal positionings. This assumption holds reasonably well for populations of filter feeding zooplankton which are considered to exhibit generalized feeding behavior. Many other types of aquatic organisms are also generalized feeders although it is still an open experimental question how validly the analysis can be applied to other groups.

The basic alpha approximation does not give a good measure of the intensity of overlap for species which are resource allocators, that is, species which alleviate competition by utilizing different resources in the same space and time. For example, a species pair, having α_{ij} equal to .9 and α_{ji} equal to .9 by the probability of co-occurrence formula, may not be competing at all because the species may be resource allocators. Species 1 may consume net phytoplankton and species 2 nanoplankton. Thus, the analysis is useful, however, in determining which mechanism of competitive coexistence may be operating.

There have been few documentations of competition in the field. In an open water system, it is almost impossible to document

competition by proving a particular species is reducing the population growth of another species. We can only assume competition occurs from several types of indirect evidence and often times the evidence is difficult to obtain and even more difficult to interpret. Since the competition has been documented in the field only in isolated instances, it is critical that as much species biology as possible is known so that identification sets of potential competitors is as accurate as the current state of knowledge permits.

There were several other biological considerations in addition to those mentioned above in the field sampling section. In general, the species biology even for the dominant species in each of the community groups is not well known. The analysis assumes that only systems of competitors are included in a given matrix. In many cases, it was difficult to determine which species should be grouped together. For example, one can group trophic categories directly, or use other measures such as size as with the phytoplankton, or habitat preferences with the adult fish community. Consequently, often more biological knowledge is needed than just trophic considerations. For example, phytoplankton size may become a more reasonable approximation of competitive ability than taxonomic group. While taxonomic groups are of some evolutionary significance, they are not always meaningful ecological categories. Since species are in one sense human abstractions, we must be careful not to be carried away with our abstraction. Selecting species for community matrices entails keen biological intuition and intimate knowledge of the system, especially when considering such a diverse group of organisms contained in total species list of the Hudson River. We were acutely aware of this problem because of our general unfamiliarity with Hudson River species.

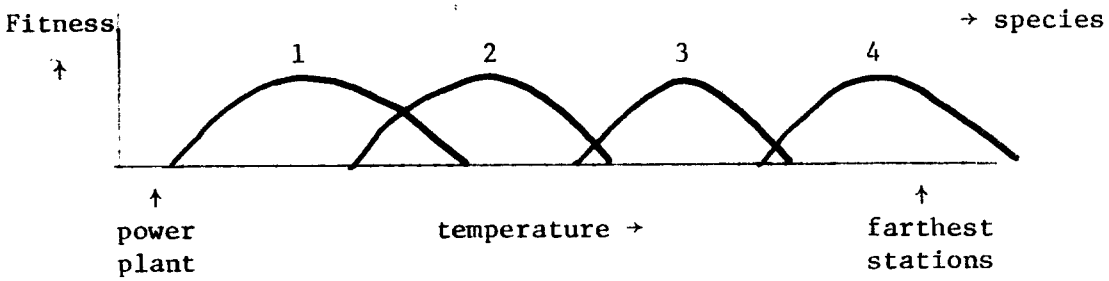
There are also many other theoretical and biological problems in measuring the community structure of an assemblage of organisms in nature. For example, if a resource is turning over slowly and if the resource itself is moving, for example, phytoplankton moving up and down in the Hudson River estuary, then herbivorous species can be in two parts of the river but consuming the same phytoplankton resources simultaneously. Thus, these species are in competition even though they never meet in nature. Likewise, even though species are co-occurring in using a given resource state, it may be so super-abundant in a given environment that it is not limiting. Several fish species can be present in the Hudson River at a given time of the year, but some of them are not eating during spawning season or really in any way interfering with the other species. Thus, they are essentially not competing at that time of the year although from probability of encounter estimates they could be expected to. Again there is no substitute for a good understanding of the species biology.

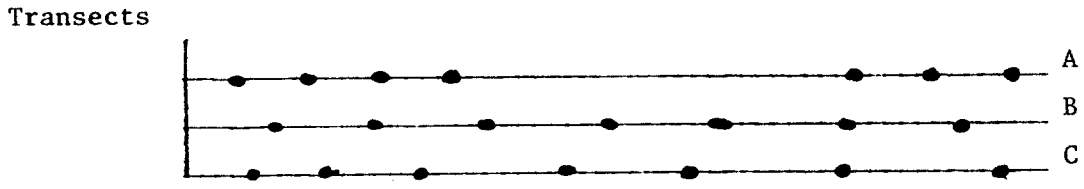
To alleviate some of the problems mentioned above, it is desirable to maintain a species file which facilitates the accumulation and storage of information on the species biology that would be useful for a variety of analyses. A species file includes not only size and other critical aspects of species types for classifying the species, and understanding their biology, but it also aids in selecting the environments that should be sampled in the field sampling program. For example, those species that migrate and are most active at night would have a different sampling plan than those that are active in the day. To date, much of the biological information needed for an adequate sampling plan to represent the community has been largely ignored.

There were also other general taxonomic problems; such as too much lumping or too much splitting. These problems are also related to those mentioned in the preceding section, involving inadequate numbers of samples necessary to characterize the community. In this particular study, the rotifer species are probably lumped too much, and the phytoplankton species were split too much. It was difficult to obtain enough ecological data on 115 species of phytoplankton when, in fact, several could probably be lumped with no concurrent reduction in the understanding generated by the analysis.

There were several types of sampling problems which relate to the inadequate understanding of the species biology. There are the general types of sampling errors related to the selectivity of samples, counting in the laboratory etc. Also, when data are collected, we tend to forget the theoretical framework in which they were collected. For example, if a one-meter net is used and the sample contains species a, b and c, they are grouped as constituting a community, where in fact, their grouping is a human abstraction based on the particular sampling method and sampler used. Thus, it should be stressed that often to obtain an adequate representation of a given community more than one type of sampler and/or sampling program is needed. For example, the adult fish community in the original 1973 study was sampled by seines, gill nets and trap nets. Because samples were not coordinated in a meaningful way, it was not possible to use all of these data, however, this overall strategy would be one way of achieving adequate sampling of the community. The fish larvae included particular species or groups of species that were selected depending on the size of the collection net, that is, one meter, or half meter. Macrozooplankton that were not

Figure 11: Diagram illustrating sources of error involved in sampling at extremes of species ranges.[1]

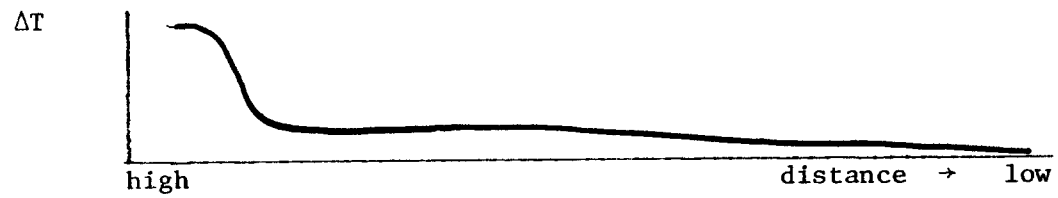




A = transect north of thermal plume running up river from power plant

B = transect east of thermal plume running across the river from the power plant

C = transect south of thermal plume running down river from power plant



[1]Adapted from Colwell and Futuyma (1971), Figure 1.

reported upon in this study were collected in four different sampling programs: microzooplankton, benthos, fish larvae and macrozooplankton.

Consequently, one must always be alert to the fact that the sampler is selecting a portion of the species with some bias, and that often ecologically-meaningful units must be constructed from more than one type of sampling program. Also, there is the added problem that when this occurs it is necessary to have good error estimates so that the samples can be grouped together and used in one set of data stratifications. In general, the theory is not completely developed for this, however, a more realistic sampling regime is dependent on a good sampling theory.

Lastly, one of the most important considerations in terms of species biology is understanding ecological space and time, which has to do with how the organisms perceive the spatial-temporal aspects of the environment. Every investigator includes with his sampling plan his particular ideas and biases in regard to the types of environmental heterogeneity that are important to the organisms.

Much of the preceding is related to what Colwell and Futuyma (1971) discussed in terms of error range, spacing and nonlinearity in delineating the species distribution over a given set of environments. Some of these problems are diagramed in Figure 11. In the top part of the diagram the fitness curves for a set of species over an environmental gradient, namely temperature effluents coming from a power station, are given. Species one has a higher thermal tolerance than does species four. The bottom part of the diagram indicates how temperature is changing

(ΔT) from the power plant to the most distant station. Temperature is changing the fastest, closer to the power station, and for quite a distance away ΔT is low. Thus, this is a particular type of environmental gradient that the species would be subject to, and would be one of the more interesting components related to a thermal perturbation study.

In the middle of the table are three hypothetical transects of how the data could be collected. Transect A shows that only the extreme areas where ΔT is rapid (the greatest, and the least) are sampled. Transect B illustrates equal spacing of the samples regardless of ΔT and transect C shows more closely-spaced samples where ΔT is the greatest,and far-spaced samples where ΔT is the smallest. This last type of transect then, would be probably more ecologically meaningful than the first two although each involves biases. For some of the LMS 1973 data collection programs, the transect A type sampling design was used, thus, only the extremes were sampled as with the plankton communities. Sometimes transect B type sampling was used, for example, the adult fish collections, with equally spaced trawls across the river. In using any of these types of transects the niche measures, for example, alpha and niche breadth, will change. Therefore, it is critical to have some understanding of the associated problems: 1) what type of sampling program will be used, and 2) how it will represent the particular environmental gradients and species distributions under study. In this study, sampling was generally not conducted to consider thermal gradients directly. Thus, many of our results on thermal effects are probably underestimates. With a slightly different sampling program, it would have been possible to measure thermal effects more effectively plus add some new results from gradient theory. As a rule of thumb, however, it

is usually better to collect the samples at equally-spaced intervals unless enough is known about species biology to warrant a more sophisticated sampling design. One exception to this general plan includes the environments in which a gradient is known to exist such as the thermal gradient at Roseton-Danskammer.

May (1975) has discussed several of the problems relating to sampling gradients, or what he terms resource-states. There are several peculiarities generated when only one resource axis is used, that is, the one dimensional niche. May (1975) describes ways that alphas can be calculated when there are two or three dimensions. For example, in Figure 5 for species E and D, if one were to measure the overlap values in terms of phosphorus concentration in the units that are indicated on the axes (within the two vertical dotted lines), species E and D are both using the same phosphorus concentrations in the environment. Likewise, at a given light intensity, (indicated by the horizontal dotted lines) they are both using similar light concentrations. If just one axis were used for the measurement of ecological overlap ($\bar{\alpha}$) the species would be shown to be strong competitors for that particular ecological factor. Yet, in their two-dimensional space species E and D do not overlap and they are not competing directly.

As several more dimensions are added to a community analysis many species that would overlap in the n-dimensional space do not overlap in an n+1 dimensional space. In conducting gradient work in the future, however, dimensionality and more sophistical gradient analyses will become more important. Much more effort will be needed to measure niche dimensionality, which is the largest part of niche analysis that is still undeveloped. This

parameter will be critical to develop if we are going to achieve accurate analysis and integrated interpretion of the results we obtain from niche theory.

We attempted to solve the problem of reconciling the theoretical parameters to the actual sampling and data collection, however, it was necessary to conduct various manipulations of the data, employing dubious weighting procedures to correct biases. Many of these problems could and should have been corrected before the sampling program was initiated. These data manipulations are discussed below. In the future studies, more care should be given in the sampling design, and data collection and application of niche analysis. Regardless of the abilities and intuition of the investigators, biases inevitably creep in and complicate the evaluation of ecological reality.

Many of the problems mentioned in this section are not unique to this particular study; on the contrary, they include the general errors involved in any study of natural communities. This particular study, however, involved a disproportionate set of problems both in their number and severity that could have been partially alleviated with prior planning.

2. Data Analysis

There are also two sections to this part, first, the mathematical and theoretical problems; and second, particular problems with the data used in this study.

a. Mathematical and Theoretical Problems

(i) Matrix Peculiarities

Several peculiarities existed in the present study due to the particular way that alpha is calculated. First, because

symmetric terms have their numerators in common, the alpha matrices generated in this study are skew with properties similar to positive semi-definite ones. Thus, no complex parts can be generated in regard to stability calculations, and only relative degrees of stability can be examined. Oscillatory systems cannot be delineated or evaluated. This results in a set of associated problems with the stability measures, some of which have been already outlined in Section 3 in Mathematical Methodology. Also, because so many rows and column are linearly-dependent, many other problems arise in the stability measures. Dependency can arise in two ways: first, rows and/or columns are identical because adequate information to characterize the ecology of the species was not collected. This was particularly evident when analyzing the phytoplankton community, where often times there were two rare species that occurred only once in a given environment, and never again throughout the study. Therefore, their row and column elements for the ^{P}matrix* would be identical. Immediately the determinant is zero and consequently, several of the eigenvalues are zero. Second, positive semi-definite matrices have either positive or zero determinants. In the case of zero determinants, all of the related stability problems are also present.

There are several assumptions that come into consideration when using the alpha matrix. For example, we assume that the community is at equilibrium or at worst in some sort of

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*^{P}matrix is the frequency values of species (p_{ih}) used in niche analysis.

a moving equilibrium within its limit cycle. Some of the overall types of evidence for equilibrium or quasi-equilibrium include regularity from other ecological communities (in particular the Gull Lake system) which leads us to believe that the equilibrium assumptions are probably valid, at least for some aquatic ecosystems. In contrast, the fish larvae (unstable) and phytoplankton (stable) results in this study also substantiate the validity of the equilibrium assumption. It is still an open experimental question, however, to what degree equilibrium conditions are present in ecological systems. This would be particularly interesting if not crucial to evaluate in the Hudson River ecosystem which is a dynamic tidal estuary, and where equilibrium would be expected to be more dubious than in a small lake with a low exchange time. At any rate, more work is needed on this interesting problem.

Another consideration is the fact that alpha is not a constant but is treated so with static data. We attempt to study the dynamics of the system by stratifying alpha over time. Even more basic than the preceding consideration is the assumption that the alpha matrix is equivalent to the matrix of first partials, the Jacobian, with which traditional stability theory is associated. From data gathered on the Gull Lake system, which are still incompletely analyzed at the present time, it appears that the alpha matrix can be considered somewhat equivalent to a Jacobian. Much experimental work needs to be done, however, on the Hudson River species in terms of growth and turnover rates to resolve this particular problem more satisfactorily.

In terms of peculiarities generated in using the probability of co-occurrence alpha that is used in this study, these problems could be avoided by using several other alpha formulations which we did not have time to develop and apply in the present study. Usually the more sophisticated and detailed alphas necessitate more detailed sampling and field experimentation.

Lastly, there is also the annoying problem that there is still no convenient measure for niche dimensionality. We have made some progress, though, on this problem in regard to the Bedford Basin community. Although, theoretical development is probably straightforward, this parameter is an important one we were not able to quantify at the present time (see above and following discussion).

(ii) Statistical Considerations

Associated with all the mathematical problems are statistical ones, many of which were beyond our expertise. In general, the biggest problem is that no sampling theory exists for niche analysis at the present time. We have no error estimates for inaccuracies in the data, thus, in constructing a sampling theory the error itself must be treated as a variable. Since there was no sampling theory, there was not sufficient information about the distributions of any of the niche parameters for community structure or stability. We made an initial attempt in examining their distributions by calculating skewness and kurtosis measures for the alpha and eigenvalue distributions, however, an adequate sampling theory would provide us information on the other moments of the distribution as well as confidence

intervals and error estimates. Sampling theory would also involve the validity of the basic assumption of normality in employing parametric statistics. Also, it would have given us the information as to how sensitive each of these niche parameters is to sampling design and methods including: how many environments must be sampled to obtain adequate information for the characterization of the species and community biology. All of the preceding information, if available, would provide for sound statistical testing of niche results. Initially it is necessary to evaluate the results with statistical tests (in this study: coefficients of variation, ANOVA, and t-tests) in order to compare means and sources of variation. Often there was not enough statistical basis to use even these relatively simple tests effectively. In many instances, if we knew more about the distributions of the niche parameters we should use the nonparametric analogs of these tests.

b. Data Problems

In general, the major difficulty centered on the fact that there was no vigorous sampling theory and the central question of how many cases are necessary to characterize n-variables was left unanswered. In much of what we analyzed, the cases were equal or only slightly more numerous than the number of species employed in a particular matrix formulation. In a more optimum situation probably 5 to 10 times the number of environments would be necessary to adequately delineate the patterns of community structure and especially stability. Therefore, we ranked species in several cases, especially for adult fish and phytoplankton. Although we tried to use our ecological intuition and experience carefully, undoubtedly some of the ranking

was inappropriate for certain species or species groups. Thus, species ranking is a dubious procedure. It was also problematic to discard environments which did not conveniently fit into one or more data stratifications. This was very wasteful in terms of the ecological data that had been collected in the initial study. For example, more than half of the data collected on adult fish could not be used because it was not collected in a meaningful way. We delineated the usuable data set, which was probably too sparse to characterize the community in question.

c. Overall Considerations

Lastly, we have several overall considerations in the analysis, most of which are related to not having the time or financial resources to complete various portions of the study. First, there was not enough time to complete the statistics, and in particular, develop the sampling theory, but also to develop other mathematical tools. For example, time series studies would probably be useful for looking at some of the temporal patterns in the niche values such as the ANOVA was used for spatial patterns. Second, there were neither time nor funds to develop measures for dimensionality and to apply loop analysis (See V-E and V-D, and below).

Loop analysis for the Hudson River had been a prime objective in the beginning of the study twenty months ago. A loop study not only would help in innumerable ways of understanding the various feed-back pathways in the community, but would also be helpful in distinguishing the heat versus impingement versus other types of perturbations on the community, and how the various niche

measures are related to the variables in question. Loop analysis would be extremely useful for developing predictive estimates of the perturbation effects and of understanding the general community biology.

Also the correlation analyses among functional groups could not be accomplished. This is unfortunate, because this development coupled with loop analysis is probably where our best understanding of the system's biology is going to originate. It was a most unfortunate problem that the microzooplankton, macrozooplankton, and benthos samples were not counted and could not be included in the present study. This was the immediate reason why correlation analyses was not initiated.

Third, there was not time to adequately evaluate the data stratifications in terms of developing a set of recommendations for using a smaller set of niche values, both in terms of the number of parameters measured as well as the number and types of data stratification used to generate a useful representation of community structure [See Lane and Wright (1977) for some suggestions]. Also, this latter problem is partially related to the sampling theory problem.

Fourth, there was also not enough time to include more of the detail of the interpretation of species biology, since there is a great deal of literature on these particular species. Because the species file was not developed, and because of the time involved to do so was prohibitive, it was not possible to more appropriately and adequately interpret some of the results that we obtained in terms of the biology of the station.

Finally, we feel that we have made some limited progress in terms of the validation criteria for applying niche analysis

to the Hudson River ecosystem, however, more progress is possible. In general, there are three types of validation criteria that can be employed. The first is regularity, the second is predictability, and the third is delineation of mechanism and understanding.

In terms of delineating regularities, this is paramount to identifying consistent properties in the community structure and stability patterns. We were able to demonstrate several regular patterns in the data set, and to develop statistical tests to compare these patterns, both in terms of total variation and the mean and range of variation. There are several other types of tests, however, such as the time series and/or the outlyer test which were or could be developed for these data, but were not used because we did not have the time or financial support to do so. For example, the outlyer test essentially tests values that are outside the range of the regular ones, and is an important test when comparing and evaluating differences among stations, (which is appropriate for the problem of thermal effluents). Consequently, the validation criterion of regularity is one that was partially resolved in this study. Also, experimentally it may be necessary to analyze the data over several years to obtain better estimates of natural temporal heterogeneity.

The second validation criteria is predictability to the extent it is presently possible to achieve using niche analysis. Although we generated enough information on niche measures to look at predictability; time and resources did not permit extensive validation in this regard. Predictability can be evaluated by comparing niche values trends with what is known about the system's biology. For example if $\overline{\$K\ (B_i/\hat{B})}$ falls for a predator then the densities of its food resources may have decreased or its environment become more harsh. There was no time to identify many of these types of patterns from the

massive number of tables we generated, nor to develop an automated system necessary for performing the correlation analysis. The second major method of improving predictability is through using the loop analysis which directly models the effects of perturbations and generates predictive tables of their effects. Likewise, there was no time to develop even simple loop diagrams looking at the general results that we had obtained in this study.

Thirdly, there was not enough time to correlate the environmental and biological information that was at hand, and to generate and test particular hypotheses and assumptions both in terms in regularity and predictability. These hypotheses could be further examined in a mechanistic view, both using the data at hand as well as literature results. Again, there was not time to adequately do this although undoubtedly considerable progress could have been made with the available information.

In conclusion, there are a number of different types of sources of error, problems, inadequacies and other considerations that make our final product less than desirable. Some of these problems are readily solved with a little more time and work, others would require better data collection programs, expensive technology, tedious detours into ecological theory, and sophisticated statistical refinements. Enough development has been made to this point, however, that the analysis is usable as it is and definitely superior to traditional methods that mainly center on presentation of species density or diversity curves with a minimum of interpretation. Without a sampling theory to facilitate a firm basis for the data collection program, and some associated theoretical development, several timely questions could be raised as to the mass application of the

present state of the analysis for applied ecological problems without the (necessary) research and development. This latter course of action could represent a monumental exercise in misplaced economy.

E. RECOMMENDATIONS FOR APPLYING THE ANALYSIS TO AQUATIC DATA SETS[1]

In general, our recommendations center around correcting all the sources of error and problems that have been outlined in Section C. The more of these that are corrected or resolved, obviously the better the application of analysis to natural communities is going to be. The following is a list of the more general recommendations. In Section E, we present some of the more detailed descriptions of how this development could proceed.

First, unless considerable species biology and environmental heterogeneity is known, it is better to collect the data in a regular pattern than to initiate a more sophisticated type of sampling program. For example, even if one had good data on thermal plume characteristics and knew the delta T gradient it might not be best to collect samples in relation to ΔT, (for example, transect C in Figure 12) because there may be another resource gradient that necessitates consideration. For example, a nutrient or salinity gradient running counter to the thermal gradient might exist, in which case, measures of niche dimensionality might be needed to distinguish species responses in two dimensions. Consequently, unless there is a good reason to the contrary, data should be collected in a regular way, and the odd samples should be avoided. In the fish samples that we analyzed, more than half the samples

[1] See also sections VC and VE.

were unusable and a tremendous waste of time and effort as well as valuable information that was needed to characterize the system was lost.

Second, choosing the community involves a great deal of biological skill and experience. Since it is not necessarily the organisms that are sampled together that represent a coherent community unit, there can be no substitution for skillful biology.

Third, the station characteristics must be carefully selected and analyzed before the actual biological sampling begins. As in this study there was not enough care and attention devoted to this particular problem. Fourth, a cardinal rule of multivariate statistics is that there have to be more cases than variables. If we had to recommend a rule of thumb based solely on our intuition and not any firm sampling theory, we would suggest five times more cases than variables are needed, although some of the niche measures themselves are relatively insensitive to a number of environments. There are two basic ways to achieve this rule of thumb, rank species and simultaneously eliminate the rare ones thus reducing the number of variables, or sample more environments.

Fifth, many problems could be avoided if a species file were were available. This would help in choosing the groups of competitors to be studied, but also would facilitate awareness of peculiarities in the biology. For example, vertical migration, behavior of reproductive strategies, would be particularly sensitive to a given data stratification.

Sixth, all samples that are taken should be coordinated. Every sample should have a purpose in a well-planned data collection program. The whole sampling plan should be designed so that the

most information is generated with the least amount of effort and expense. For example, in this particular program it is extremely difficult to look at a lot of the predictive results, because the samples were not coordinated. Seventh, before this theory is applied on a more widespread scale the sampling theory and some of the mathematical problems should be resolved. With some careful planning and a limited number of additional samples, some of the sampling theory problems could be resolved experimentally.

Finally, despite the massive amount of data, and the large number of data tables that were generated in this study, many were of a experimental nature since we attempted to determine the least amount of information needed to characterize community structure, especially in regard to thermal perturbations. At the basis of this study, is the assumption that we can evaluate a dynamic and complex system such as the Hudson River estuary in terms of static data, that is, with species densities collected over a variety of spatial-temporal environments. The problem with this, as with most ecological studies, is that the ecosystem may be too dynamic to be represented by a few static glimpses through a year. Much of the understanding of the ecological systems would more appropriately be based on turnover rate measurements. While these data are often prohibitive in terms of technology and expense, some improvements could be made in the present data collection frame.

F. RESEARCH AND DEVELOPMENT NEEDED FOR NICHE ANALYSIS

The research and development needed for niche analysis can be divided for convenience into two categories: (1) computer technology, and (2) methodology associated with ecological theory and system biology. These two categories in practice remain well-integrated and usually any developments we make in ecological theory

and system biology necessitate associated computer "creations." The developments we feel are most important at the present time are briefly summarized below:

1. Computer Technology[2]

a. Automated Data Handling System

This is a priority item since the niche program (NICHE) is stable and loop analysis can be developed concurrently. Although this is a large and long term undertaking, it can be developed along with the other things with relatively little overhead and it should save us considerable time in the long run. There are three main areas where we are having problems with data processing, and accordingly there are three stages of development that are needed.

(i) Direct Data Entry:

Currently as samples are counted, the raw counts and pertinent information are written on sheets and kept in books. The calculation to densities are done in one or more stages, usually on the HP 9830 but sometimes by hand, and the results written on other sheets and then on Fortran Coding Forms to be keypunched. When the keypunching comes back the cards are listed, run through NICHE to check for errors and visually checked against the original sheets. When the data are corrected and free of errors, hopefully, it is put on a magnetic tape file and the analysis run. This process

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[1]See also section V-C and V-D

[2]Enclosure #71, entitled Annual Report IV, New Computer developments planned for year II.

involves considerable overhead, is expensive on time and introduces too much error. Therefore, we need an interactive (terminal) system for taking in raw data in any form, say from the counting sheets, and, flawlessly processing it to a form suitable for storage and analysis. It would have facilities for verification (having the raw data entered twice, independently and cross-checking), making sure all the pertinent information (sample volumes, sampling time, etc.) has been entered and recorded, thus producing listings to have cards punched (if needed) from or to go in the data books, and for checking syntactically and numerically, any cards that were punched. Of course, while this would be particularly useful for certain common types of large scale data processing, specialized sets would still have to be done by hand or with the HP calculator.

(ii) Report Generator:

When NICHE runs it produces much more information than is required for initial interpretation, for instance, niche values for every species plus means, standard deviations, variances, etc. when all that is required are the means and coefficients of variation. Also, the data are scattered and hard to follow. Therefore, for a paper or report, tables must be generated by going through the outputs, pulling out the desired numbers, rounding when necessary and writing then in place. Then the tables are typed, which is also a time consuming step. A report generator would read in the output of an analysis, either the print file or a specially produced internal file, select, re-order and re-format to produce desired reports and summary tables, perhaps with some of the statistical analyses.

(iii) Data Base Manager

In order to conduct the statistical analysis of the niche values that we hope to do, it will be necessary to obtain the output of niche analysis in machine-readable form. It could be pulled from the outputs, written on coding forms and keypunched but this would be expensive and time limiting. Also to do all the desired stratifications, some sort of automatic data selection would be useful. Therefore, we plan to have an information-retrieval system which will be able to channel, select, and transform data for analysis, and from one analysis to another as well as for report generation. This will be the center of the automated data handling system and encompass the other two as well as, perhaps, supervising the execution of the various analyses. The whole thing will, of course, be written to run interactively, as well as in batch mode. For more detail see enclosure 50, entitled Niche Documentation.

b. Rewrite of Niche Program

NICHE should be redesigned and recoded to integrate the improvements and changes we have made so far, to make it easier to modify and make more changes, to make it easier and more flexible to use, and to make it interactive, that is, usable from a terminal which we have already purchased and expect to be functional in March 1976. (ASL/1 Multi-writer). An effort should also be made to produce more usable summary tables and to make it compatible with the above described data system. See enclosure 50 for specific details.

c. Rewrite of Loop Program

An interactive driver program is needed to make loop analysis feasible. It will use the special features of the ASL/1 Multi-

writer, for instance, subscript printing. The present path and loop algorithms will be used as well as some utility subroutines in common with NICHE which we are now working on, however, it may also require some special software to operate the terminal.

New algorithms should be developed for loop and path enumeration; both APL and the terminal would be used. However, this is neither urgent nor absolutely necessary.

d. New Programs

For the theoretical and biological developments listed in Part 2, several new computer programs need to be written. These programs would include the following types of calculations:

(1) sensitivity analysis for niche parameters
(2) confidence intervals and significance tests for niche parameters
(3) sampling theory for niche parameters
(4) environmental heterogeneity measures
(5) new alpha formulations
(6) sophisticated correlation analysis for functional groups between and among sets of niche values
(7) multi-variate statistics - niche dimensionality
(8) new stability measure for loop analysis
(9) incorporation of niche into loop diagrams

2. Methodology Associated with Ecological Theory and System Biology

a. Statistical Analysis of Niche Measures

A better understanding of the statistical theory behind the niche measures should lead to better treatment of them in

interpreting comparisons or computing statistics on them. Also some new measures may be found to be useful. A large part of this will involve developing a sampling theory which includes questions such as: are the niche measures sensitive to the difference between a zero and a small number in the data? How do the actual number of species or environments affect the niche measures? How do the problems of spacing, range and nonlinearity affect the calculation and interpretation of niche measures? How many degrees of freedom are there in the alpha matrix? This should also help us determine what kind of difficulties in the data lead to problems like dependent species. Also, we have to determine confidence limits for each of the niche measures so that we can distinguish significant differences and the sensitivity of the niche measures to errors in the data and to particular sampling designs.

Thus, included in this statistical analysis of niche measures will be the following development:

(a) sensitivity analysis of niche parameters
(b) elaboration of niche statistics including outlyer tests
(c) development of confidence intervals and significance tests

b. Environmental Heterogeneity

For our Gull Lake, Lawrence Lake, and Bedford Basin data sets we will have a fairly complete set of environmental parameters coded and on computer file. These data will include physical measurements such as temperature and light intensity, chemical measurements such as dissolved oxygen and particulate organic carbon, as well as biotic factors such as algal biomass and predation rates. We will be conducting ANOVA breakdown analysis

on these data in order to determine if there are any simple correlations between the changes of external conditions (environmental heterogeneity) and the niche values of representing the communities. Also, a quantitative measure of the degree of environmental heterogeneity is needed in order for us to adequately evaluate how a particular perturbation, e.g., a thermal effluent or a nutrient addition compares to the observed "natural" heterogeneity. To answer particular questions on variability and significance it will be necessary to develop some short term sampling projects as have been done for the Gull Lake system.

c. Other Formulations of Alpha

The development of other types of alpha are necessary for two reasons; first, to add ecological reality to our present measures both in terms of 1) measuring niche patterns more accurately and 2) by considering the effects of other important ecological factors such as resource turnover, predation rates, temperature, time lags, etc; and second, to alleviate some of the mathematical difficulties and artifacts inherent in the present calculations (see also sections V.C and III.A). We presently have several niche formulations and anticipate creating several more especially for predator - prey pairs that can be used directly in loop analysis.

Many species or species-groups will need custom-made alphas; that is, alphas that take into account 1) the species' ecological peculiarities, 2) the peculiarities of the environment they inhabit, and/or 3) the peculiarities of the perturbations that they experience. There is no reason to believe that one alpha would be the best for all types species; it is not desirable to

develop one such alpha measure. The probability of co-occurrence alpha is simple and can be calculated with density data from the field. Since alpha integrates the environmental factors in a relatively-unbiased way for most types of species (if the data collection is carefully done including the field sampling program and subsequent laboratory analysis) the probability of co-occurrence measure reasonably circumvents some of the problems with zooplankton and phytoplankton. Much more of this type of work will have to be done, however, to develop particular types of alpha as we have been developing for other groups of organisms in our other study environments.

It is also necessary to test more vigorously the new as well as old measures of alpha for their similarity to the matrix of first partials (Jacobian). This will involve more theoretical as well as biological effort on the measurement of growth and turnover rates in ecological systems.

d. Correlation of Functional Groups of Organisms

Until recently, we have been studying consistent properties within various biological functional groups in an ecosystem. The next step in understanding the whole picture is to search for these regularities among functional groups and their associated niche measures. This endeavor will involve the use of a sophisticated type of correlation analysis and some associated statistical techniques. This will give us the means to determine the links between and among the groups which showed lead to a more detailed loop analysis of the community (See Appendix A).

This particular portion of the research will be especially dependent on the related computer technology both because of the

complexity of the problems involved and because of the large amount of data that will be stored and manipulated.

Thus, good data manipulation system is invaluable in this study. Regardless of how we get the required data into the computer, we will be using the SPSS statistical package. This will place at our disposal the analysis of variance, correlation analysis, regression analysis, factor analysis, and several other multivariate techniques that we will be using. It will also be necessary to study the distribution curves of some niche values, for example, the skewness and kurtosis of alpha which will be useful in these analyses.

If this correlation analysis is to be conducted in a comprehensive way, then the other functional groups that have not been included in the present study (benthos, macrozooplankton, and the rest of the microzooplankton species especially the cladocerans and copepods) would need to be recounted to an adequate level of taxonomic expertise. If this were accomplished it would be possible to develop and complete the correlation analyses of all the important functional groups. This would give us a greatly enhanced understanding of the Hudson River ecosystem at Roseton-Danskammer Point. If recounting were possible then the data tables could be developed as they have been in this report for the other functional groups. If it is not possible to recount the samples, which actually represents a small amount of time in comparison to the time already put into the project, it would still be worthwhile to conduct the correlation analysis among the functional groups that have been analyzed even though the final result would not represent the total ecosystem.

e. Multivariate Analysis: Niche Dimensionality

To date we have only used multivariate techniques with the Bedford Basin data. These techniques need to be improved especially in regard to their applicability for aquatic data. This effort will also be part of section d of the above commentary in that we can look for more complex correlations among functional groups and environmental parameters. Principal component analysis and discriminant analysis will be useful for determining niche dimensionality. These techniques group (by way of linear combinations) the data by variable and case respectively. The SPSS computer package will be used. Related to this portion of the study will also be the application of some new results from gradient theory to the Hudson River ecosystem.

f. Loop Analysis and Its Relation to Niche Analysis

Strengthening the links between niche analysis and loop analysis is necessary (See first Appendix A for a detailed discussion of how loop analysis could be applied to the Hudson River ecosystem). Levins, our coinvestigator, has recently been doing this (Levins, pers. comm). Hopefully, it will be possible in the near future to model niche values directly into loop diagrams. Coupled with the new statistical treatment of loop analysis results it will be possible to test for the statistical correlations of niche values directly from loop diagrams. This process will serve as one of our most valuable checks on our understanding of a given ecosystem as represented by a loop diagram. For example, if the B/E value of the phytoplankton community and the value of the fish larvae community were negatively-correlated with a high degree of consistency, we

would construct our concept of the ecosystem using a loop diagram modified from the usual format to include their niche values. If after calculating the pathway and complement feedback effects, we would test their results using a covariance formulation to evaluate the +/- correlations. If the results of this latter procedure yielded correlations similar to those directly calculated from the niche values, we would have an increased confidence in our representation and thus, understanding of the ecosystem under study.

SECTION VI

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VI. BIBLIOGRAPHY

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HYDROTHERMAL MODEL STUDIES

ROSETON – PHASE II

DANSKAMMER POWER PLANT

QUIRK, LAWLER AND MATUSKY ENGINEERS
CENTRAL HUDSON GAS AND ELECTRIC CORPORATION

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April, 1973

TABLE OF CONTENTS

ABSTRACT
INTRODUCTION
DESCRIPTION OF DANSKAMMER COOLING WATER STRUCTURES
TESTS CONDUCTED AND DATA FORMAT
TEST RESULTS AND EVALUATION
CONCLUSIONS
REFERENCES
FIGURES
APPENDIX A

ABSTRACT

Temperature rises of the Hudson River due to artificial means must presently (1973) meet thermal criteria adopted by New York State regarding maximum surface temperatures at any point and with respect to the extent of the 4F rise isotherm. These criteria are under review, and it has been proposed to modify these sometime in the future such that the 4F isotherm cannot be exceeded 1,000 feet from the point of discharge. Such a possible change in the thermal criteria would affect the operation of some existing plants, and therefore, the present discharge structures at the Danskammer Plant shown on Figure 3, were re-examined relative to present and future thermal criteria.

A 1/90 undistorted scale model was used to directly measure river temperatures using the existing discharge structures with Danskammer at nominal 80% and 60% of full load, and with two proposed alternative structures with the plant at full load. Operation of the nearby Roseton station was included in the study. One of the proposed alternate structures consisted of submerged slots in a bulkhead and the second was a submerged diffuser. These two designs shown on Figures 4 and 5, produced similar river temperatures.

Test data in this report, in conjunction with that from a previous study (1), showed that the existing structures, with Danskammer at 100% load, would exceed the maximum surface temperature criteria but would meet present criteria as to the extent of the 4F rise isotherm. However, even load reduction to 60% of full load did not produce temperatures which would comply with the future criteria of 4F at 1,000 feet.

All present and proposed future temperature criteria would be met with either the proposed bulkhead or diffuser discharge structure at Danskammer. The choice between these schemes may therefore be based on factors other than river temperature patterns.

INTRODUCTION

The existing Danskammer Plant on the Hudson River, owned and operated by Central Hudson Gas and Electric Corporation, uses a once through flow system to provide condenser cooling. Resulting temperature patterns in the estuary are subject to review by the New York State Department of Environmental Conservation. Possible future revisions of existing thermal discharge standards have prompted a re-evaluation of the Danskammer discharge structures.

Present regulations adopted by New York State for thermal discharges basically require that temperature rises of 4F or absolute temperatures of 83F shall not be exceeded over more than two thirds of the river surface width nor over more than 50% of the cross-section and/or volume. In addition, temperatures at any point on the river surface shall not exceed 90F. It has been proposed that these criteria be supplemented sometime in the future such that temperature rises of 4F also shall not be exceeded at a distance of 1,000 feet from the point of discharge.

Cumulative temperature rises in the estuary are complicated by thermal discharges from the existing Roseton Generating Station, located approximately 3,000 feet south of and on the same river bank as the Danskammer Plant. Thermal effects of the Roseton Station will be minimized by using a multi-port diffuser to discharge the cooling water. Temperature rises produced at Danskammer will be affected by the Roseton plant since, during flood flow, warm water discharged from Roseton will be entrained into the Danskammer plume. Conversely, during ebb flow, the Danskammer discharge will affect temperatures at the Roseton site.

To study the complex interaction of the plant cooling water flows and assist in evaluating the cumulative temperature effects, Quirk, Lawler and Matusky Engineers contracted with the Alden Research Laboratories to construct a hydraulic model and measure the resulting temperature patterns directly. The model was constructed to an undistorted scale of 1 to 90 and simulated approximately 15,000 feet of the river, including both shorelines. The intake and discharge structures of both plants were constructed to scale, and operated at the expected condenser temperature rise. Field measurements of river stage and velocity variations with time were conducted and the data used to adjust comparable tidal flow characteristics of the model. Comparisons of model and field data on thermal patterns produced by the existing Danskammer discharge structure were made. Test data and an evaluation of the temperature rise patterns

produced by the existing outfall structure were given in the April 1972 ARL report, "Hydrothermal Model Studies for Roseton Generating Station", No. 40-72/M65F (1).

This report is a supplement to the above referenced report, and provides results of tests conducted to determine:

a) load reductions at Danskammer required to meet the present and proposed future temperature criteria,

b) design changes to the Danskammer discharge structure to produce temperature rises which comply with possible future criteria.

Reference should be made to the ARL report mentioned above for a description of the Roseton Plant, hydraulic characteristics of the river, field data on the existing thermal plume at Danskammer, model instrumentation, operation, similitude criteria, verification of the model tidal hydraulics, and the ability of the model to reproduce measured field temperature patterns. This report will describe the existing and recommended changes to the Danskammer cooling water structures, and give data on river temperatures for the various load reductions and discharge designs tested.

As was the case with the previously reported results, model data included herein are as directly measured and therefore do not indicate final steady-state temperatures due to the short section of the river simulated relative to the horizontal tidal excursion. Analytic studies must be conducted to evaluate the effects of heat returned with the reverse in tidal flow, and evaluate the mechanisms for reaching ultimate steady-state conditions in the field with successive tidal cycles.

DESCRIPTION OF DANSKAMMER STRUCTURES

The existing Danskammer Plant is located on the west bank of the Hudson River, approximately 65 miles north of New York City, as shown on Figure 1. As indicated by Figure 2, the Roseton plant is located on the same shore approximately 3,000 feet downstream. Also illustrated is the section of river included in the 1 to 90 undistorted scale model.

The fossil-fueled Danskammer Plant is rated at approximately 500 MWe with all 4 units in operation. At full plant load, 700 cfs is withdrawn from the river, raised in temperature approximately 17F as the flow passes through the condensers, and discharged back into the river 800 feet downstream from the intake. Figure 3 shows the basic arrangement and design of the existing Danskammer cooling water structure. The intake is located close to the tip of Danskammer Point, and the flow enters the plant by a 500 foot long open channel. The discharge pipes from all units are immediately adjacent to each other, effectively producing a point discharge oriented downstream along the west bank. Although the discharge conduit from Unit 4 is turned vertically downward at the end in comparison to the other horizontal discharge pipes, the local topography and the small submergence of the outlets essentially produce a surface discharge.

To reduce surface temperatures, two alternate discharge designs were investigated in the model:

1. a sheet-pile bulkhead with submerged slots, and
2. a submerged multiport diffuser.

The orientation and geometry of the bulkhead design is illustrated in Figure 4. An enclosure around the present structures would be affected by a bulkhead constructed essentially parallel to the river and a dike perpendicular to the river. No alteration to the existing structures would be required, and conversion to the new discharge scheme may be possible without a plant shut-down. Five slots would be provided in the bulkhead to discharge the plant flow essentially perpendicular to the river. Each slot is 2 feet high by 10 feet long, with a space of 12 feet between openings and submerged 18 feet from mean water to the slot centerline. Using a contraction coefficient of 0.7, the initial discharge velocity would be approximately 10 ft/sec. at 700 cfs plant flow.

The submerged diffuser, illustrated on Figure 5, was investigated in case there would be objection to the bulkhead design, for reasons such as aesthetics, and to determine if river temperature rises would be lower than with the bulkhead scheme. The diffuser would be oriented parallel to the river with 7 ports discharging perpendicular to the river axis. Port geometry and spacing was essentially that of Roseton prorated for flow, resulting in a port diameter of 3.55 ft. at a 25 ft. spacing. The centerline submergence was 18 ft. from mean water, and at a plant flow of 700 cfs, the initial discharge velocity would be approximately 10 ft/sec. assuming no flow contraction in the semi-streamlined ports.

Construction of the diffuser scheme would presumbly require a physical connection to the existing discharge conduits, and therefore may involve some period of plant shut-down.

The two proposed designs are evidently quite similar with respect to the initial discharge conditions, and this similarity was intentional so as to have a choice based on considerations other than hydraulic. As will be shown, the two designs produced similar river temperature patterns.

TESTS CONDUCTED AND DATA FORMAT

Tests using the existing Danskammer discharge structures were conducted to determine the effect of plant load reduction on: a) meeting present maximum surface temperature criteria, and b) on meeting future temperature criteria of less than 4F at 1,000 feet from the discharge. Load reductions in the model were affected by reducing the initial plant temperature rise, in proportion to the plant electrical outputs, while maintaining the full circulating water flow. Tests were conducted with Danskammer operating alone at various loads and in conjunction with Roseton at various loads, as summarized in Table 1. Data on temperature patterns with either Danskammer alone at 100% load using the existing structures, or with both plants at 100% load are given in the previously mentioned report (1). All tests were for a fresh water flow of 6,000 cfs and summer ambient temperatures.

TABLE 1 – REDUCED LOAD TESTS

	DANSKAMMER		ROSETON			RIVER
Test Date	Load (%)	ΔT(°F)	Load (%)	ΔT(°F)	Barge	Ambient (°F)*
6/12/72	80	13.5	97	16.5	no	81.7
6/15/72 (pm)	80	13.5	85	14.4	no	81.0
6/16/72	80	13.5	0	shutdown	no	82.0
6/13/72	60	10.3	106	18.1	no	75.6
6/15/72	56	9.5	85	14.5	no	80.6
6/16/72 (pm)	58	9.9	0	shutdown	no	81.4

*River runoff = 6,000 cfs for all tests

Subsequent to the load reduction tests, alternates to the existing Danskammer discharge structures were designed and tested as shown on Figures 4 and 5. For these tests, both plants were operated to simulate 100% load, and one test was conducted with the refueling barge anchored at its pier near the Roseton intake. Table 2 summarizes tests conducted to investigate the alternate Danskammer discharge structures. As was the case for the load reduction tests, these tests were all conducted to simulate a fresh water runoff of 6,000 cfs and summer ambient temperatures.

TABLE 2 – ALTERNATE STRUCTURE TESTS

	DANSKAMMER		ROSETON		
Test Date	Structure	Load (%)	Barge	Load (%)	River Ambient (°F)*
9/27/72	Bulkhead	100	yes	100	78.1
9/28/72	"	100	no	100	76.7
9/29/72	"	100	no	Shutdown	74.6
9/20/72	Diffuser	100	no	100	74.8
9/21/72	"	100	no	Shutdown	69.9

*River runoff = 6,000 cfs for all tests

To illustrate the effects of load reductions and alternate discharge schemes on river temperature rises, test data has been plotted using four formats:

1) temperature patterns at the surface and vertical sections at various times throughout the tide cycle,

2) tidal average temperature patterns at the surface,

3) maximum surface temperatures versus distance during a tide cycle irrespective of time,

4) maximum local surface temperatures at various times throughout the tide cycle.

The first of the above formats shows the influence of the tide on temperature patterns. To minimize scatter associated with temperature patterns which vary at a given time in successive tide cycles due to natural changes in the complex flow patterns, data at a point

for a given tide time was averaged with data at the same point and time from one or more other tide cycles. This technique produces more consistent and representative plots of temperature patterns as a function of time throughout the tide cycle. Due to the detailed nature and volume of these data, they are presented separately in Appendix A.

The second data format is intended to provide a single summary plot for each test condition, such that obvious comparisons between conditions is facilitated. These plots were produced by averaging the temperature rise at a given point throughout the entire tide cycle irrespective of time.

The third data format is intended to summarize data relative to the proposed future temperature criteria requiring 4F or less at 1,000 feet from the discharge. All surface temperatures measured within 1,600 ft. from the discharge structure with temperatures in excess of 2.4F were plotted versus distance. Such data were plotted on a single sheet, irrespective of time, for each test condition.

The fourth format is to summarize the test conditions with respect to meeting the criteria of a 90 F maximum surface temperature. These data also come from raw plots of format 1, and represent the maximum local surface temperature as a function of time during the tide cycle.

TEST RESULTS

Reduced Loads – Existing Discharge Structure

Tidal average surface temperature patterns, and maximum surface temperatures versus distance, for Danskammer at 80% load using the existing discharge structures are shown in Figures 6 through 11. Data for Danskammer operating in conjunction with Roseton at 97% load are on Figures 6 and 7, with Roseton at 85% load are on Figures 8 and 9, and with Roseton shut-down are on Figures 10 and 11. It is evident from Figures 7, 9 and 11 that, irrespective of the load at Roseton, the present discharge structures with Danskammer at 80% load will not produce temperatures which would comply with the proposed future criteria. However, reducing load at Roseton lowered overall river temperatures as is evident from the averaged patterns shown on Figures 6, 8 and 10.

Plots of river temperature patterns versus time in the tide cycle with Danskammer at 80% load, for each of the Roseton plant loads mentioned above, are given in Appendix A as Figures A-1 through A-45. These plots illustrate compliance at all times with the present thermal criteria that the 4F rise isotherm shall not exceed more then two thirds of the river surface nor more than one half of the river cross-section.

Figures 12 through 17 show both tidal average surface temperature patterns and maximum surface temperatures versus distance, for Danskammer with the existing discharge structures and a nominal 60% load. Temperature rises for Danskammer operating in conjunction with Roseton at 106% load are shown on Figures 12 and 13, with Roseton at 85% load on Figures 14 and 15, and with Roseton shut-down on Figures 16 and 17. Even with Danskammer at only 60% load, it is again evident from Figures 13, 15 and 17 that the proposed temperature criteria of 4F or less at 1,000 feet would not be met irrespective of the Roseton load. Overall river temperature patterns, illustrated on Figures 12, 14 and 16, show a consistent trend of decreasing temperatures with decreasing load at Roseton.

Variations of temperature patterns with time in the tide cycle for each of the plant conditions just described are given in Appendix A as Figures 46–90. Compliance with present criteria as to river surface and cross-section is evident as would be expected at the reduced loads.

Maximum local surface temperatures at Danskammer as a function of time in the tide cycle for the various loads tested are shown on Figure 18. The 100% load test is taken from previous tests reported in reference (1). These data illustrate that the maximum surface temperature at Danskammer is not perceptibly influenced by Roseton since temperatures tend to be lower during the later stages of the flood tide, and since there is no consistent trend of temperature rise with respect to the load at Roseton. The decrease in maximum surface temperature is shown to be essentially proportional to load, and this would be expected since the initial temperature rise in the model was prorated to plant load.

Whether or not load reductions at Danskammer would be required to meet the existing maximum surface temperature criteria of 90F depends on the ambient river temperature. For the maximum river ambient of 79F, the temperature rise could be no greater than 11F. To illustrate the variation in temperature rise versus plant load, the average maximum surface temperature rise throughout the tide cycle from Figure 18 was plotted as a function of plant load at Danskammer, for 85 and 100% load at Roseton and the resulting trend is shown in

Figure 19. The right hand ordinate shows actual average maximum surface temperature for two river ambients, 79F and 75F. At the maximum river ambient of 79F, the load at Danskammer would have to be reduced to approximately 75% of full load to meet present criteria relative to maximum allowable surface temperatures. If the river ambient were 75F, no load reductions would be required.

Alternate Discharge Structures – Full Load

Bulkhead

Tidal averaged surface temperature patterns, and maximum surface temperatures versus distance, produced by the bulkhead design at Danskammer, are given in Figures 20 through 25. The refueling barge was anchored near the Roseton intakes for the test data shown on Figure 20 and 21, and no discernible difference between the tidal average data without the barge, Figures 22 and 23, is evident. The somewhat lower local temperature at Danskammer on Figure 20 as compared to Figure 22 was due to a lower initial temperature rise. Comparable data without Roseton operating are shown on Figure 24 and 25.

The maximum surface temperatures versus distance shown on Figures 21, 23 and 25 illustrate that temperatures produced with the bulkhead would comply with the future criteria of 4F or less in 1,000 feet at both power plants. Maximum local surface temperatures at Danskammer would also comply with the existing maximum temperature criteria irrespective of ambient river temperatures, as shown by the lower portion of Figure 18.

River temperature patterns at various times in the tide cycle for tests using the bulkhead design are given in Appendix A as Figures A91–A135. These data show compliance with present criteria as to the allowable extent of the 4F isotherm at the river surface and at any cross-section.

Diffuser

Figures 26 through 29 show the tidal average river patterns and maximum surface temperatures versus distance using the proposed Danskammer diffuser. Figures 26 and 27 are with both Danskammer and Roseton operating; whereas Figures 28 and 29 are with only Danskammer operating. The average river temperature patterns with the diffuser, Figures 26 and 28, were similar to those with the bulkhead, Figures 20, 22 and 24, except that local temperatures were somewhat lower with the diffuser. This latter trend of slightly lower surface temperatures

is also evident from the plot of maximum surface temperatures versus time on Figure 18, which show compliance with present criteria for maximum surface temperatures.

Data on maximum surface temperature versus distance, Figures 27 and 29, illustrate that the diffuser design would also comply with proposed future criteria requiring 4F or less in 1,000 feet from the discharge.

River temperature patterns for the various times in the tide cycle corresponding to the above tests with the diffuser are given in Appendix A as Figures A136-165. Compliance with present regulations at all times in the tide cycle is evident.

CONCLUSIONS

A review of the data included in this report in conjunction with previous test results given in this report indicate that:

1) Operation of the Roseton plant had little effect on critical river temperatures at Danskammer.

2) The existing discharge structures, with Danskammer at 100% load, produces surface temperatures which may exceed present maximum temperature criteria depending on ambient river temperatures.

3) Load reductions to 75% of full load may be required at Danskammer, irrespective of load at Roseton, to meet present maximum temperature criteria with the existing discharge structures.

4) Load reductions at Danskammer to 60% of full load, irrespective of load at Roseton, did not produce temperatures which even approached the proposed criteria of 4F in 1,000 feet from the discharge.

5) All combinations of load at the two plants showed compliance with present regulations as to the extent of the 4F isotherm at the river surface and in cross-section.

6) Present and proposed future temperature criteria would be satisfied with either the bulkhead or the diffuser design tested in the model.

7) The similarity in river temperatures produced by the bulkhead and diffuser suggests that adoption of one design over the other may be based on other than hydraulic considerations such as economics, construction problems, plant shut-down during conversion and possibly aesthetics.

It should be noted that these conclusions are based directly on model data and do not include the effects of heat returning with successive tide cycles. This effect has to be analytically superimposed on the isotherms measured in the model to determine cumulative temperature rise patterns.

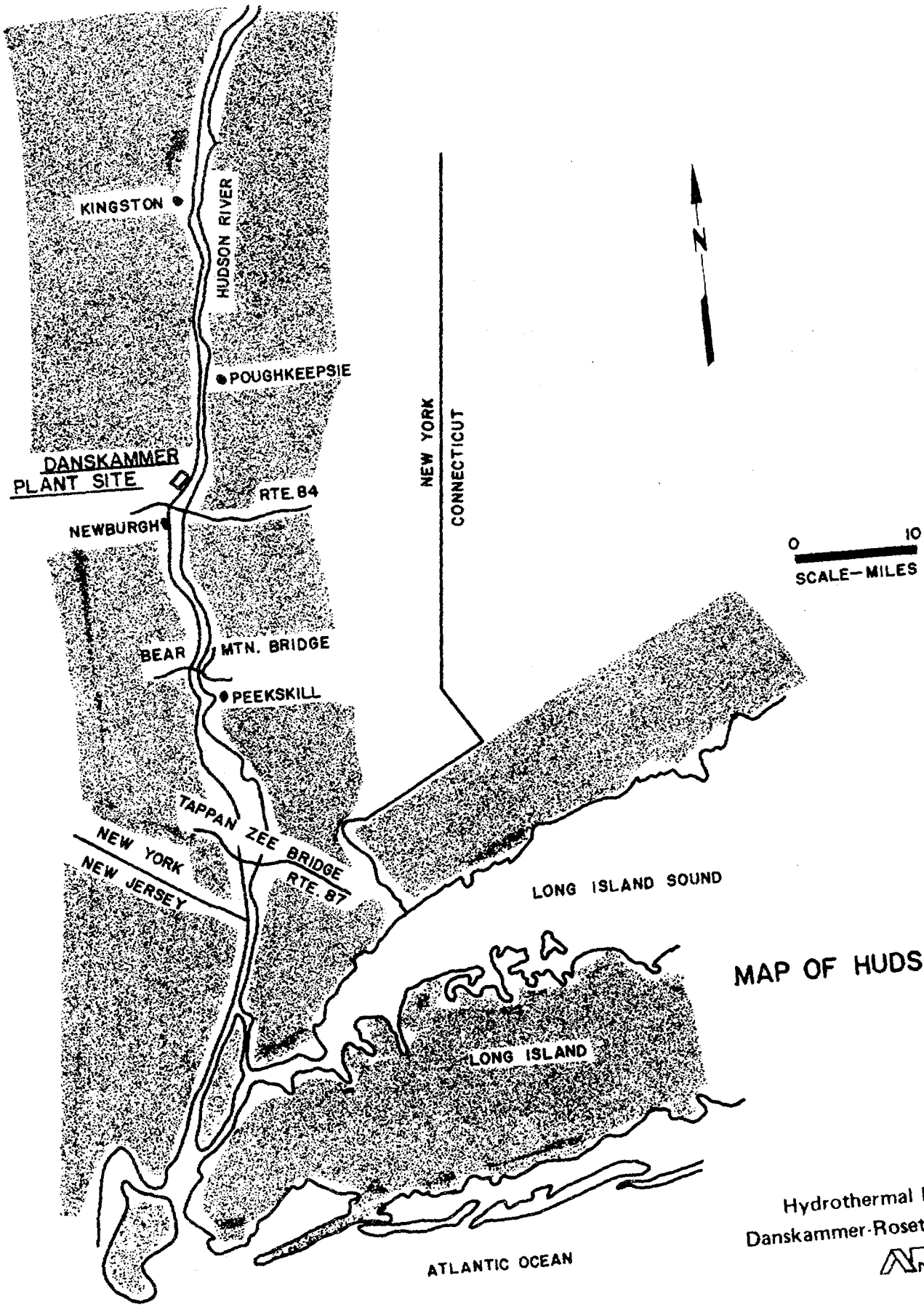
REFERENCES

1. "Hydrothermal Model Studies for Roseton Generating Station", Alden Research Laboratories Report No. 40-72/65F (April 1972).

2. "Effects of Roseton Plant Cooling Water Discharge on Hudson River Temperature Distribution and Ecology", and Appendix thereto, Quirk, Lawler and Matusky Engineers, and Oceanographic Analysts, Inc. (December 1969).

F I G U R E S

FIGURE 1

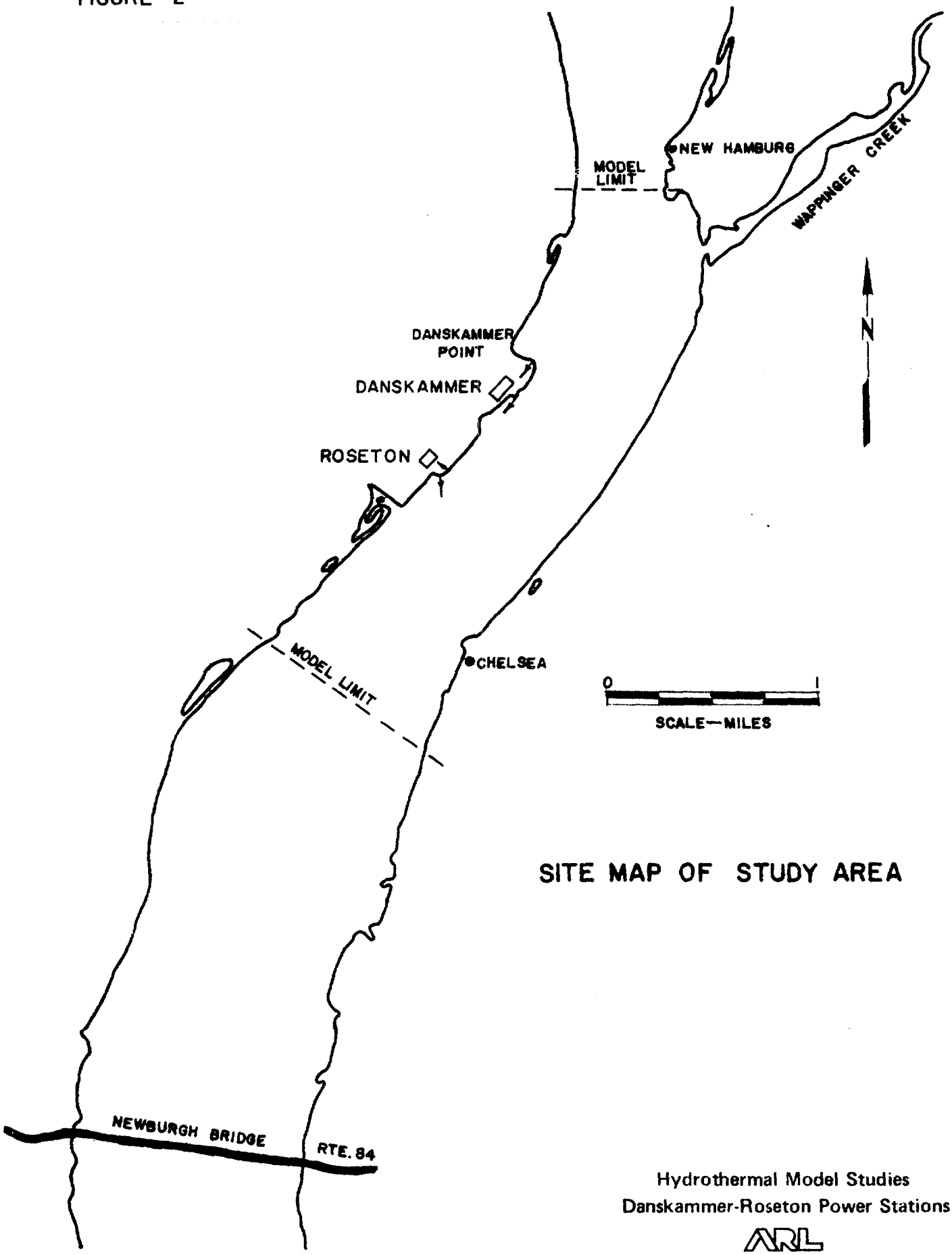


MAP OF HUDSON RIVER

Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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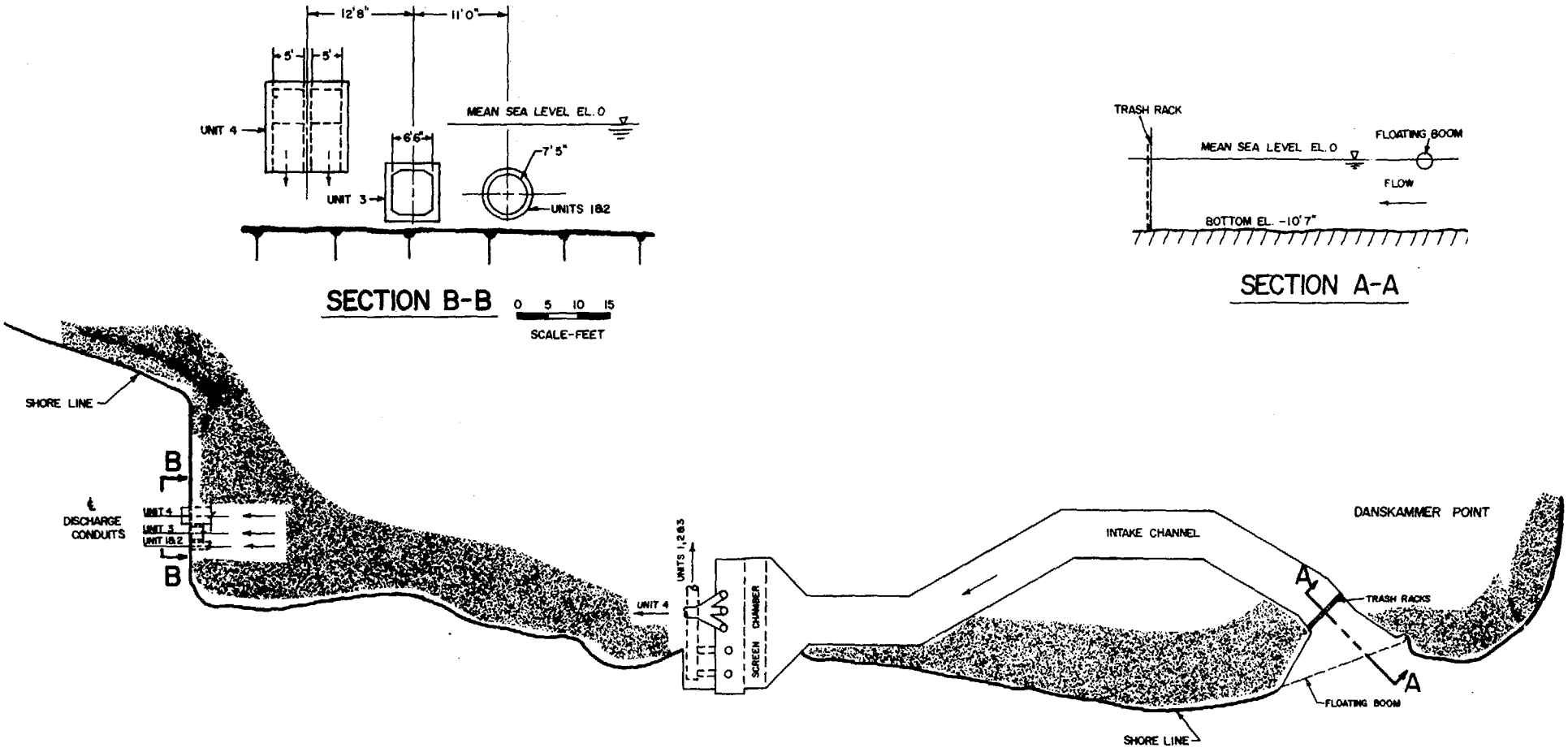
FIGURE 2



SITE MAP OF STUDY AREA

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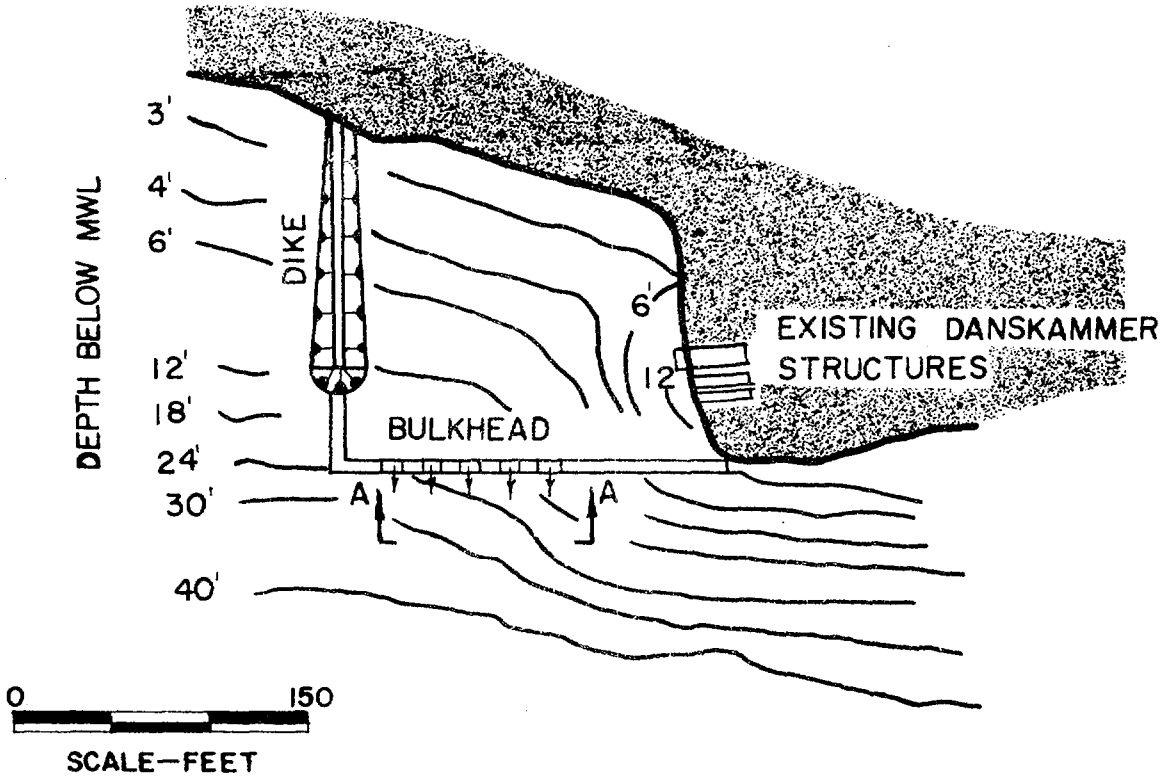
GENERAL ARRANGEMENT OF EXISTING DANSKAMMER COOLING WATER STRUCTURES

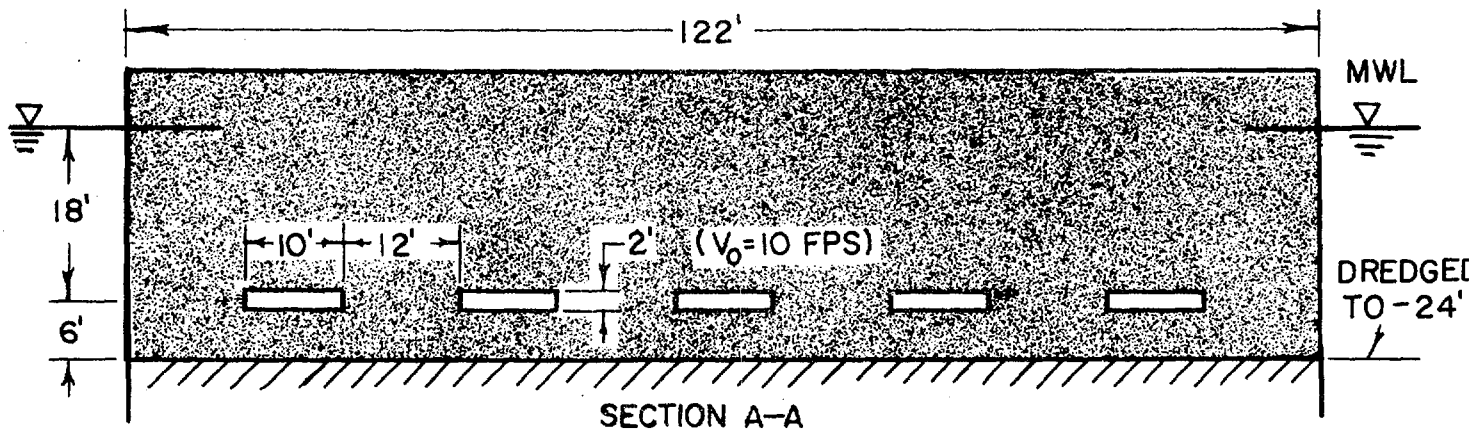
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 3

FIGURE 4





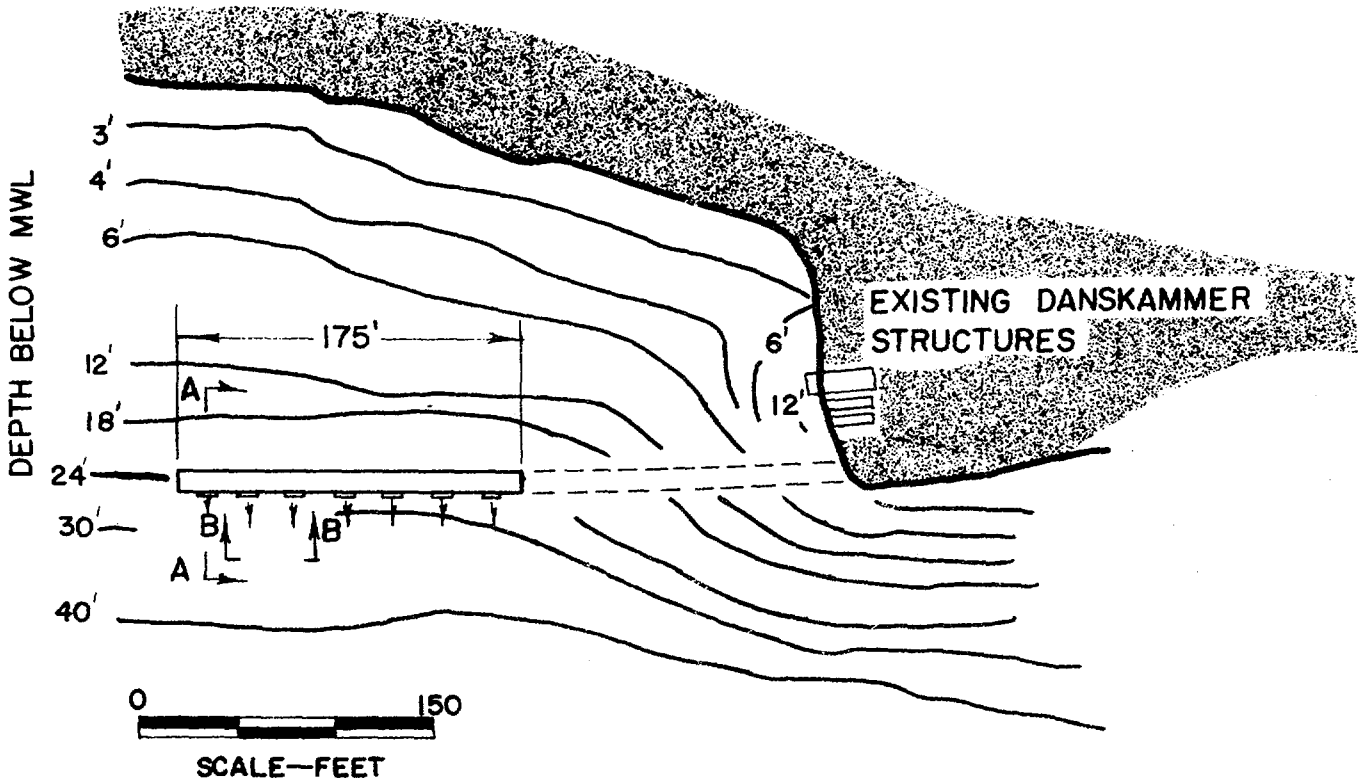
BULKHEAD STRUCTURE

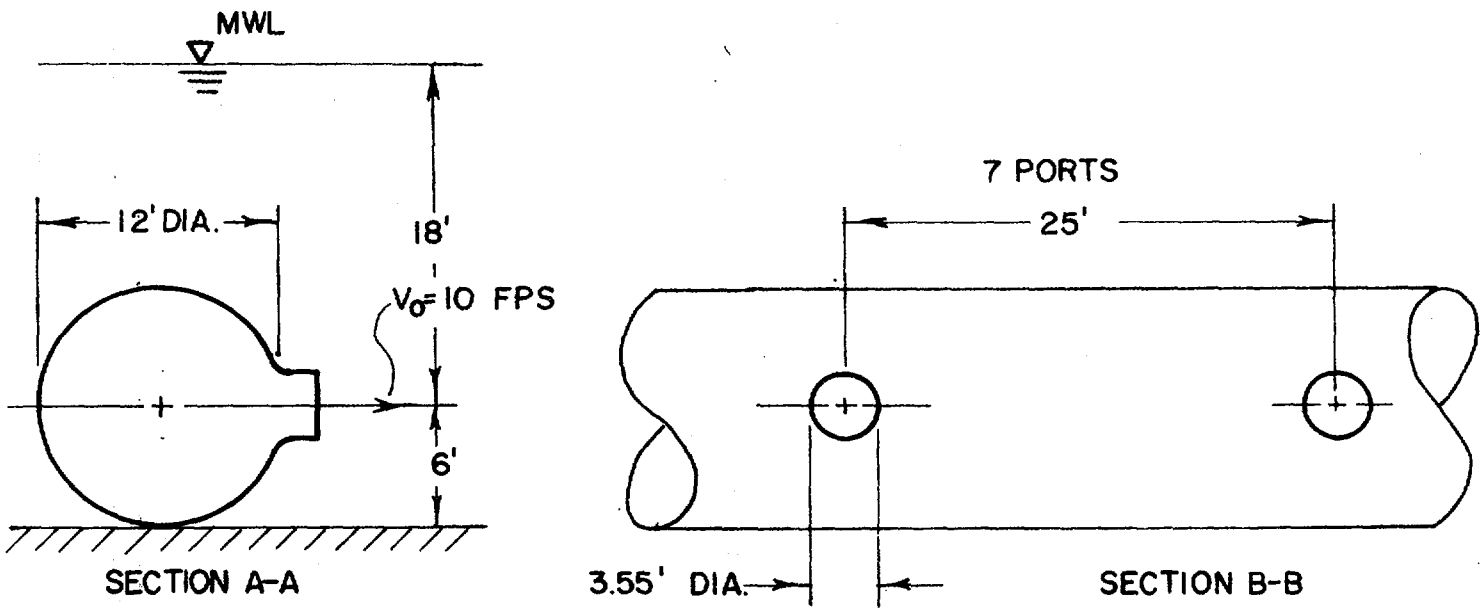
Hydrothermal Model Studies

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FIGURE 5





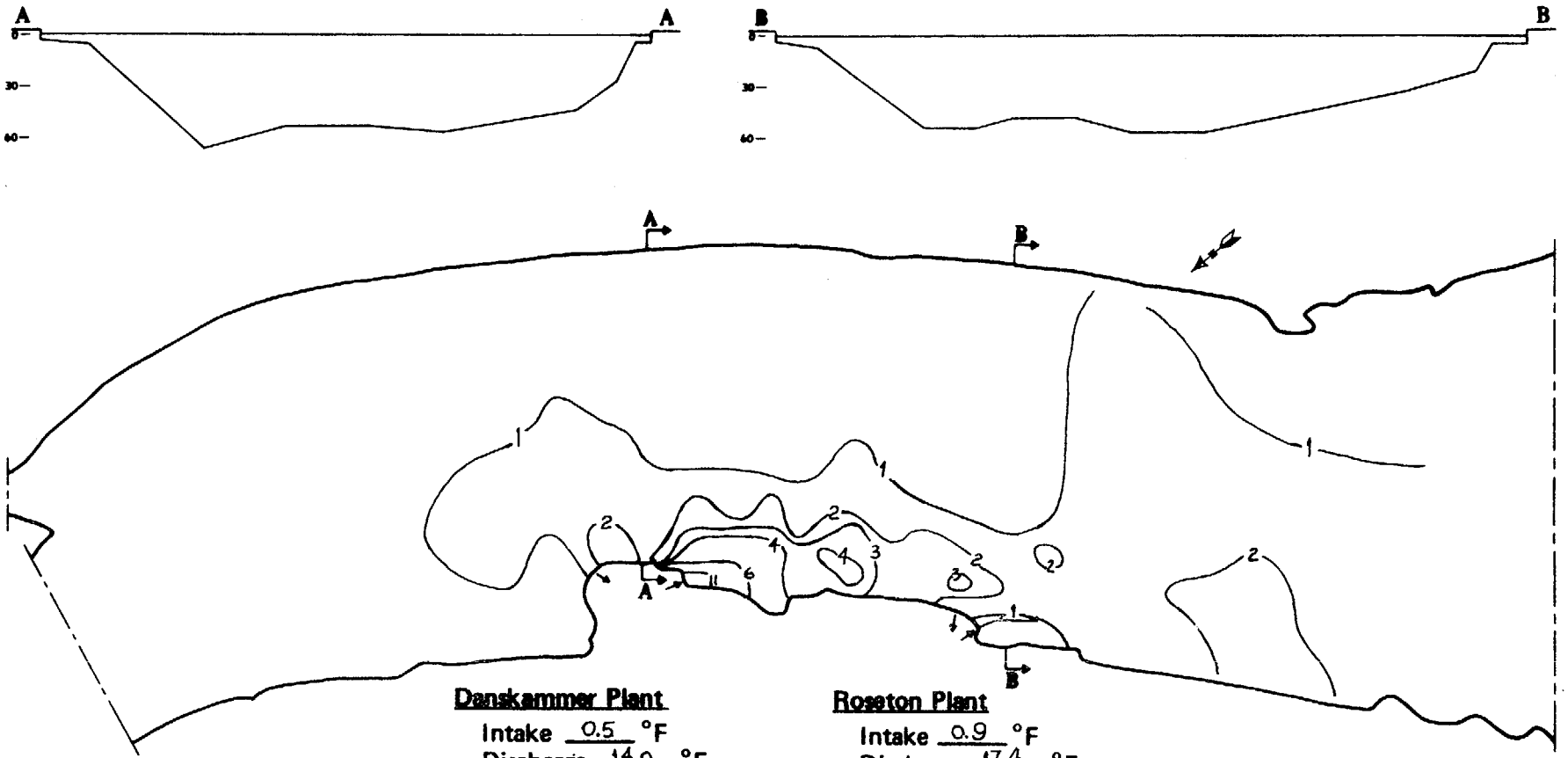
SUBMERGED DIFFUSER

Hydrothermal Model Studies

Danskammer-Rosaton Power Stations

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FIGURE 6



Danskammer Plant

Intake 0.5 °F
Discharge 14.0 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 17.4 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

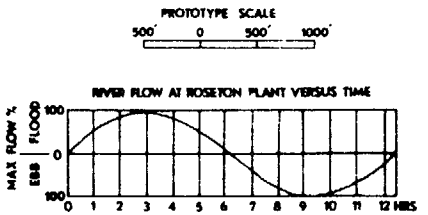
Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.8 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72



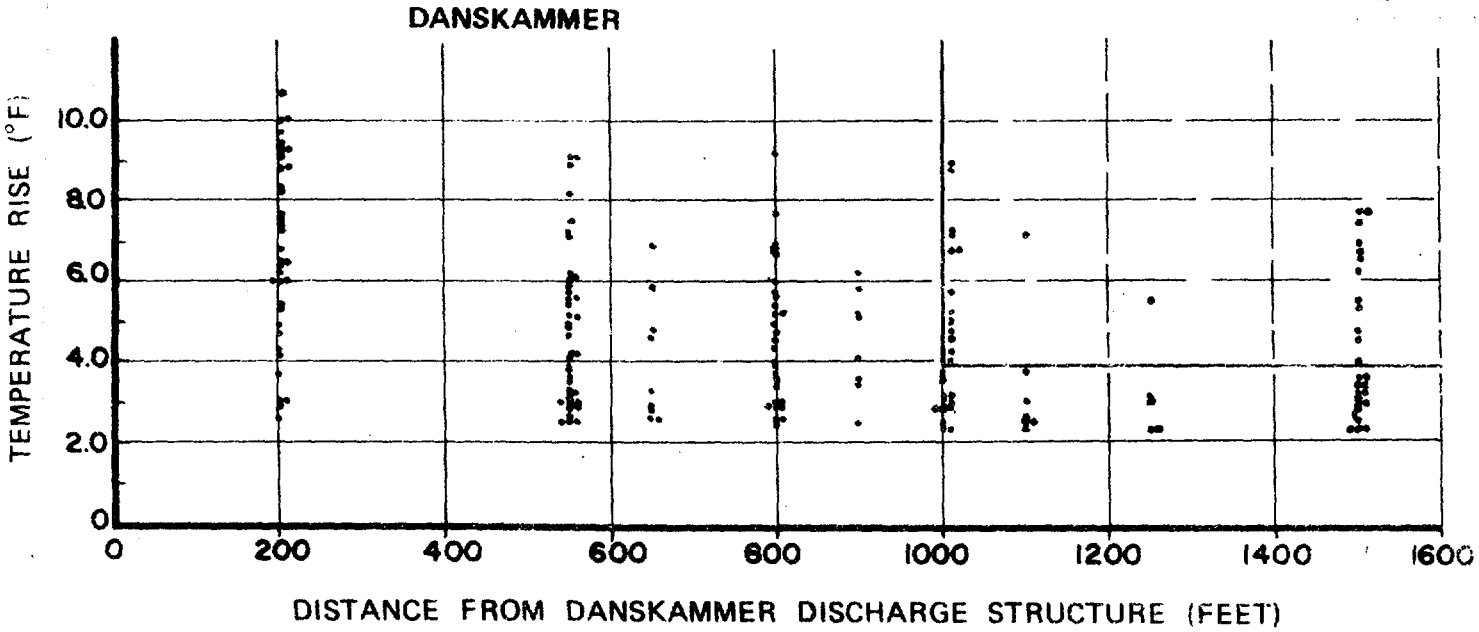
TIDAL AVERAGE

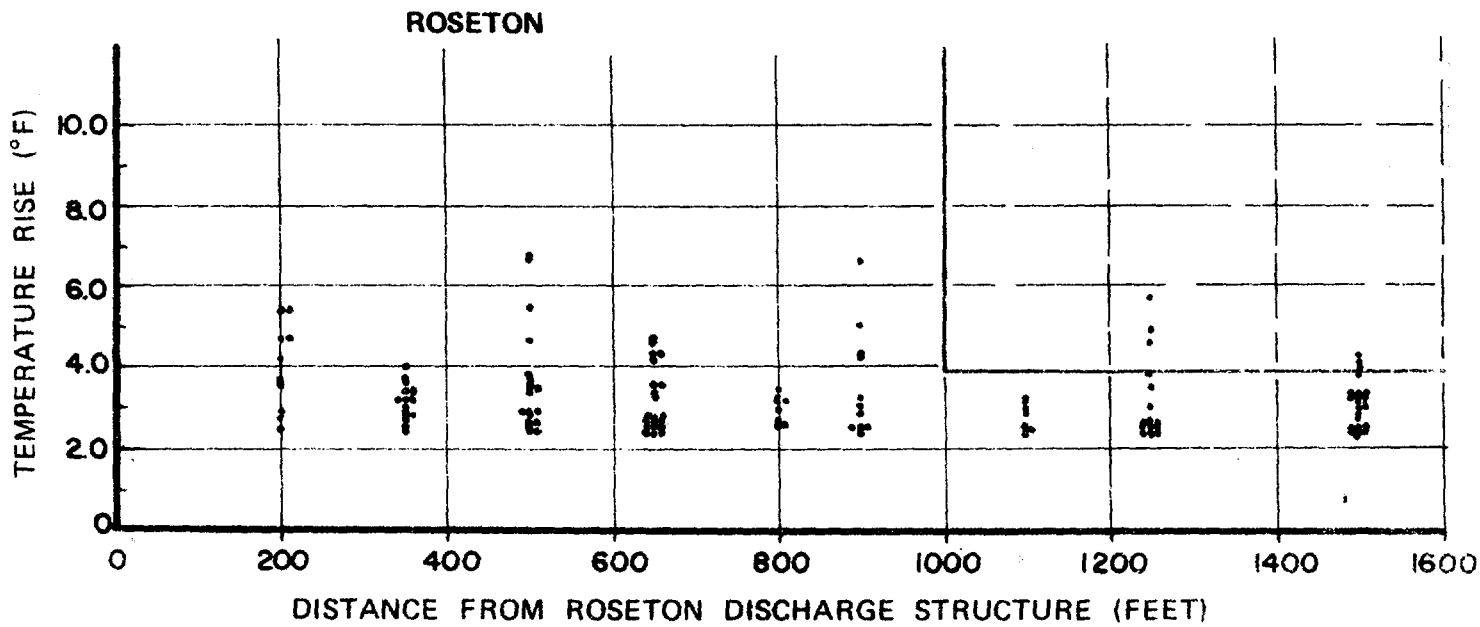
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE 7





OPERATING CONDITIONS

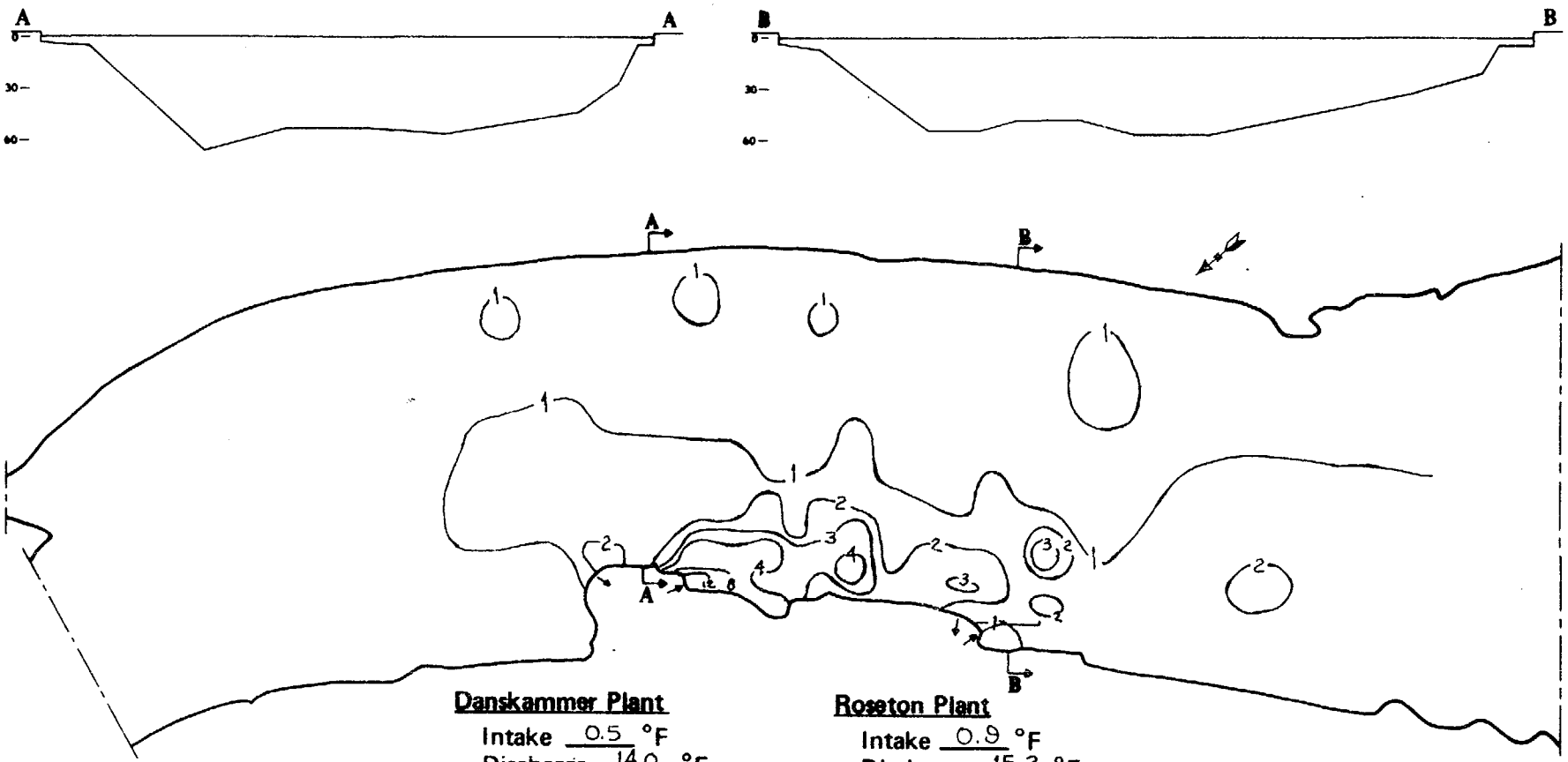
	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	13.5 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	16.5 °F
Test Date	12 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 8



Danskammer Plant

Intake 0.5 °F
Discharge 14.0 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 15.3 °F
ΔT 14.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.3 °F

River

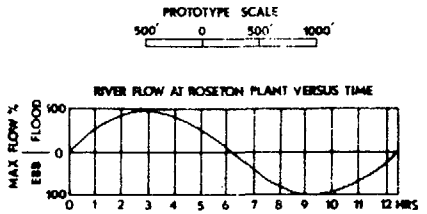
Fresh Water Flow 6000 cfs
Ambient Temperature 81.0 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



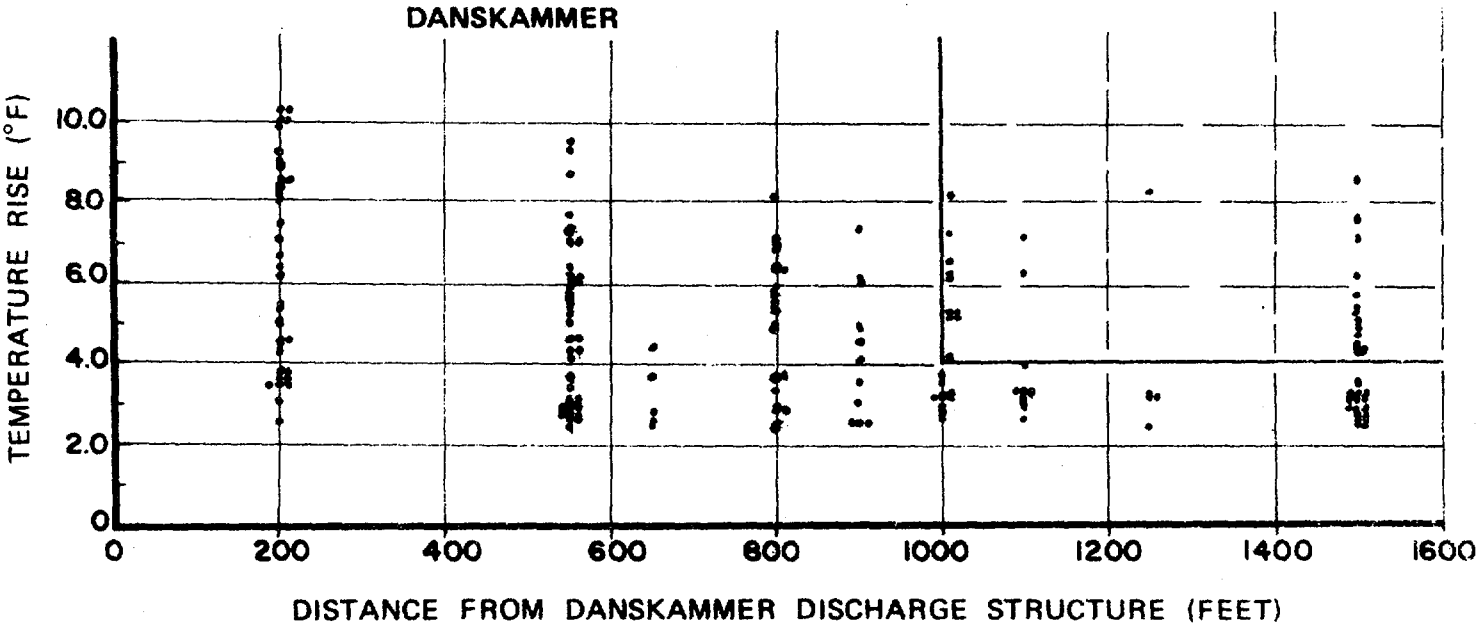
TIDAL AVERAGE

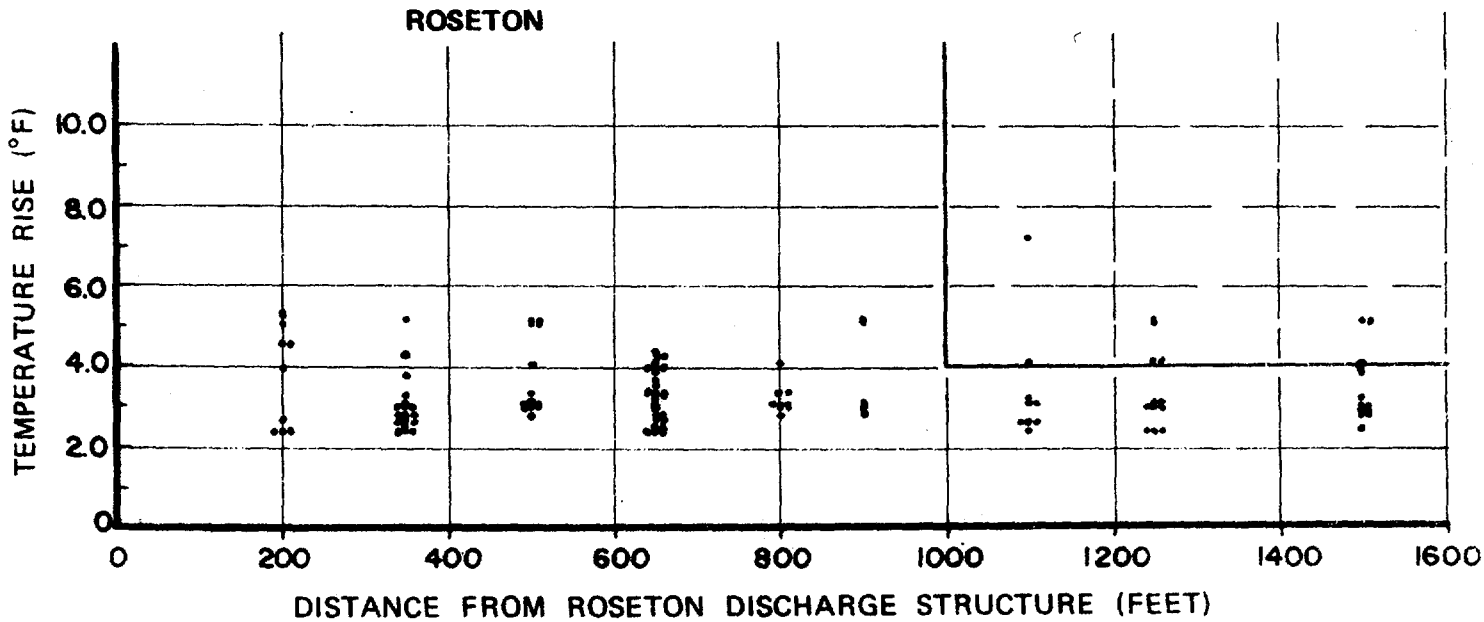
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 9





OPERATING CONDITIONS

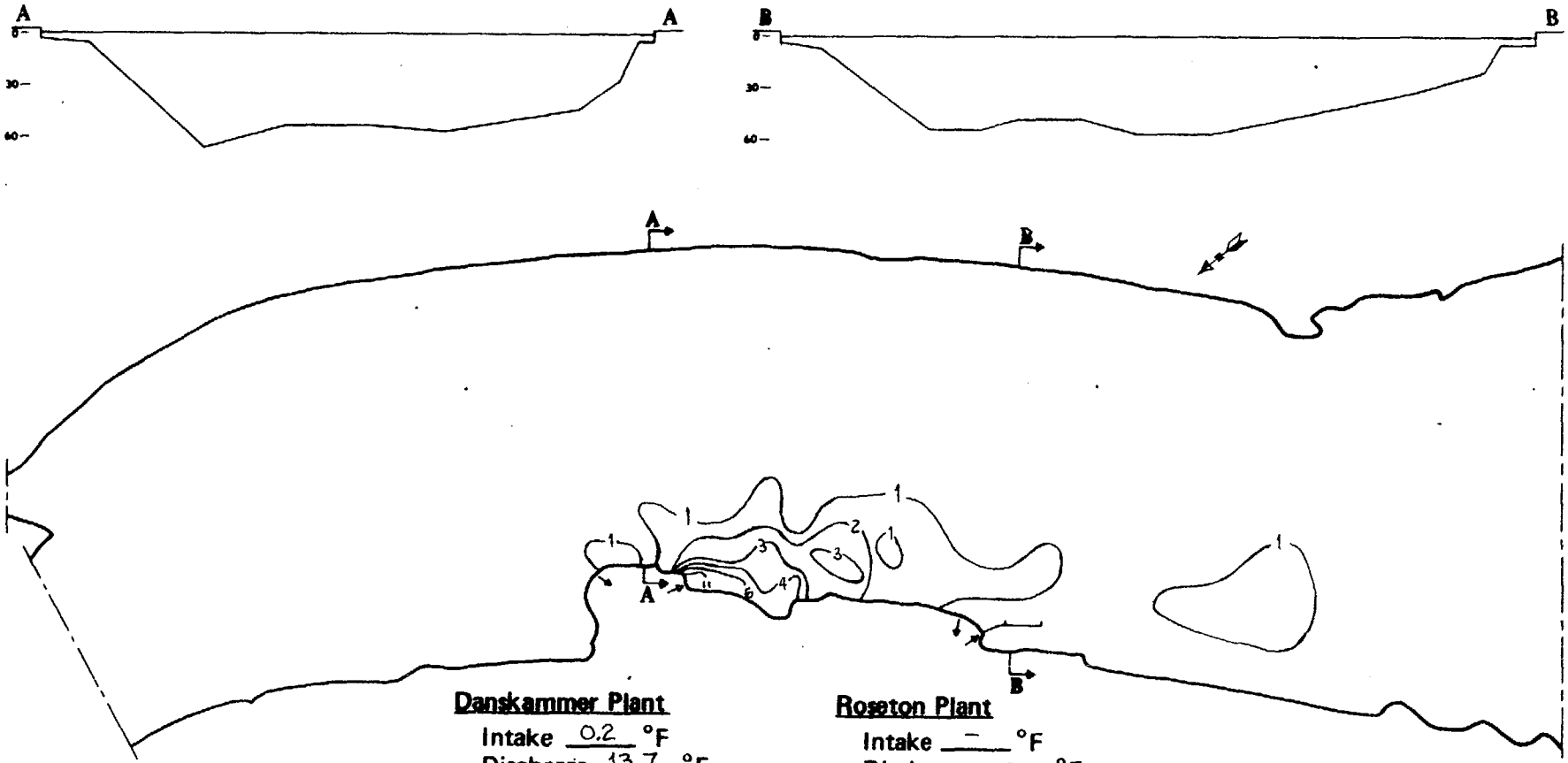
	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	13.5 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	14.4 °F
Test Date	15 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 10



Danskammer Plant

Intake 0.2 °F
Discharge 13.7 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake – °F
Discharge – °F
ΔT – °F
Flow – cfs
** Outfall Configuration –

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 82.1 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

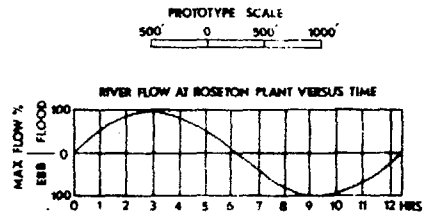
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



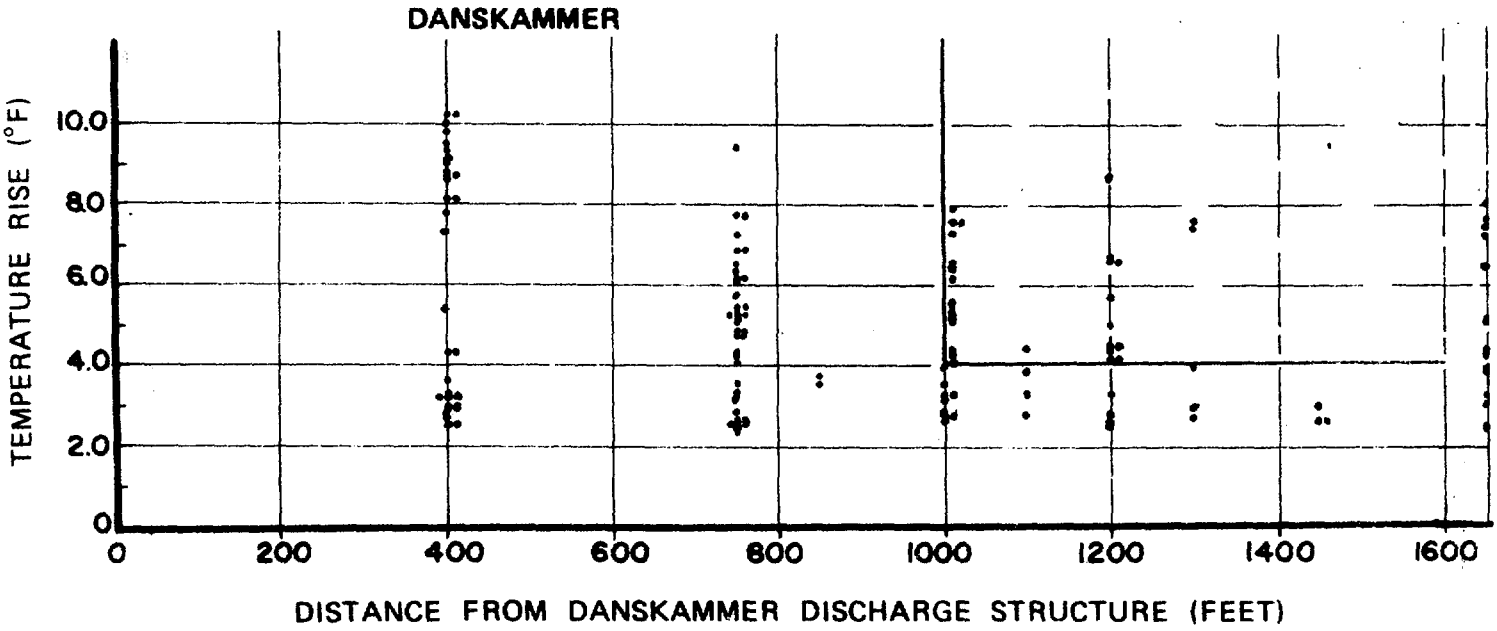
TIDAL AVERAGE

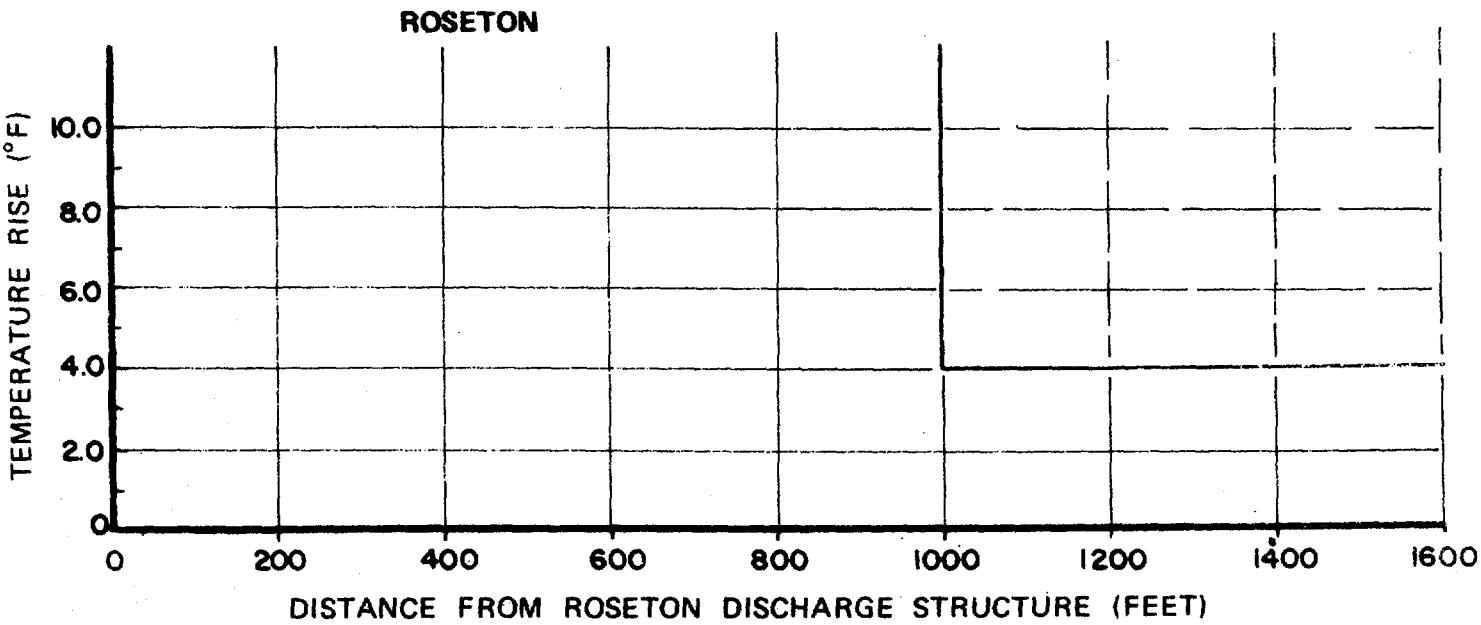
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 11





OPERATING CONDITIONS

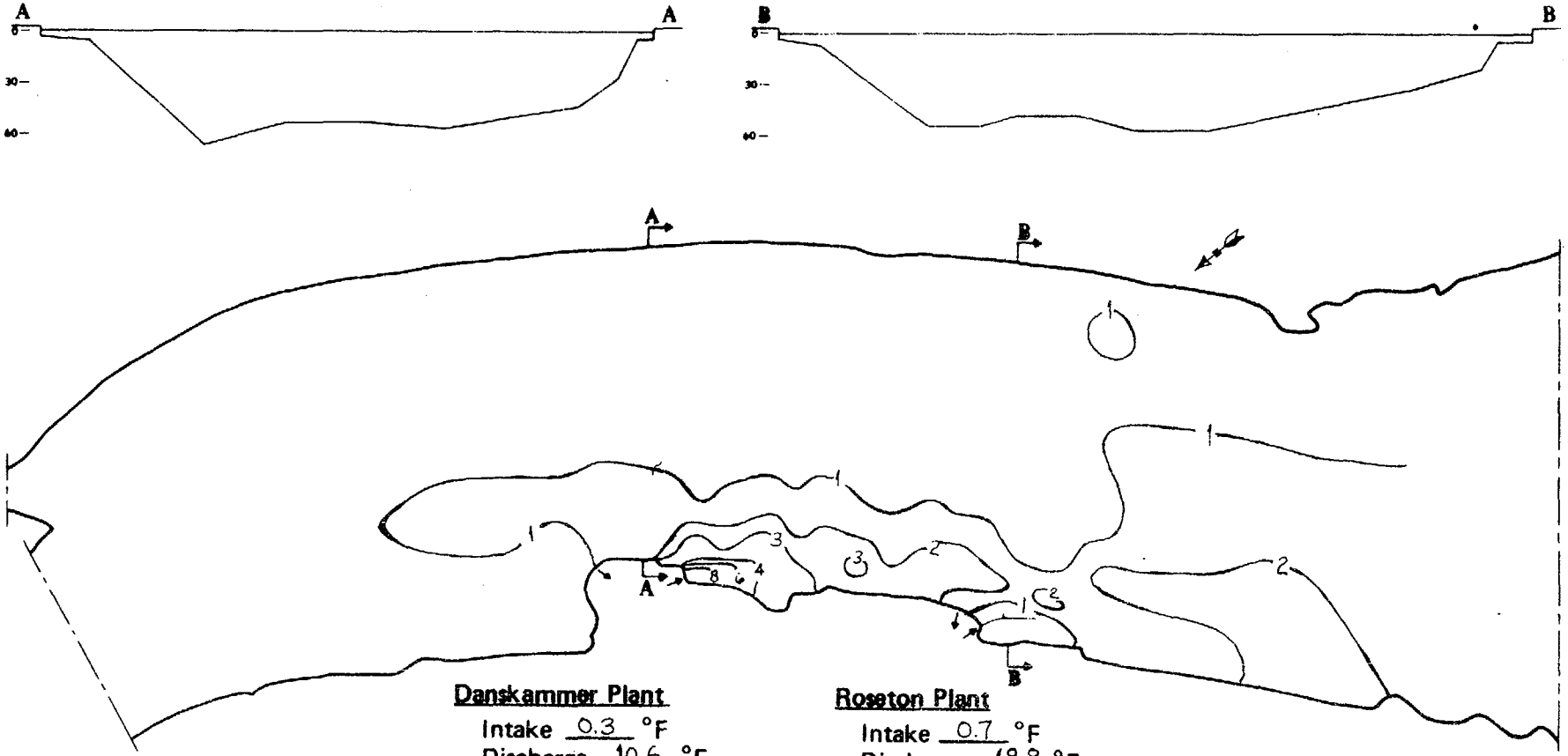
	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	13.5 °F
Roseton Plant	NOT OPERATING	____ cfs	____ °F
Test Date	16 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 12



Danskammer Plant

Intake 0.3 °F
Discharge 10.6 °F
ΔT 10.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 18.8 °F
ΔT 18.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

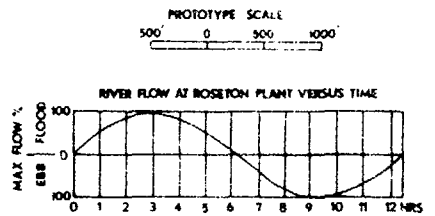
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6°F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



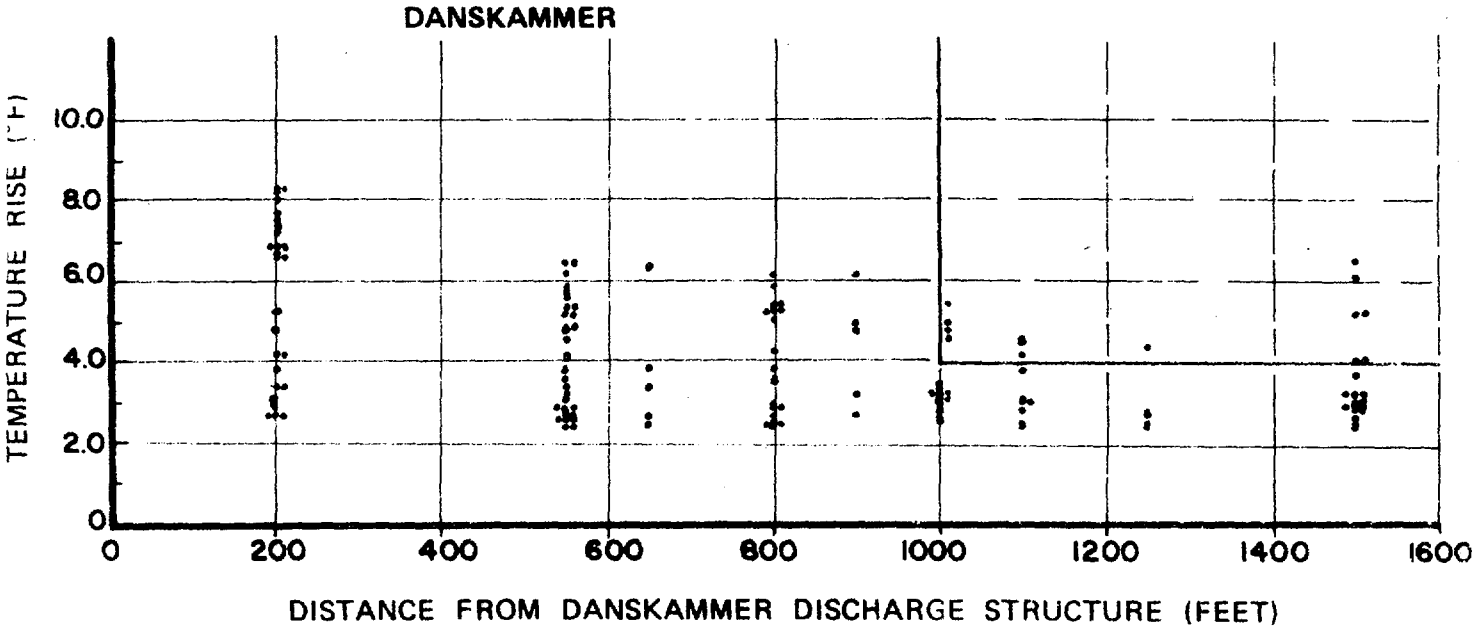
TIDAL AVERAGE

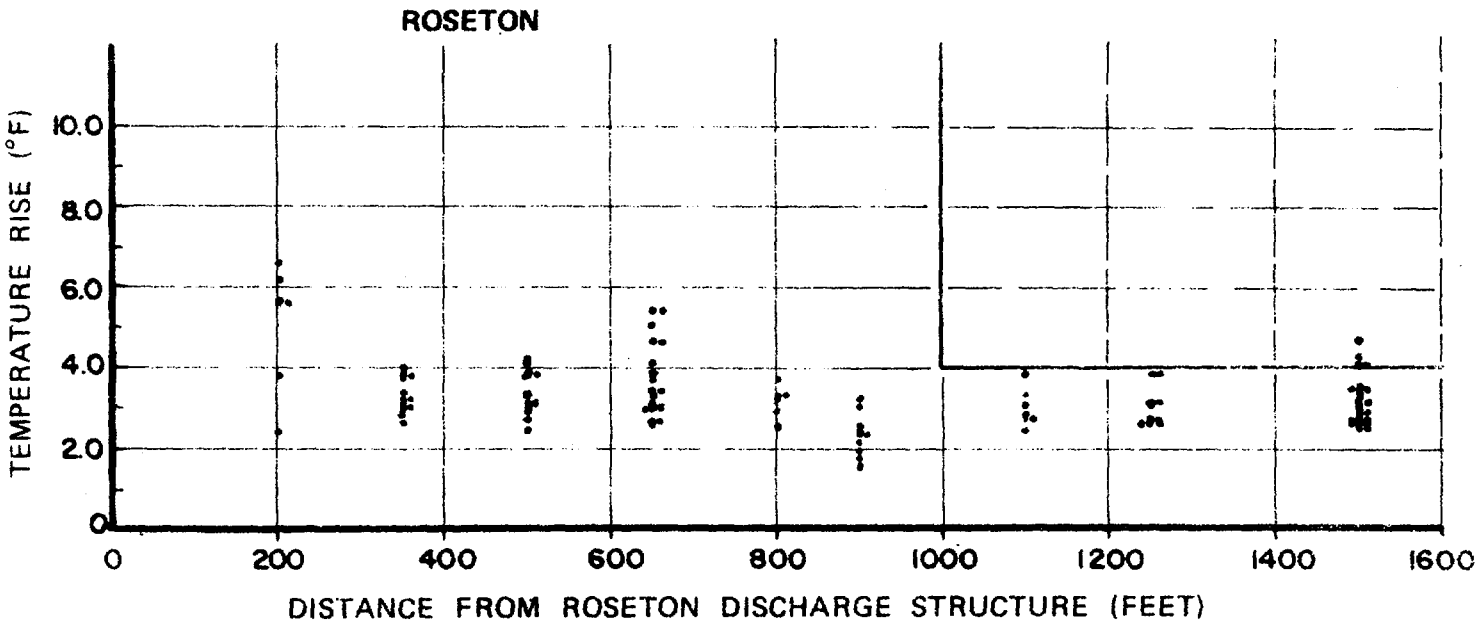
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 13





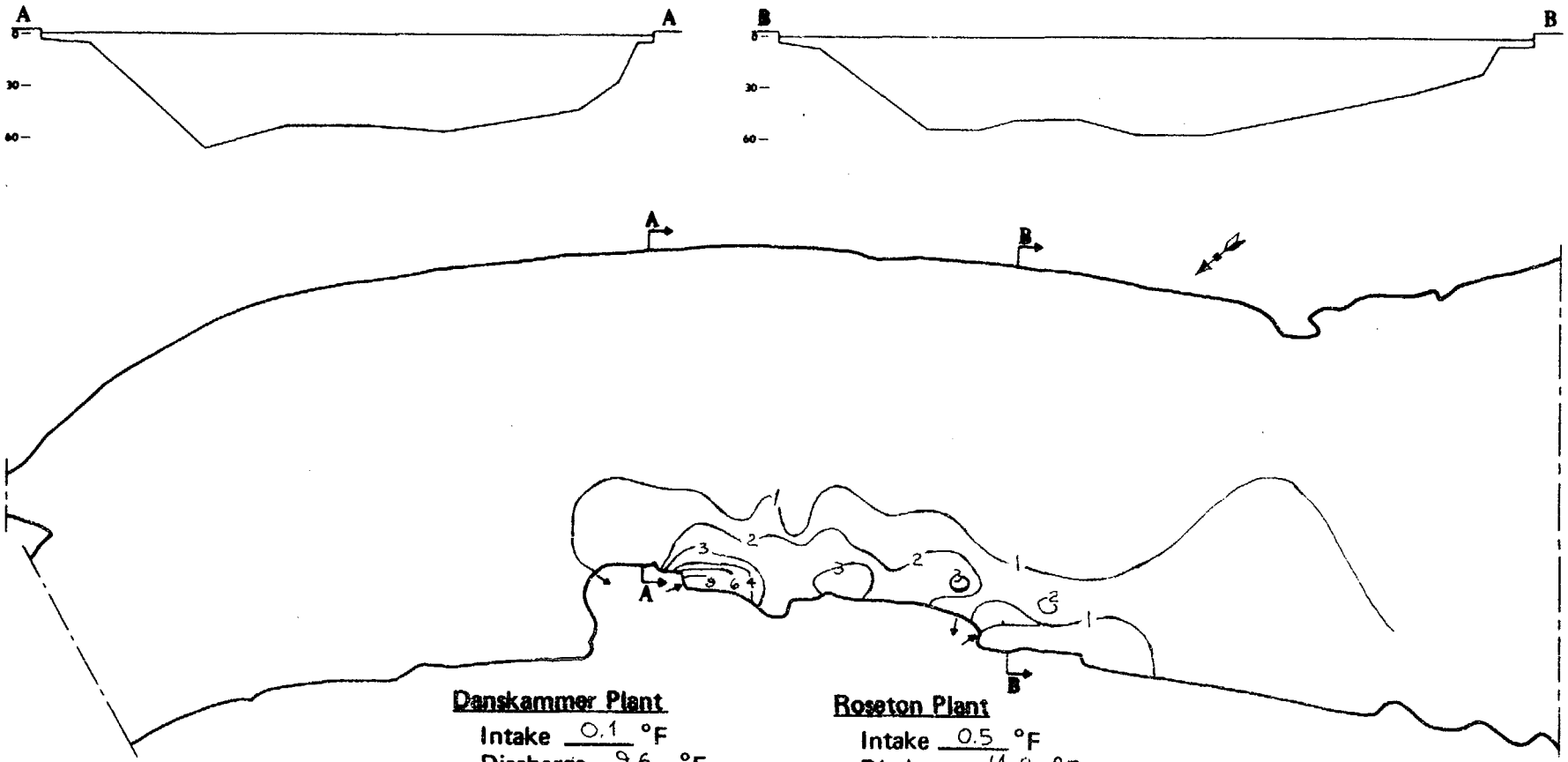
OPERATING CONDITIONS

	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	10.3 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	18.1 °F
Test Date	13 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations
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FIGURE 14



Danskammer Plant

Intake 0.1 °F
Discharge 9.6 °F
ΔT 9.5 °F
Flow 700 cfs
*Outfall Configuration 1

Roseton Plant

Intake 0.5 °F
Discharge 14.9 °F
ΔT 14.5 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.5 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

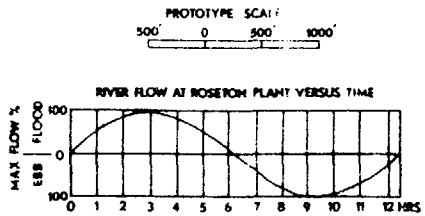
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



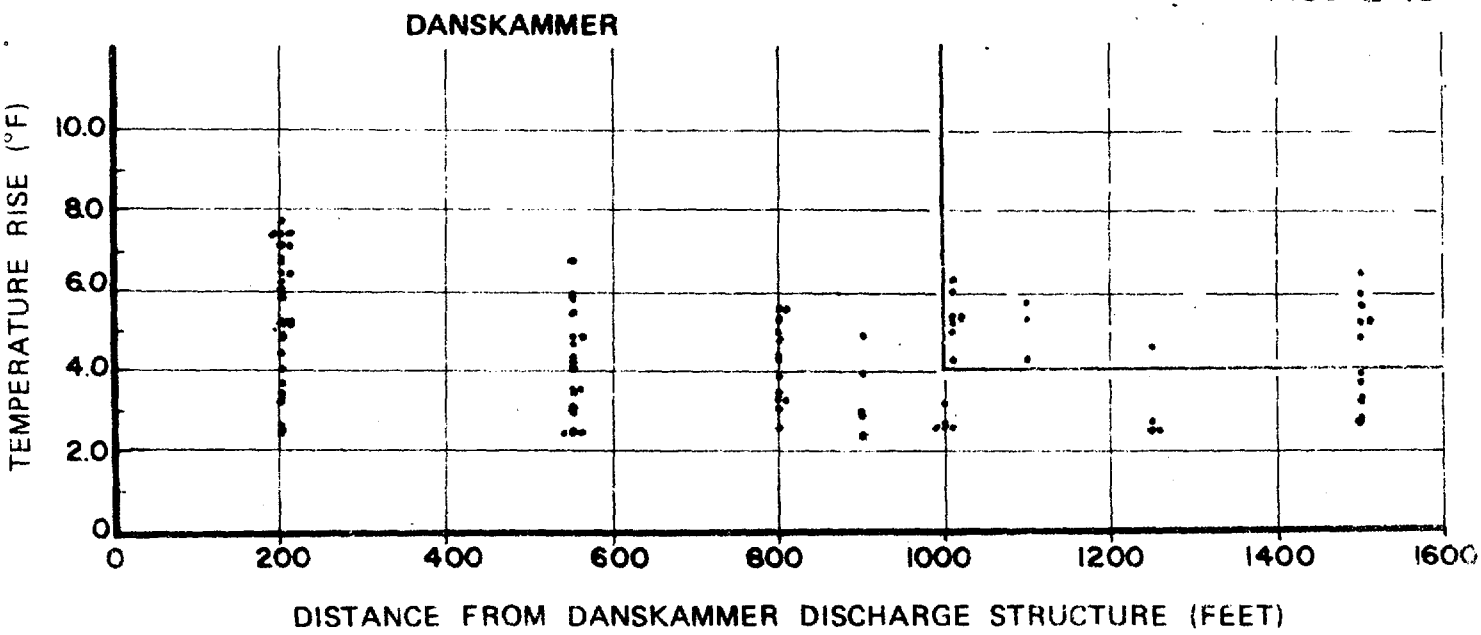
TIDAL AVERAGE

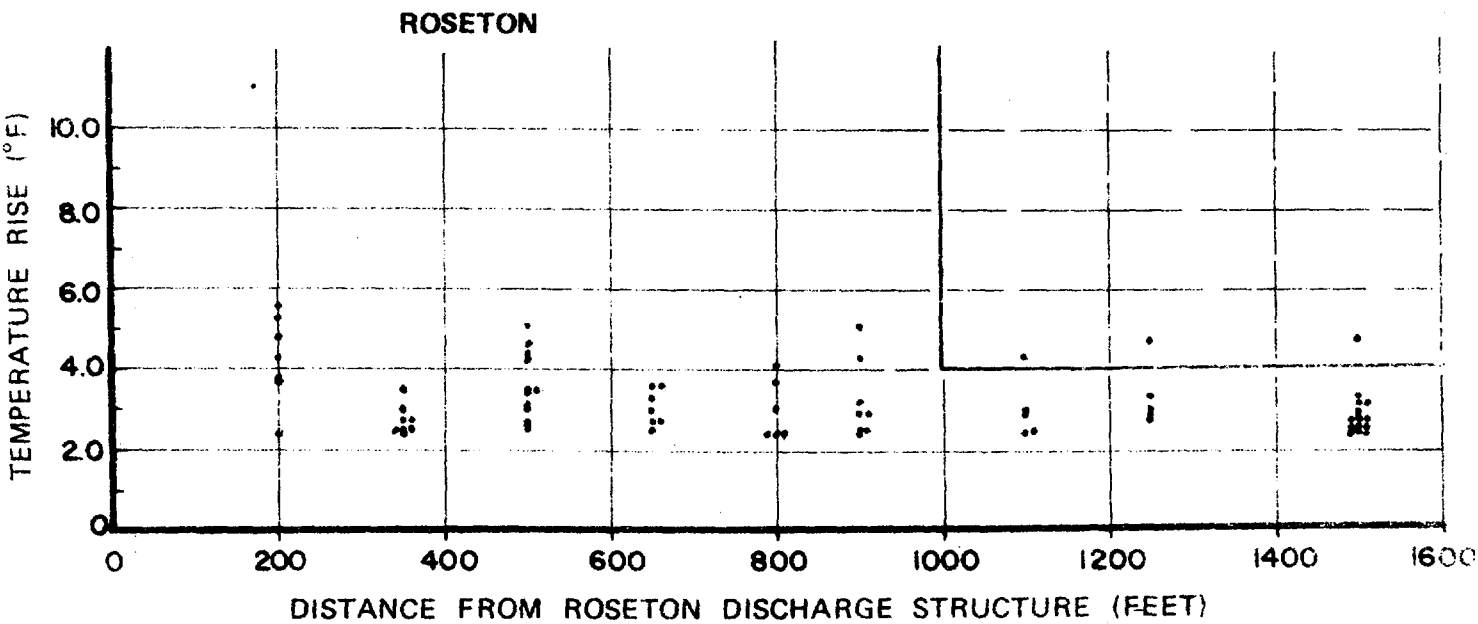
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 15





OPERATING CONDITIONS

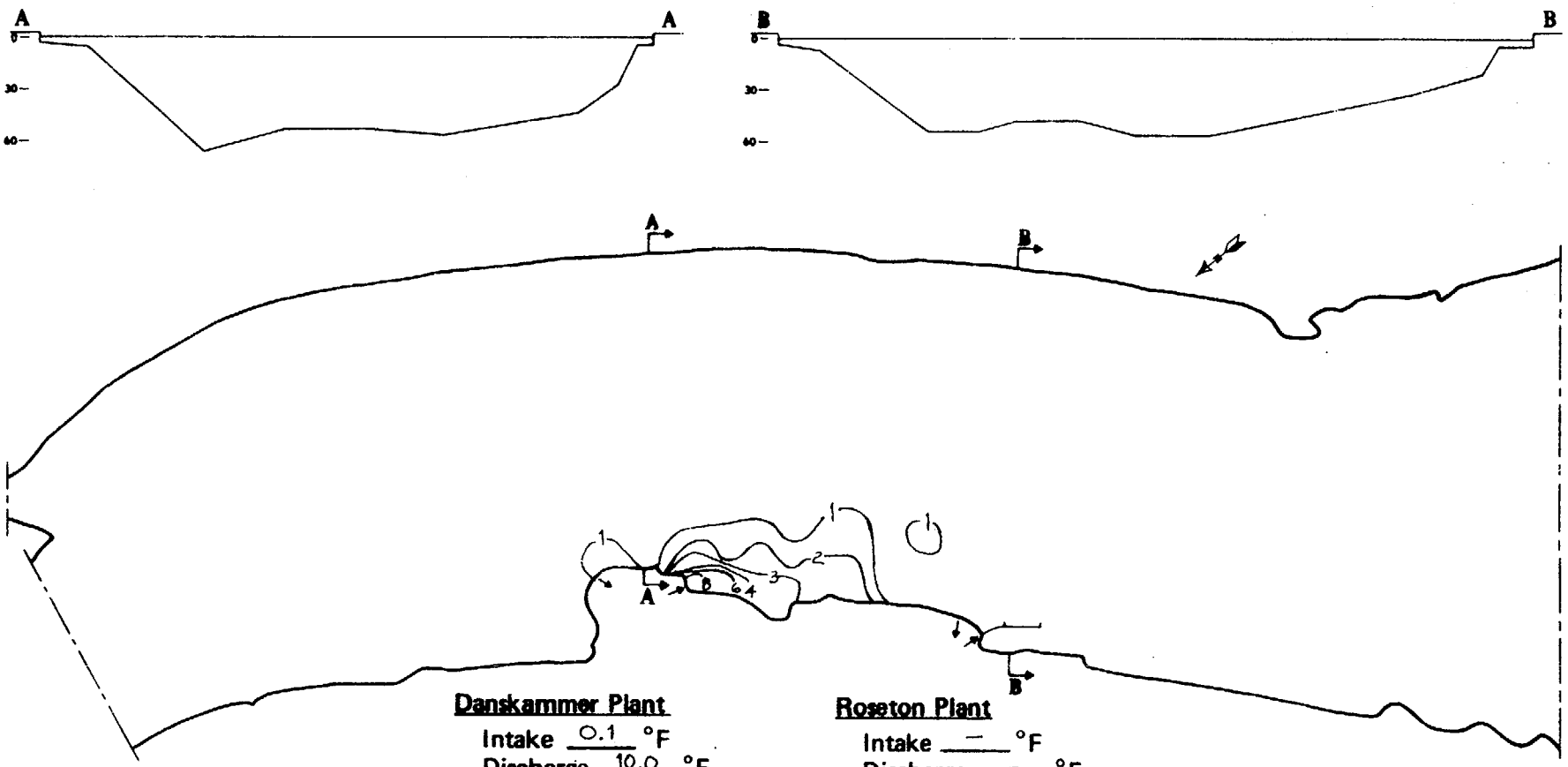
	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	9.5 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	14.5 °F
Test Date	15 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 16



Danskammer Plant

Intake 0.1 °F
Discharge 10.0 °F
ΔT 9.9 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 81.5 °F
Thermal Equilibrium Box Temperature −0.4 °F

River

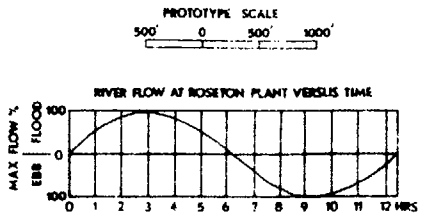
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



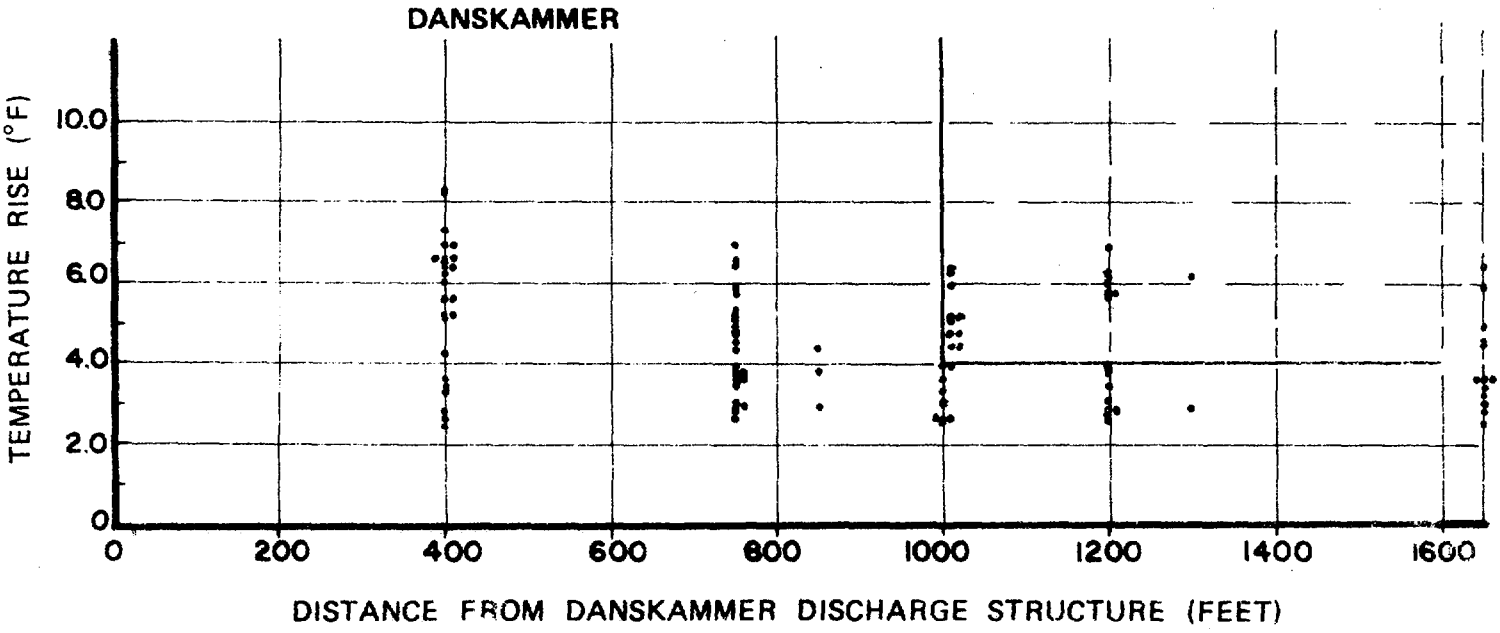
TIDAL AVERAGE

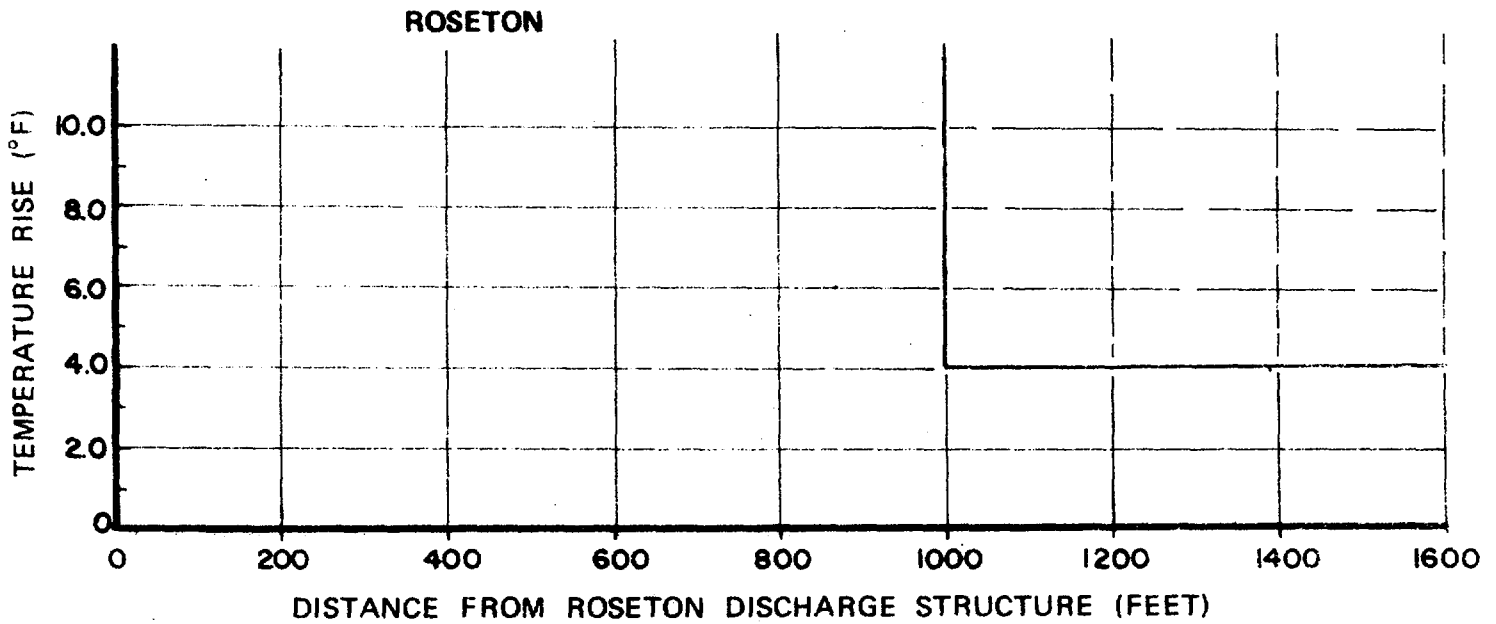
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 17





OPERATING CONDITIONS

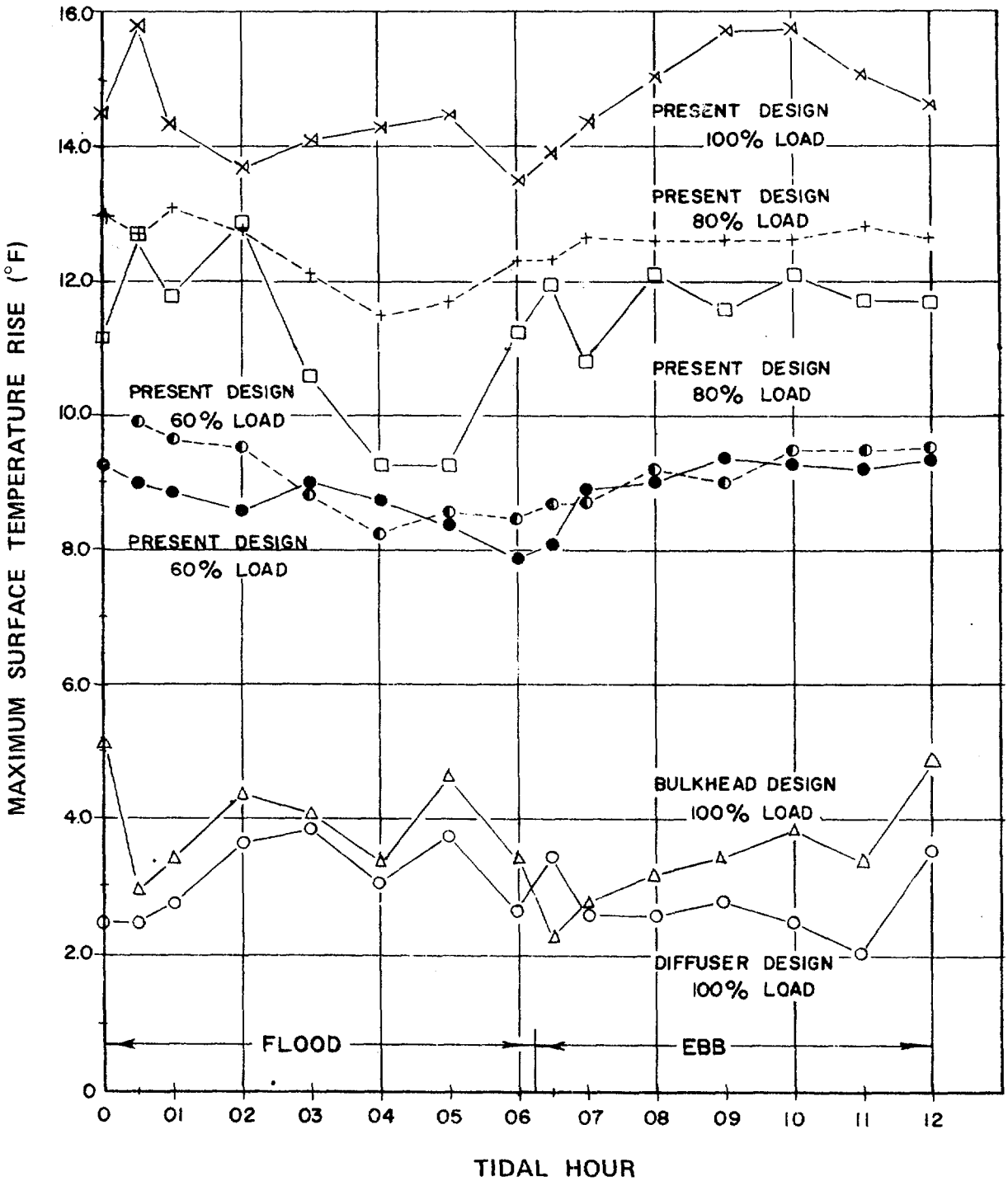
	Outfall Configuration	Flow	ΔT
Danskammer Plant	PRESENT DESIGN	700 cfs	9.9 °F
Roseton Plant	NOT OPERATING	____ cfs	____ °F
Test Date	16 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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FIGURE 18



NOTES: Solid connecting line represents Danskammer operating in conjunction with Roseton at 100% load.

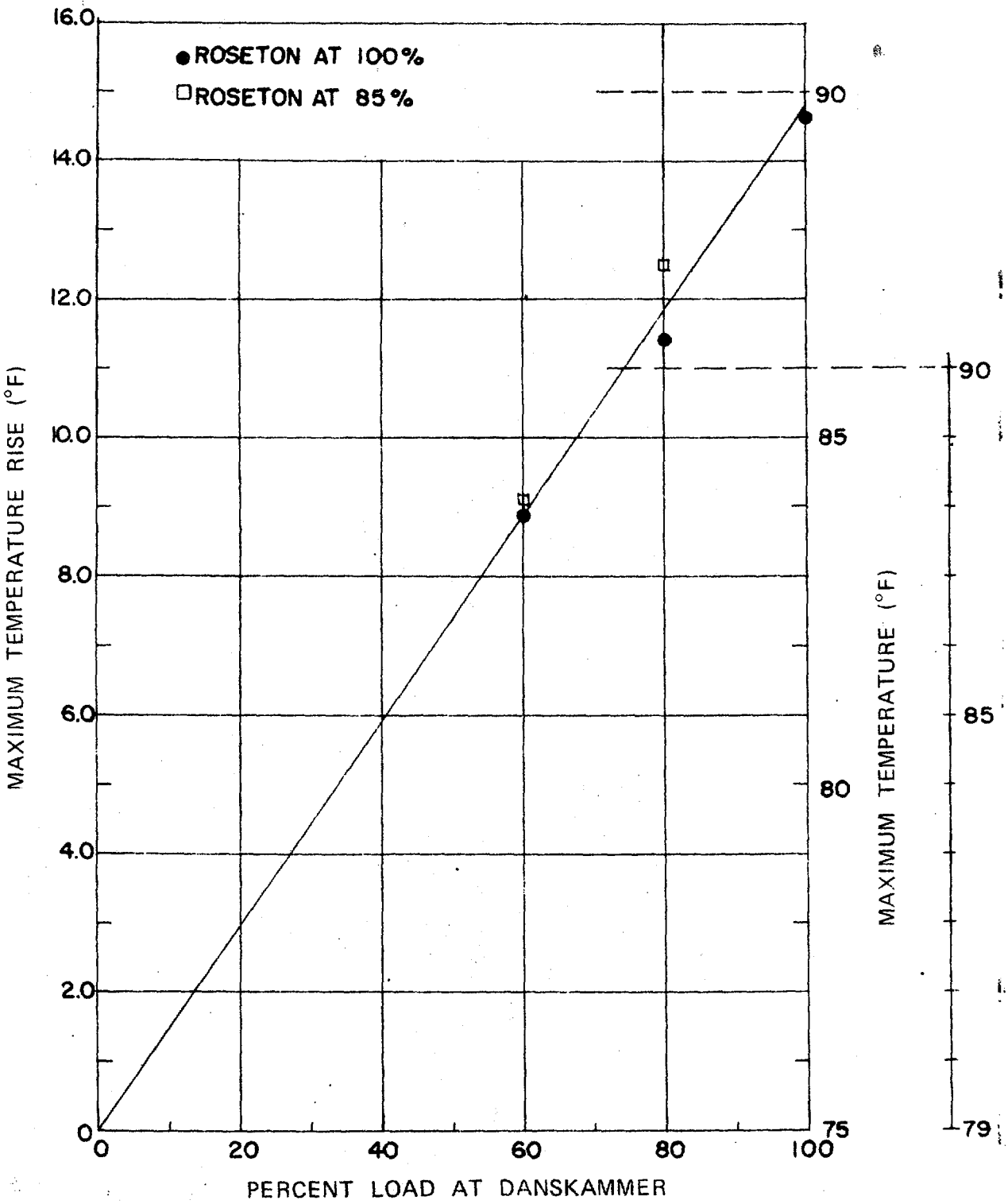
Dashed connecting line represents Danskammer operating in conjunction with Roseton at 85% load.

MAXIMUM SURFACE TEMPERATURE RISE ABOVE RIVER AMBIENT AT DANSKAMMER POWER PLANT

Hydrothermal Model Studies
Danskammer-Roseton Power Stations

ARL

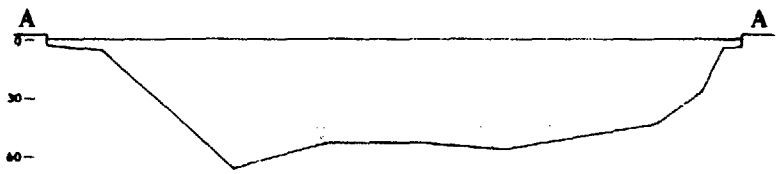
FIGURE 19

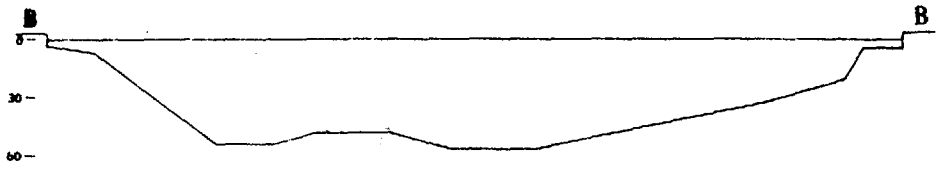


AVERAGED MAXIMUM SURFACE TEMPERATURE RISE AT DANSKAMMER VERSUS PERCENT LOAD

Hydrothermal Model Studies
Danskammer-Roseton Power Stations

ARL





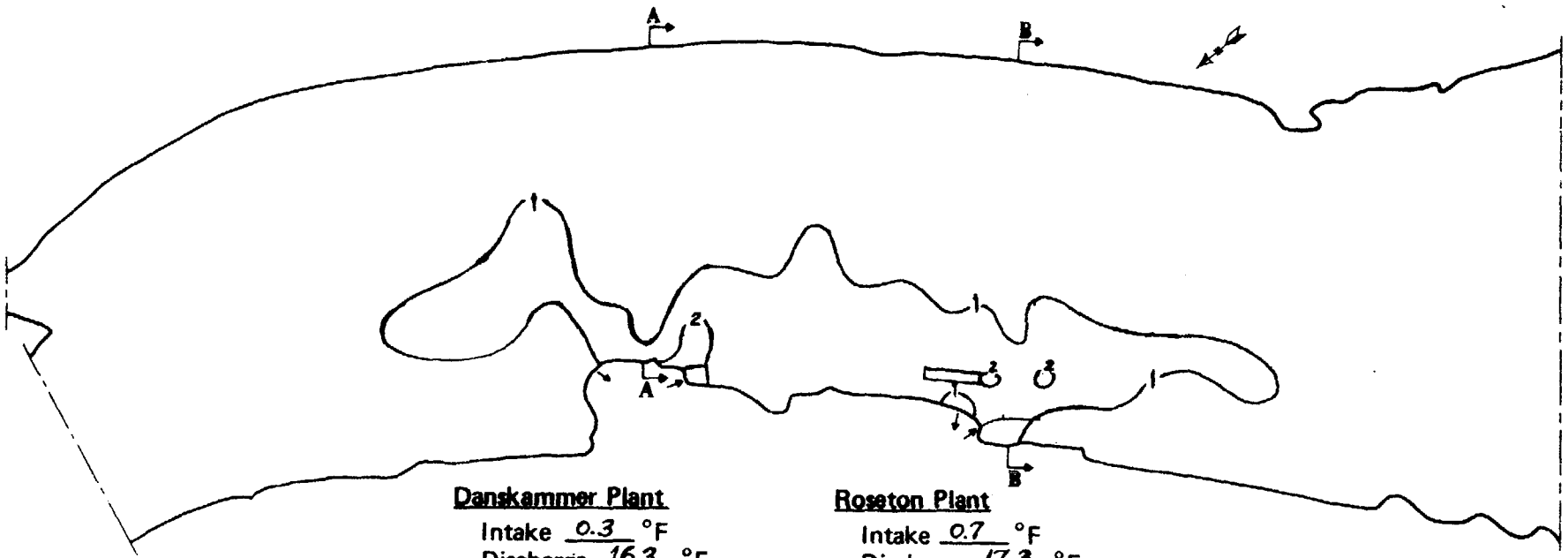


FIGURE 20

Danskammer Plant

Intake 0.3 °F
Discharge 16.3 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.7 °F
Discharge 17.3 °F
ΔT 16.7 °F
Flow 1400 cfs
** Outfall Configuration 1A

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

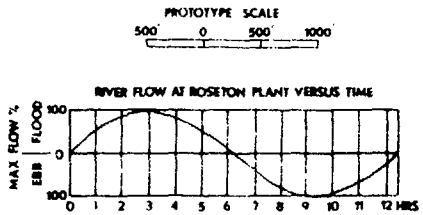
Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.7 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

Date 27 SEPT. 72



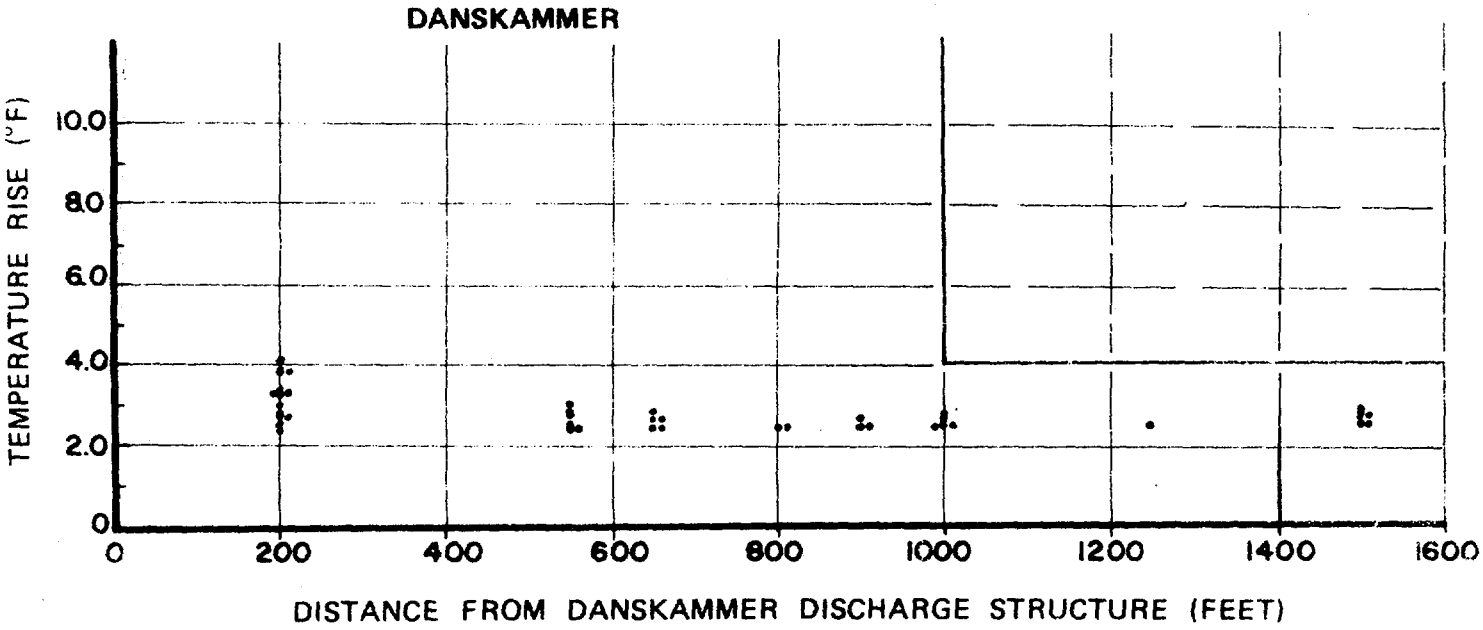
TIDAL AVERAGE

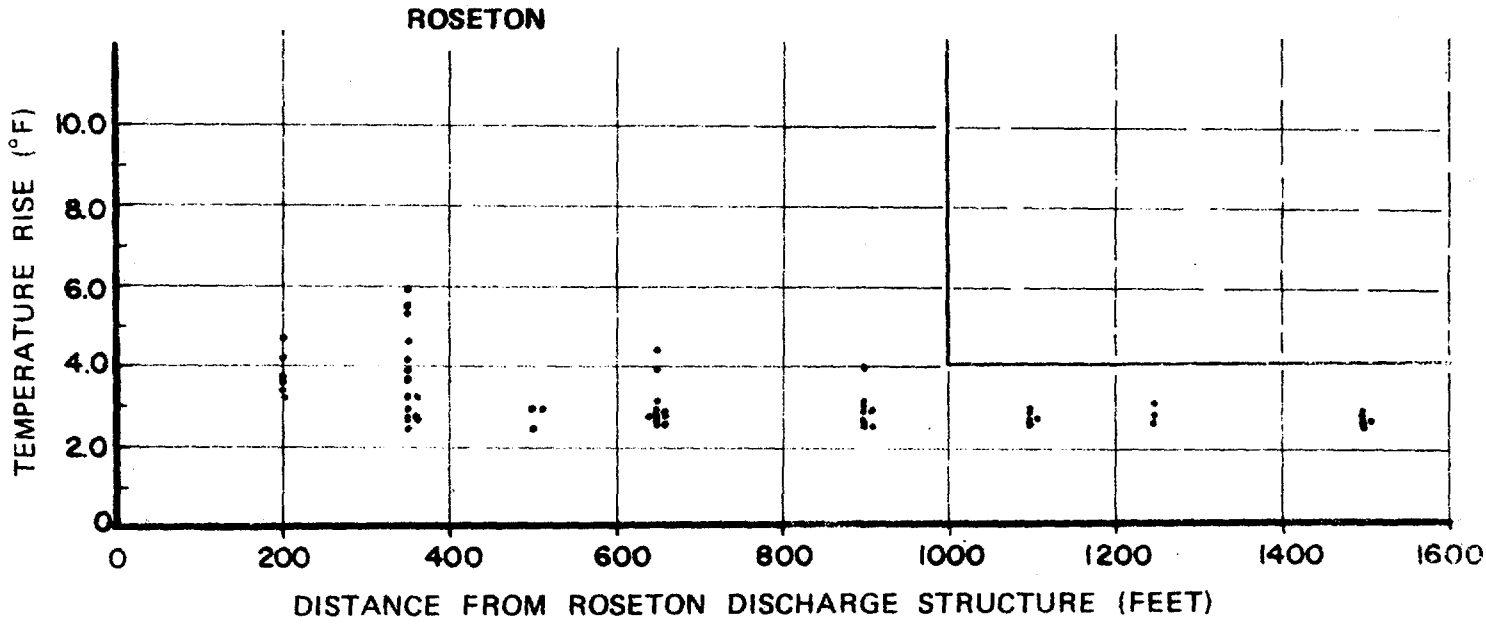
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 21





OPERATING CONDITIONS

	Outfall Configuration	Flow	ΔT
Danskammer Plant	BULKHEAD DESIGN	700 cfs	16.0 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	16.7 °F
Test Date	27 SEPT 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations
ARL

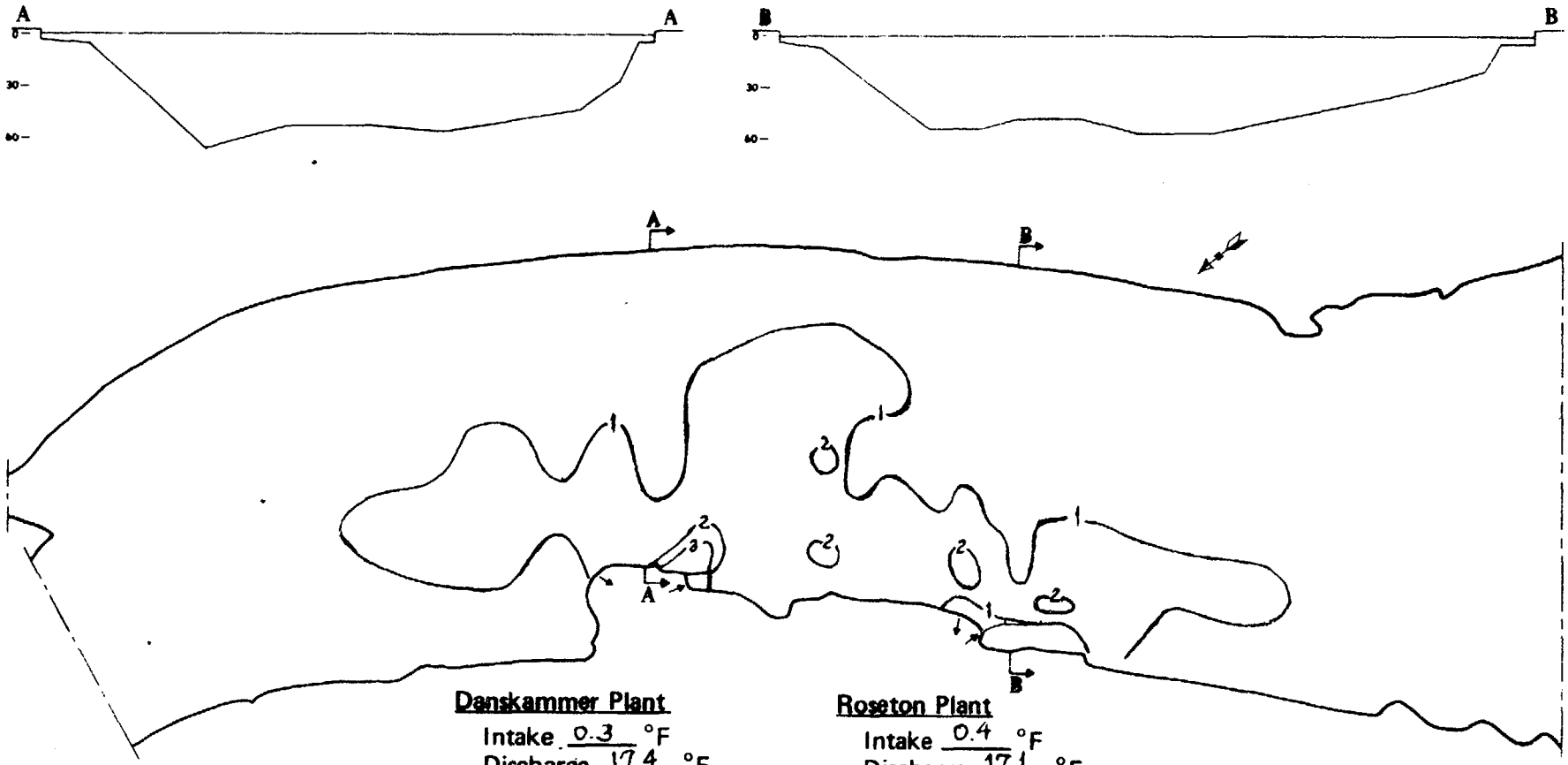


FIGURE 22

Danskammer Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.4 °F
Discharge 17.1 °F
ΔT 16.7 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 77.3 °F
Thermal Equilibrium Box Temperature −0.5 °F

River

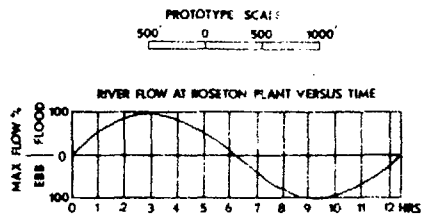
Fresh Water Flow 6000 cfs
Ambient Temperature 76.7 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



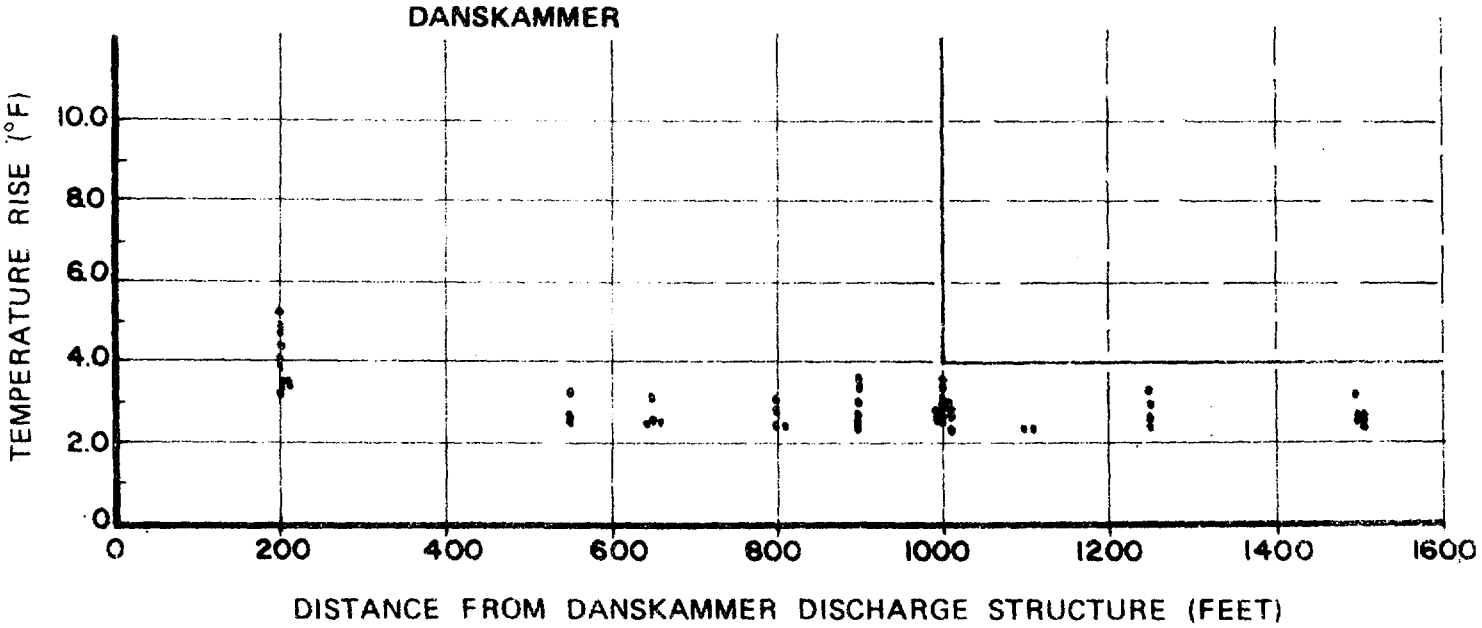
TIDAL AVERAGE

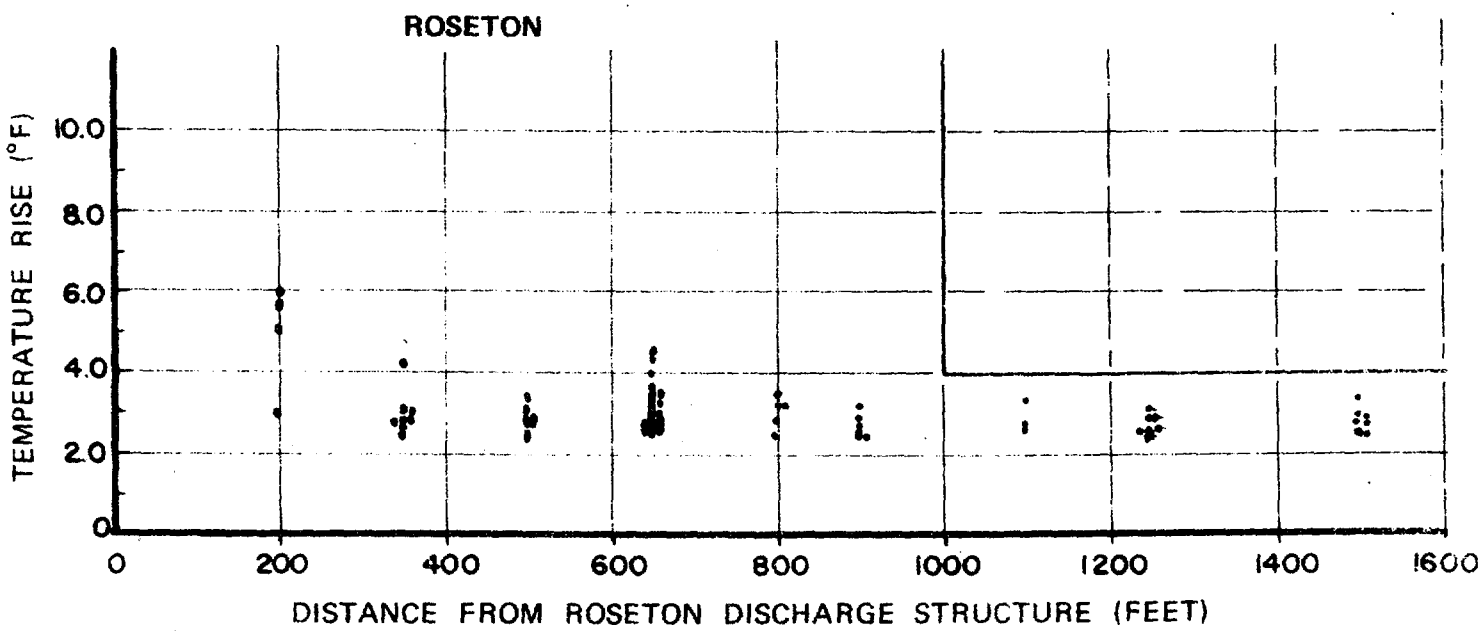
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 23





OPERATING CONDITIONS

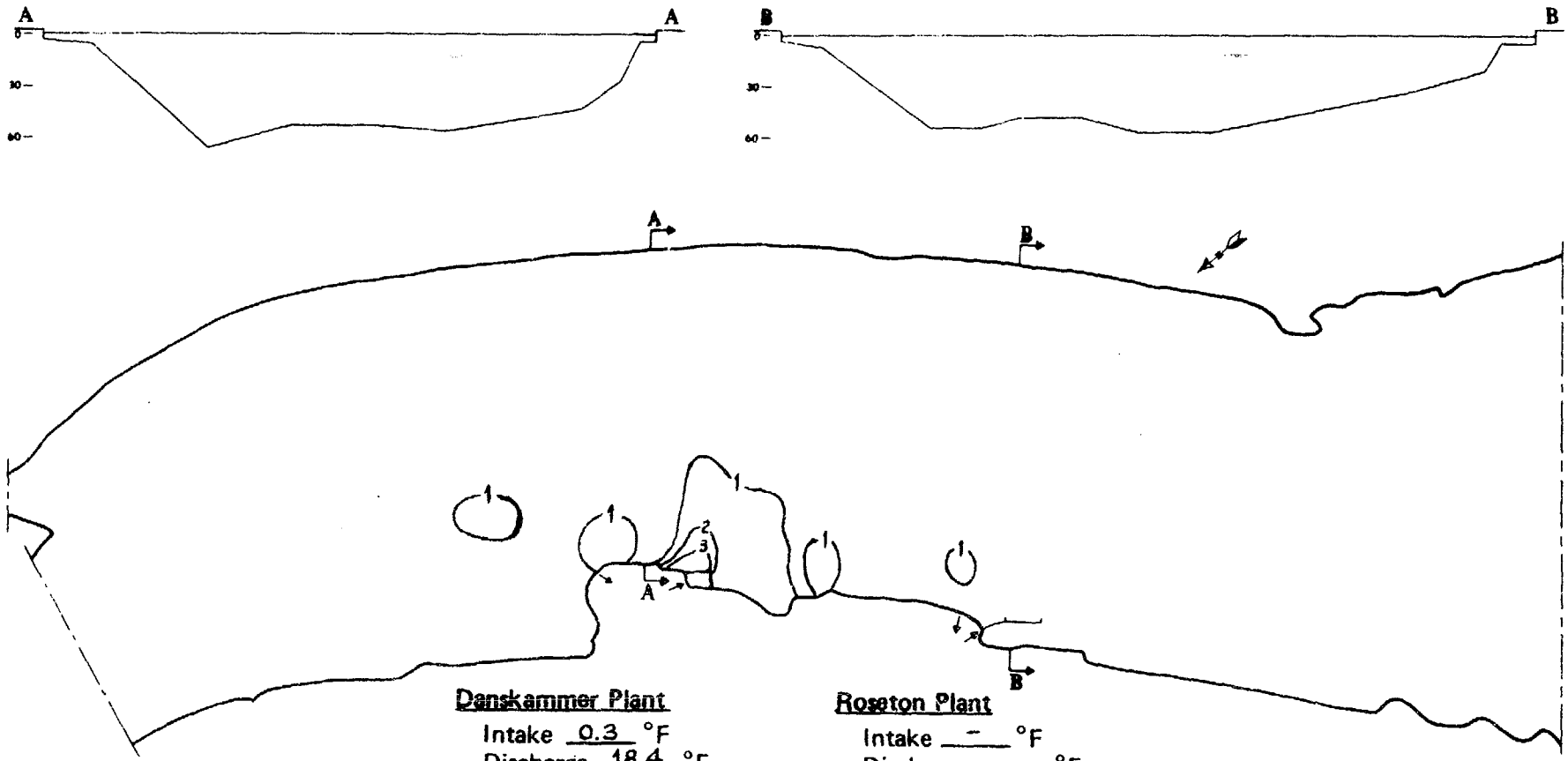
	Outfall Configuration	Flow	ΔT
Danskammer Plant	BULKHEAD DESIGN	700 cfs	17.1 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	16.7 °F
Test Date	28 JUNE 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

ARL

FIGURE 24



Danskammer Plant

Intake 0.3 °F
Discharge 18.4 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake – °F
Discharge – °F
ΔT – °F
Flow – cfs
** Outfall Configuration –

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 76.3 °F
Thermal Equilibrium Box Temperature -0.8 °F

River

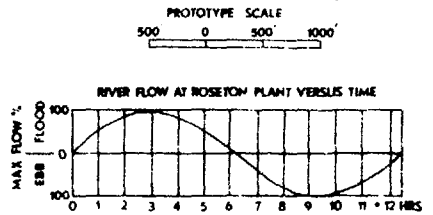
Fresh Water Flow 6000 cfs
Ambient Temperature 74.6 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



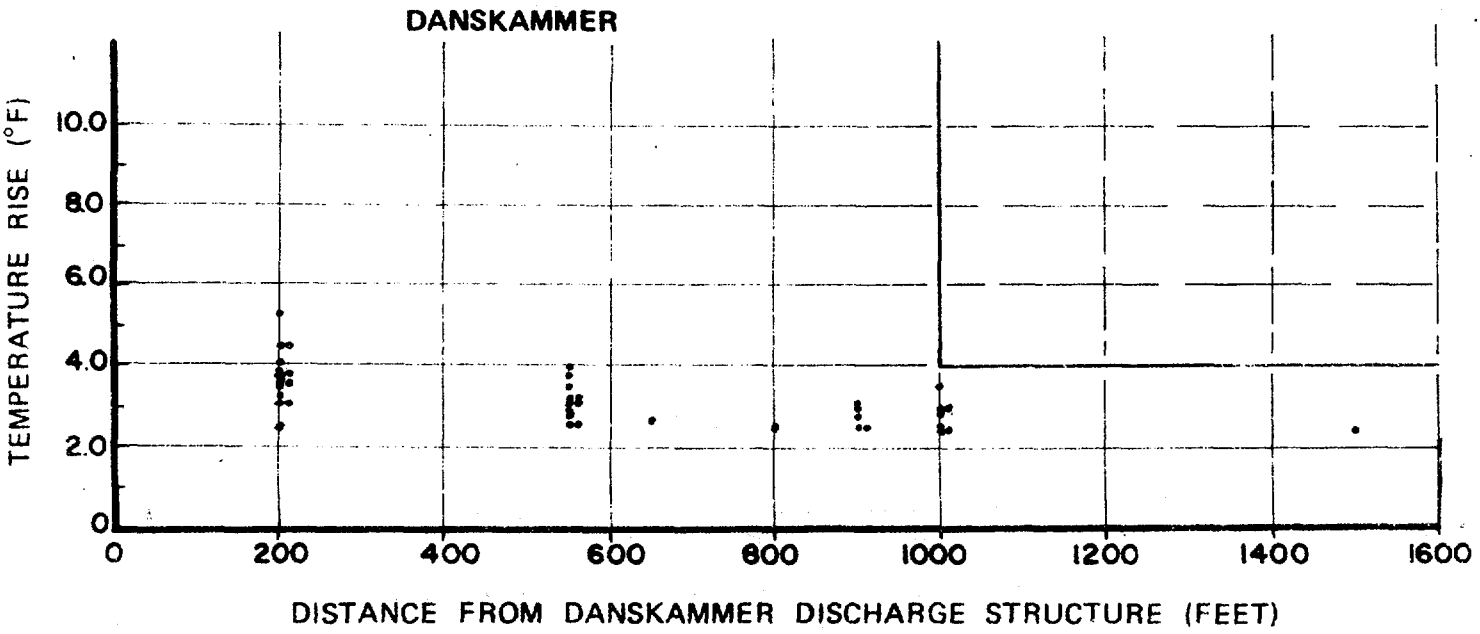
TIDAL AVERAGE

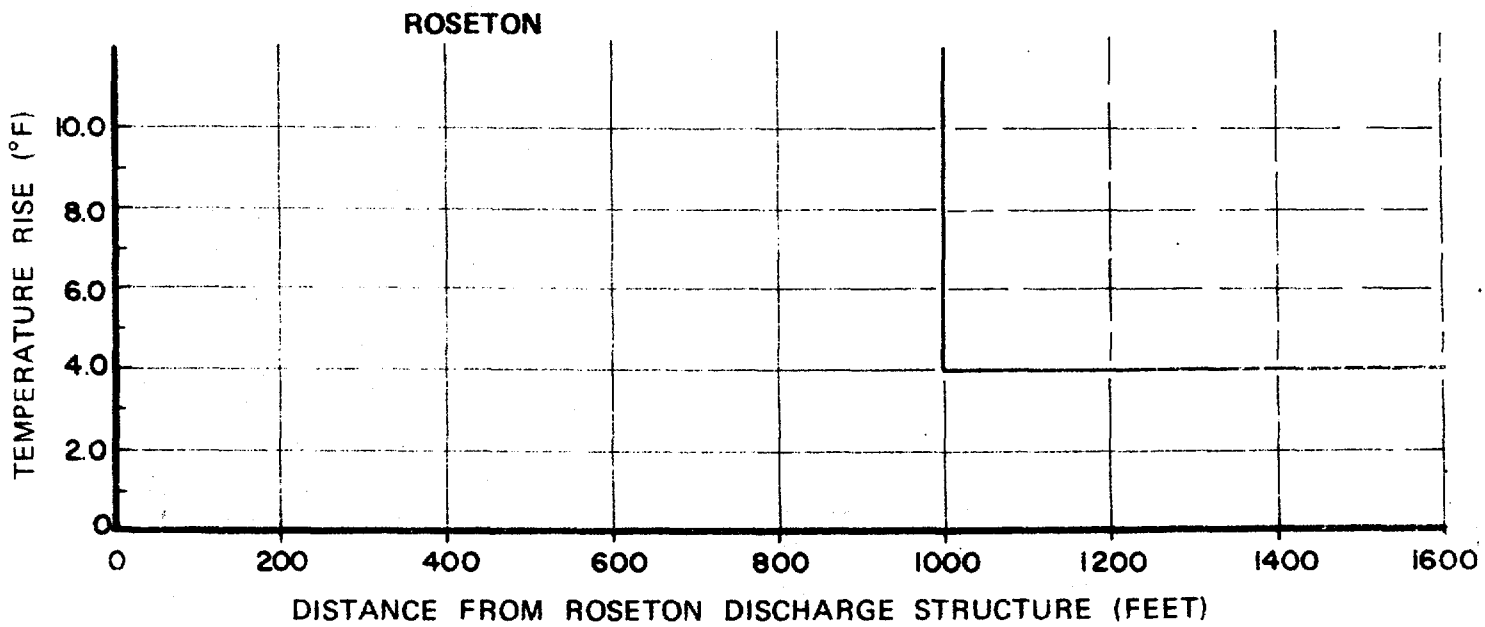
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 25





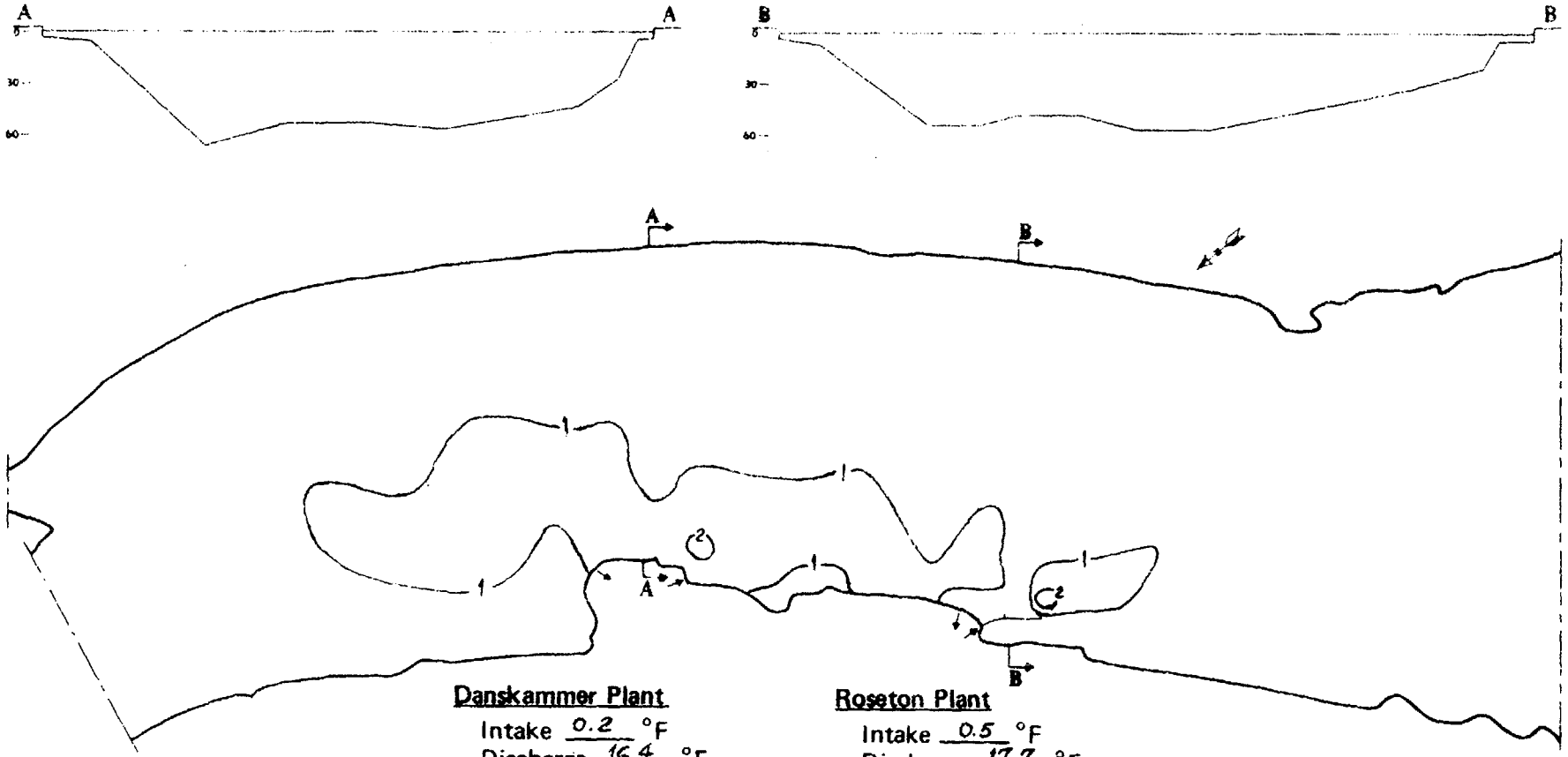
OPERATING CONDITIONS

	Outfall Configuration	Flow	ΔT
Danskammer Plant	BULKHEAD DESIGN	700 cfs	18.1 °F
Roseton Plant	NOT OPERATING	____ cfs	____ °F
Test Date	29 SEPT 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations
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FIGURE 26



Danskammer Plant

Intake 0.2 °F
Discharge 16.4 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.5 °F
Discharge 17.7 °F
ΔT 17.2 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 78 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

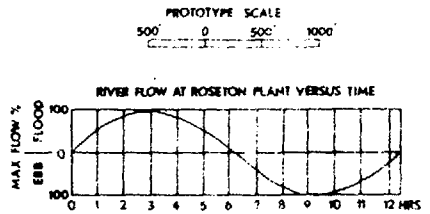
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



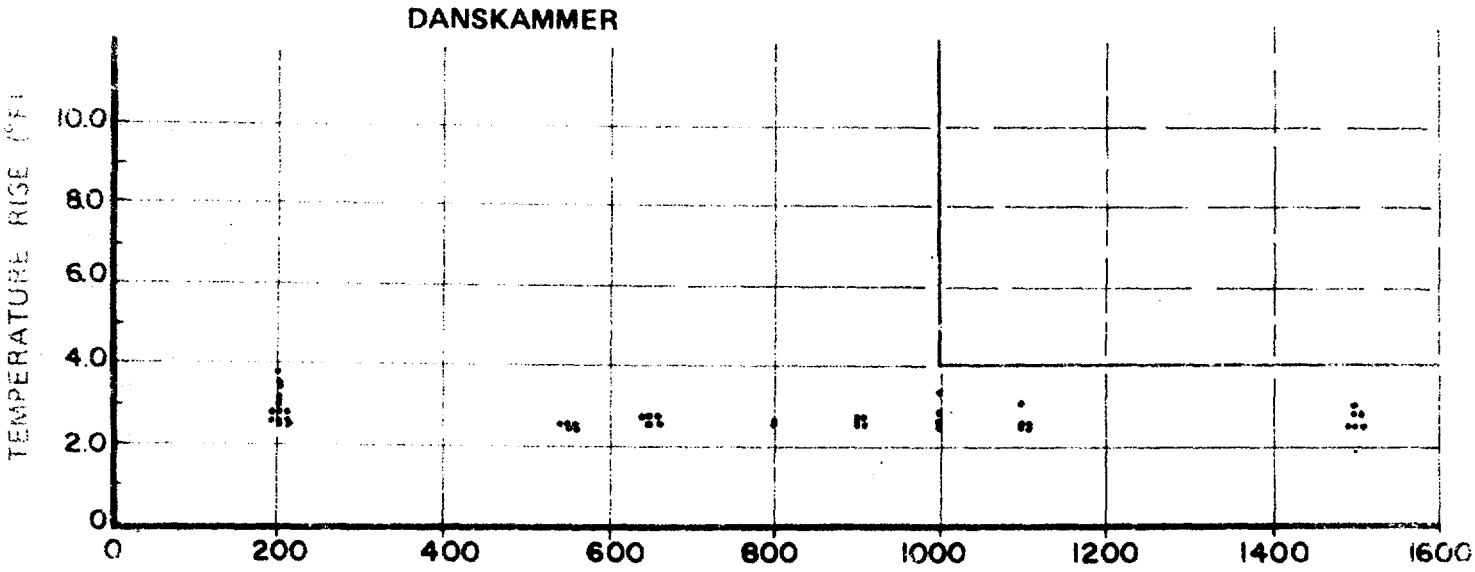
TIDAL AVERAGE

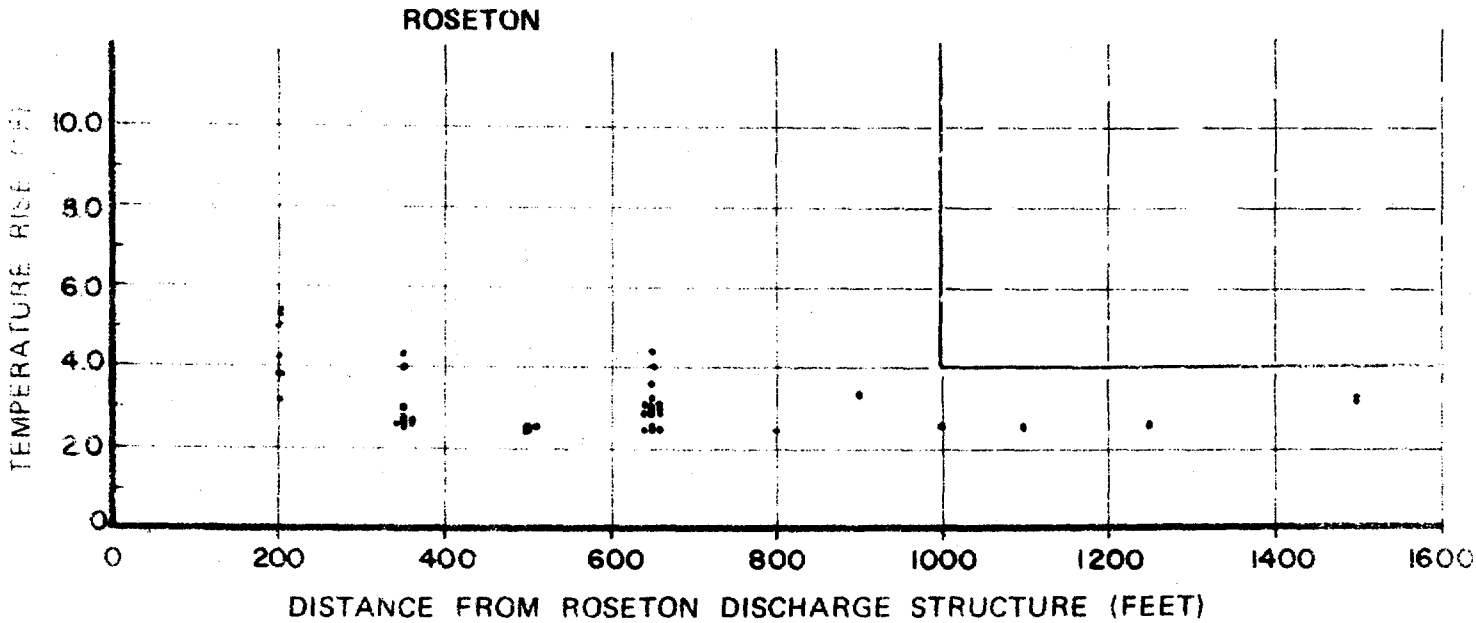
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE 27





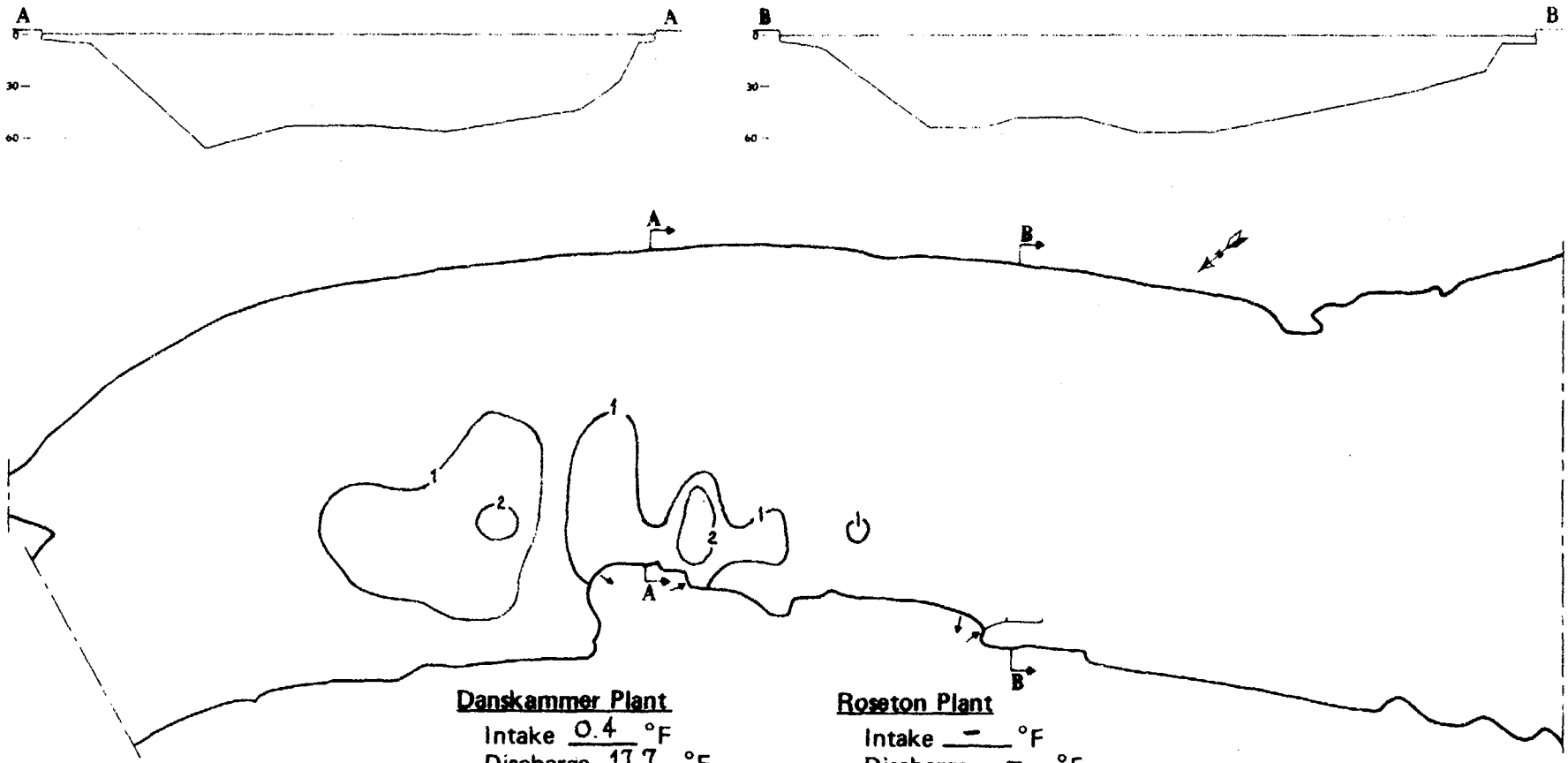
OPERATING CONDITIONS

	Outfall Configuration	Flow	ΔT
Danskammer Plant	SUBMERGED DIFFUSER	700 cfs	16.2 °F
Roseton Plant	SUBMERGED DIFFUSER	1400 cfs	17.2 °F
Test Date	20 SEPT 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations
ARL

FIGURE 28



Danskammer Plant

Intake 0.4 °F
Discharge 17.7 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 70.9 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

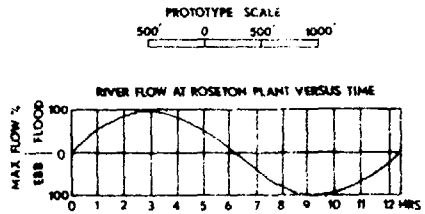
Fresh Water Flow 6000 cfs
Ambient Temperature 69.9 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



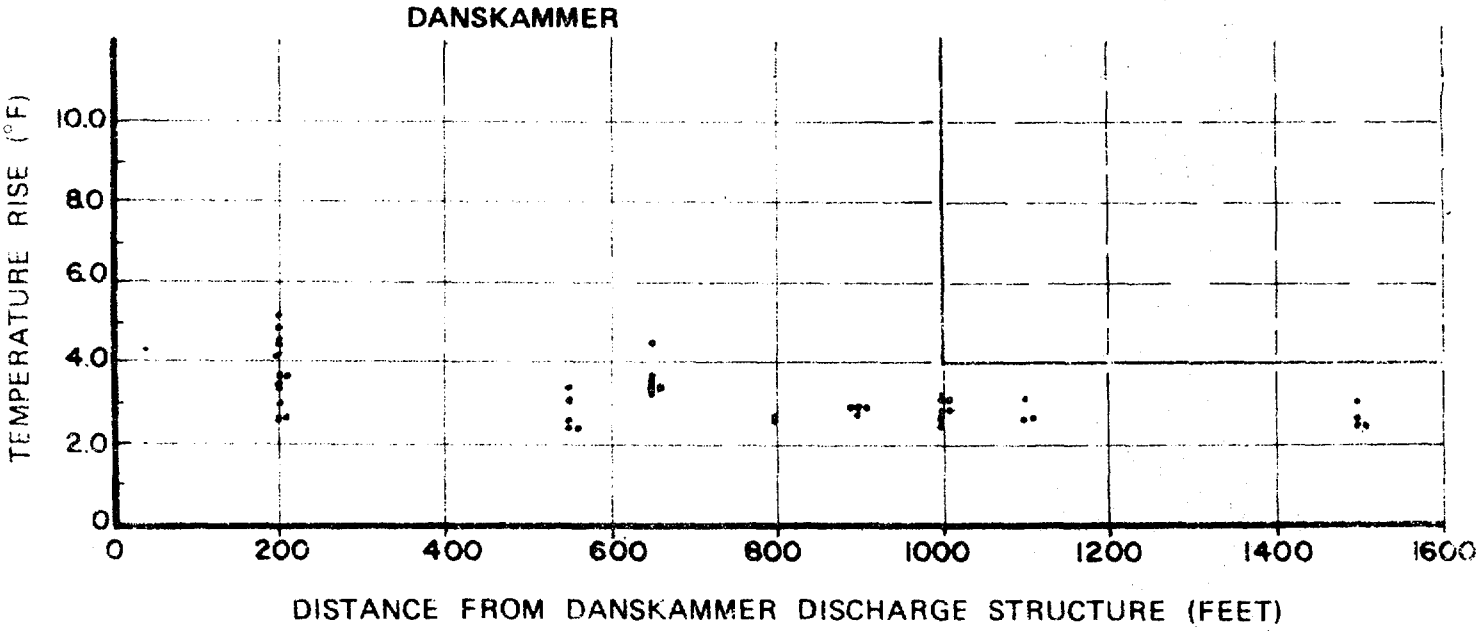
TIDAL AVERAGE

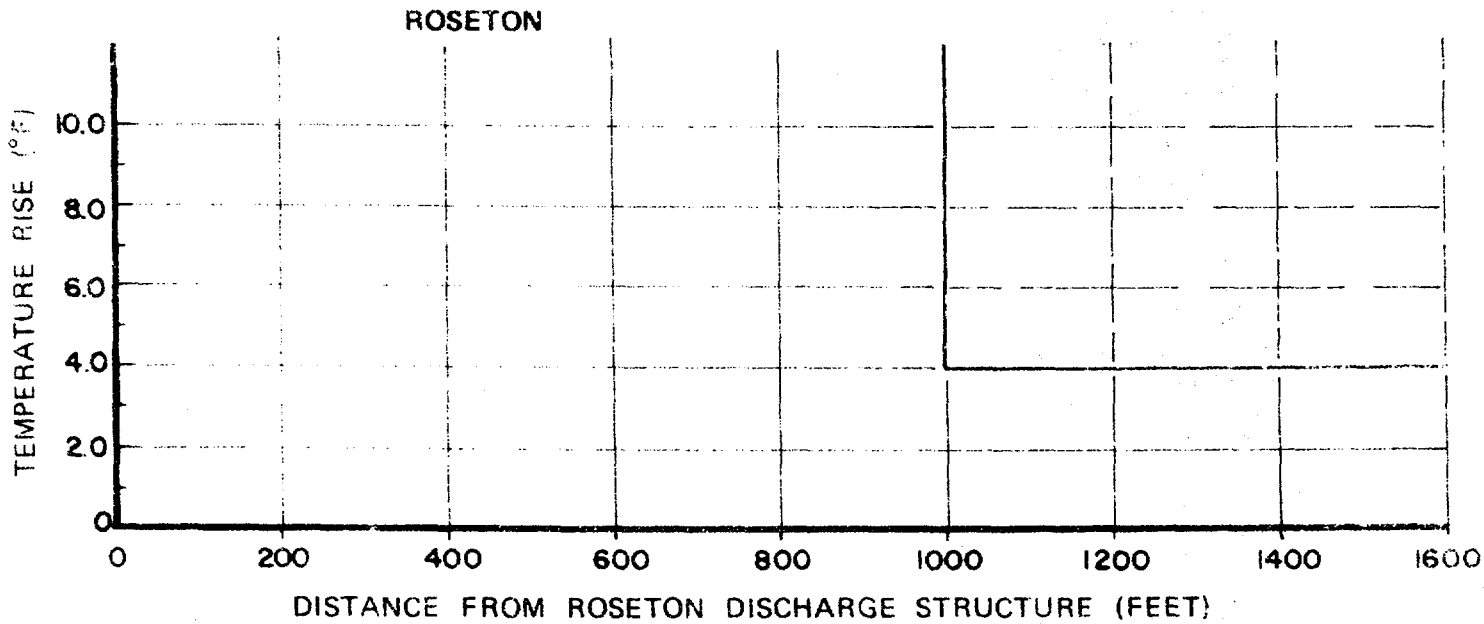
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE 29





OPERATING CONDITIONS

	Outfall Configuration	Flow	ΔT
Danskammer Plant	SUBMERGED DIFFUSER	700 cfs	17.3 °F
Roseton Plant	NOT OPERATING	____ cfs	____ °F
Test Date	21 SEPT 72		

NOTES: A. Distance measured radially from discharge structure.
B. Minimum temperature rise plotted is 2.4°F.
C. Data covers complete tide cycle.

TEMPERATURE RISE VERSUS DISTANCE
Hydrothermal Model Studies
Danskammer-Roseton Power Stations

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APPENDIX A

DANSKAMMER

LOAD	80%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	13.5 F

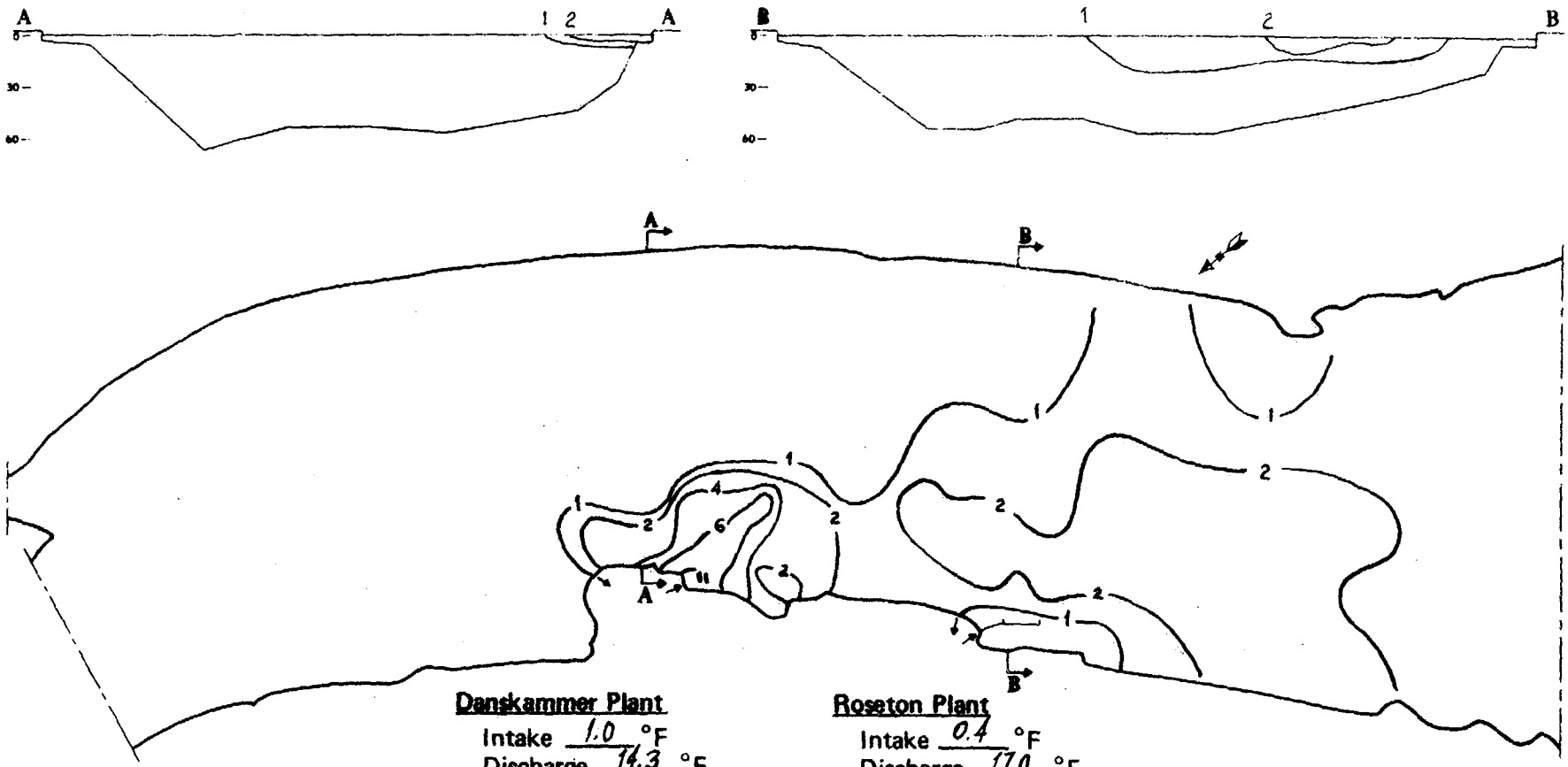
ROSETON

LOAD	100%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	16.5 F
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	81.7 F
FRESH WATER FLOW	6000 CFS

TEST DATE 12 JUNE 1972



Danskammer Plant

Intake 1.0 °F
Discharge 14.3 °F
ΔT 13.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.4 °F
Discharge 17.0 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

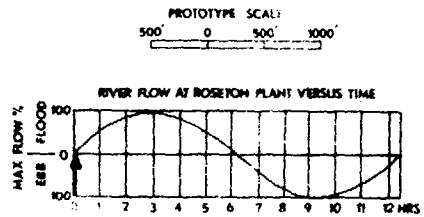
Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



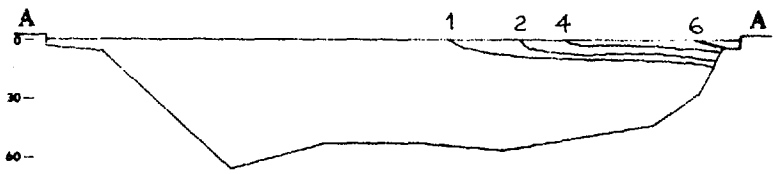
TEMPERATURE RISE ABOVE RIVER AMBIENT

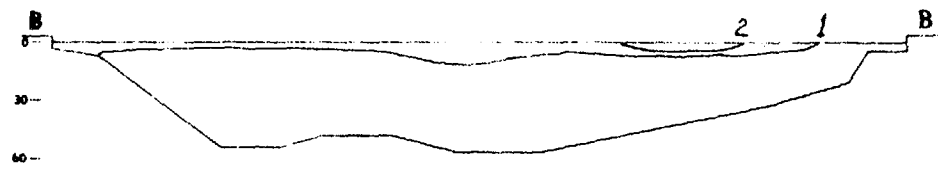
Hydrothermal Model Studies
Danskammer—Roseton Power Stations

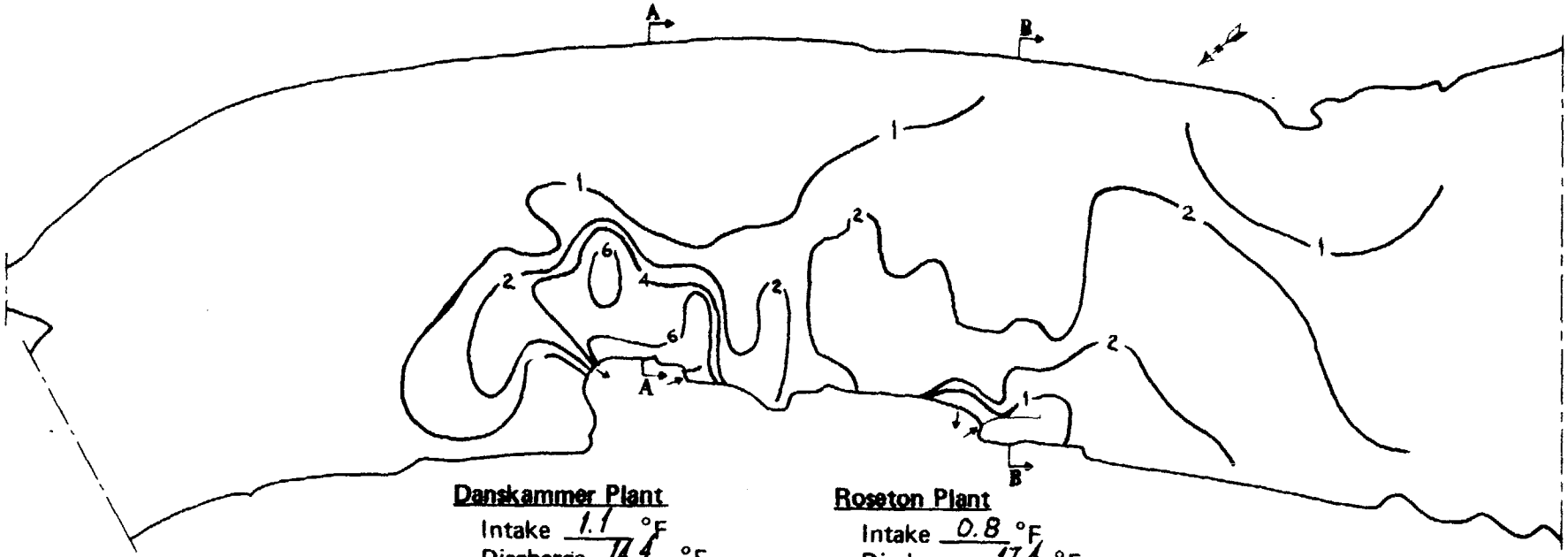
ARL

FIGURE A 1

FIGURE A 2







Danskammer Plant

Intake 1.1 °F
Discharge 14.4 °F
ΔT 13.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 17.4 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 18

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

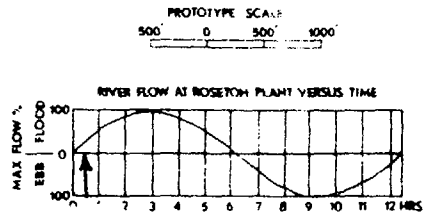
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 2.1 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.6 °F

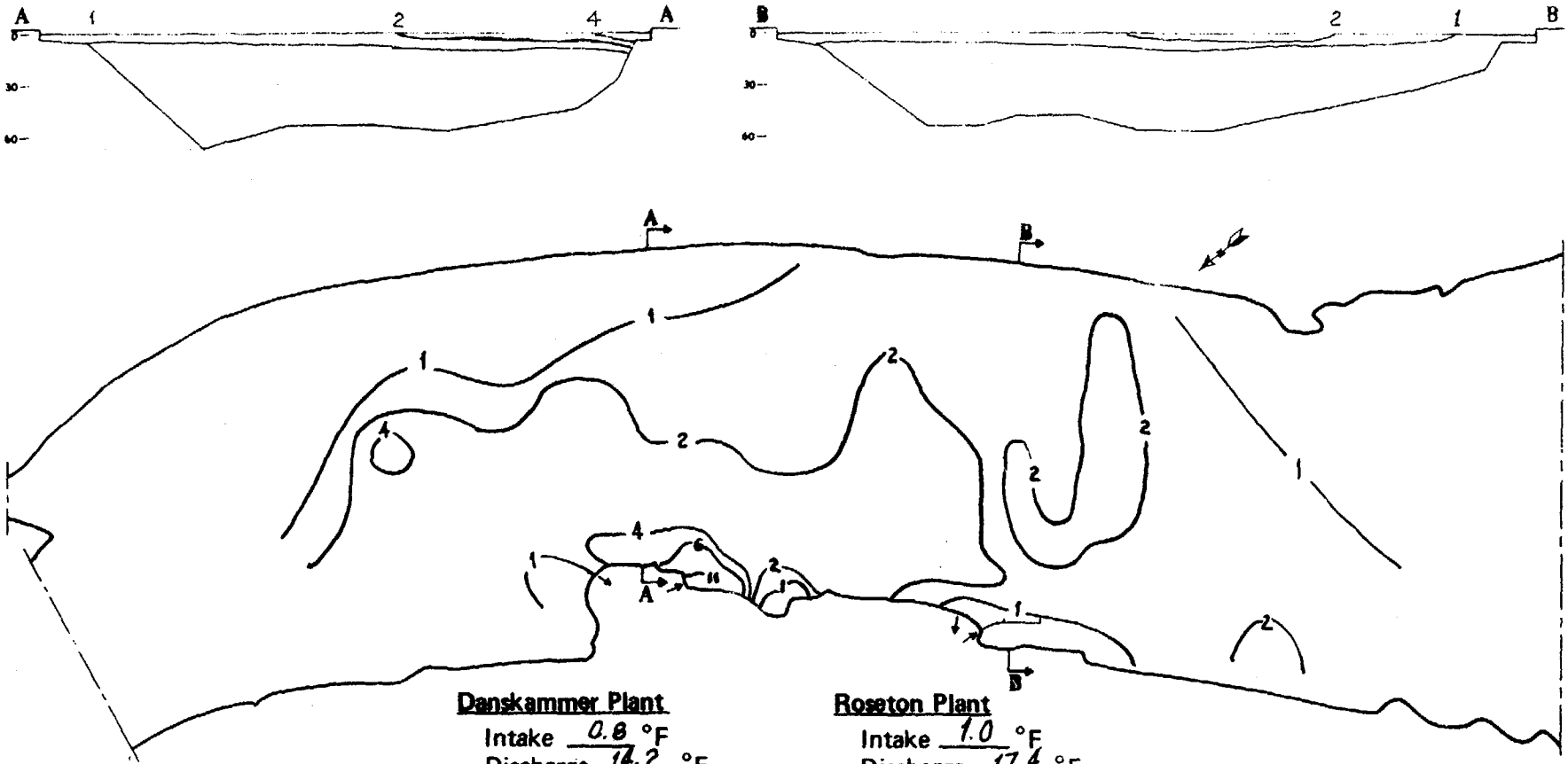
Date 12 JUNE 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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Danskammer Plant

Intake 0.8 °F
Discharge 14.2 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.0 °F
Discharge 17.4 °F
ΔT 16.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.8 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

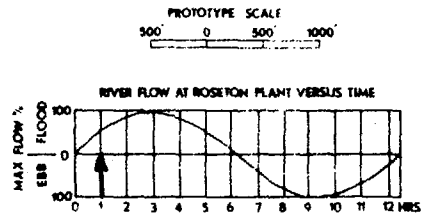
Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser – 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 3

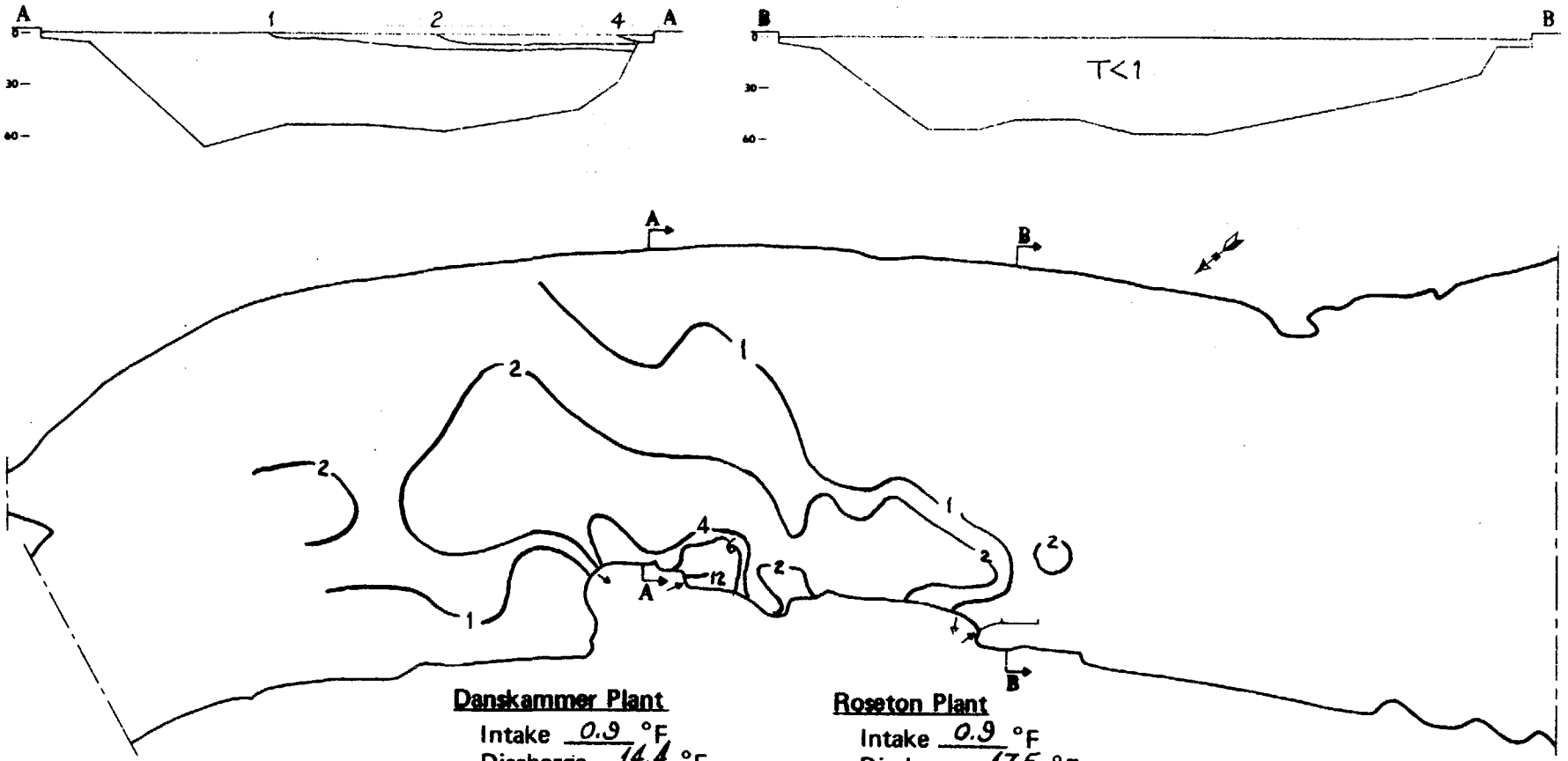


FIGURE A 4

Danskammer Plant

Intake 0.9 °F
Discharge 14.4 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 17.5 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

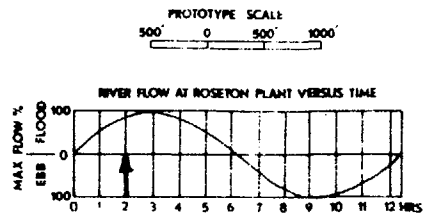
Fresh Water Flow 6000 cfs
Ambient Temperature 81.6 °F

Date 12 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

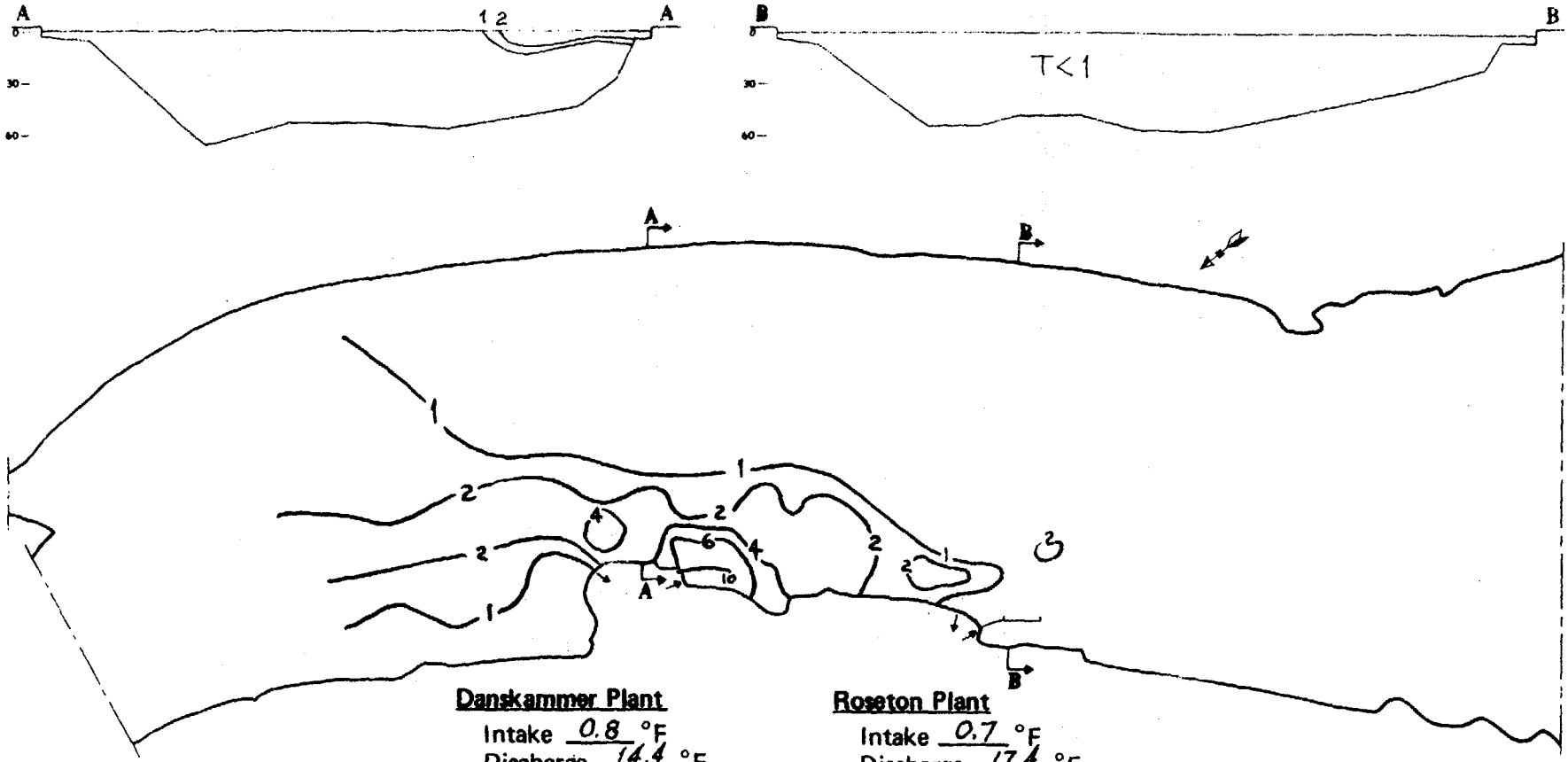
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.8 °F
Discharge 14.4 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 17.4 °F
ΔT 16.7 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

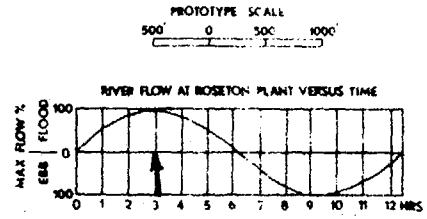
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.4 °F
Thermal Equilibrium Box Temperature 20 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 5

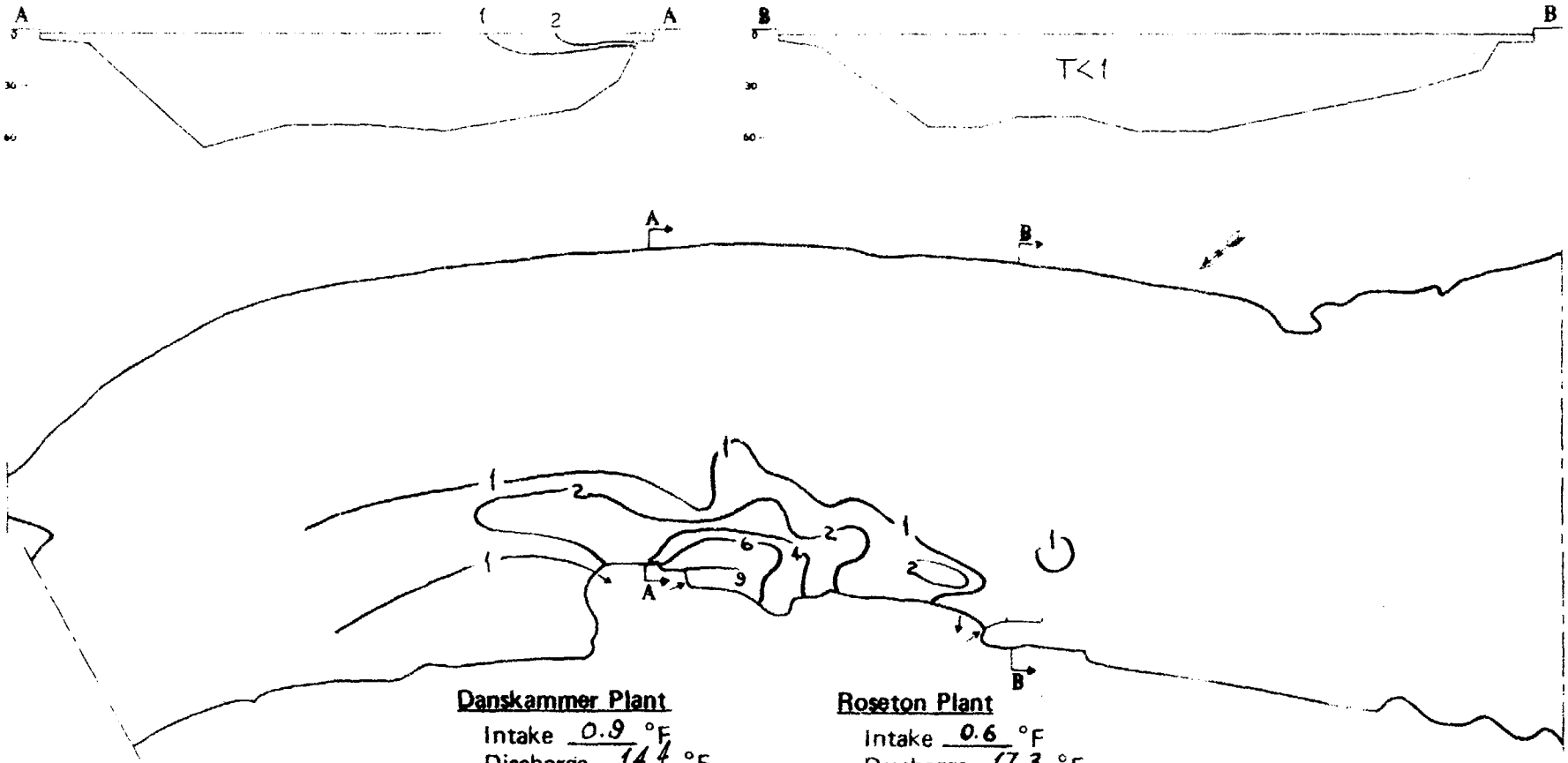


FIGURE A 6

Danskammer Plant

Intake 0.9 °F
Discharge 14.4 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 17.3 °F
ΔT 16.7 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 79.1 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

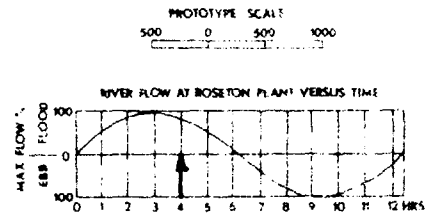
Fresh Water Flow 6000 cfs
Ambient Temperature 81.6 °F

Date 12 JUNE 72

*1. As Designed
*2 Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

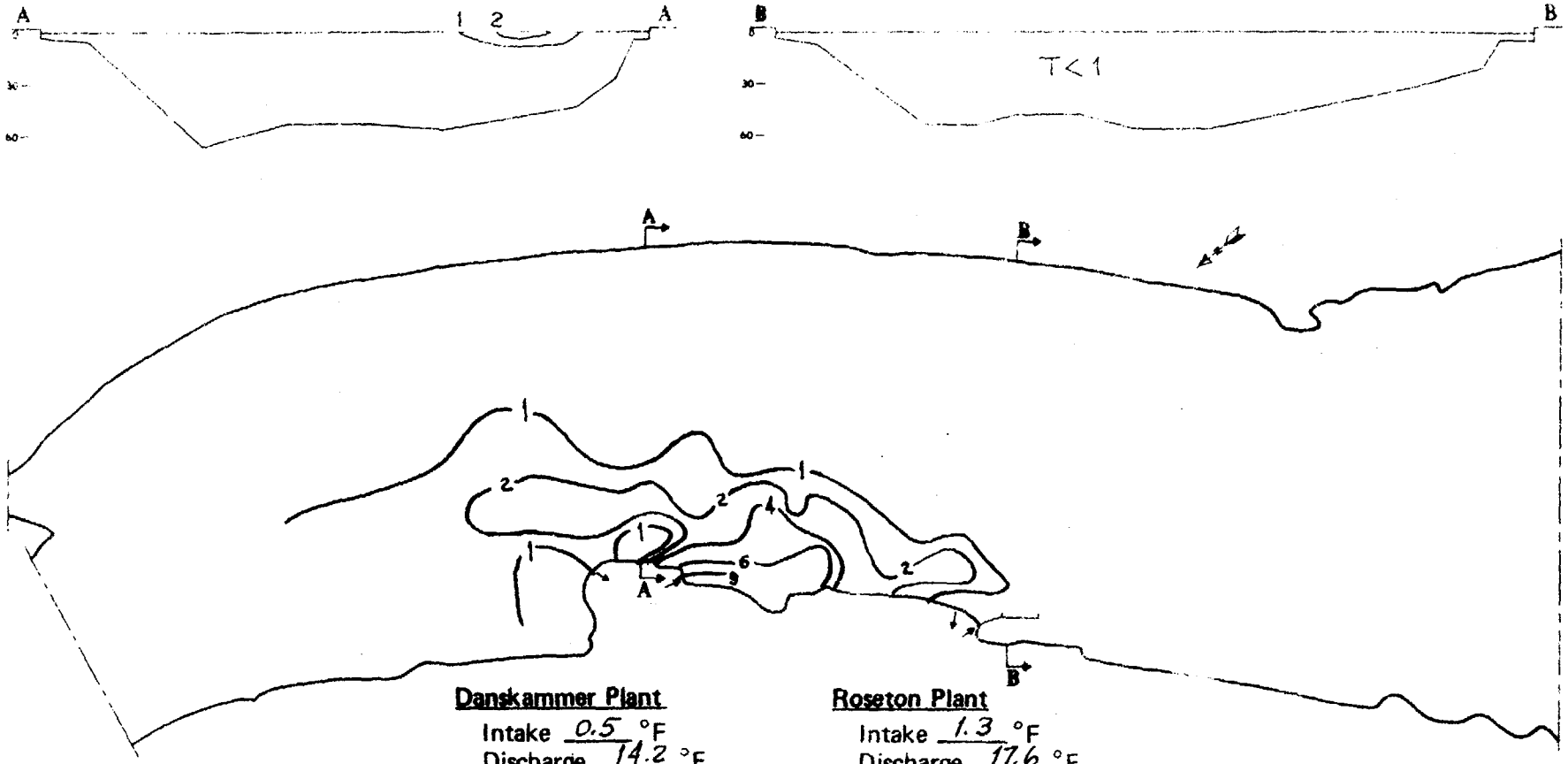
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies

Danskammer Roseton Power Stations



Danskammer Plant

Intake 0.5 °F
Discharge 14.2 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.3 °F
Discharge 17.6 °F
ΔT 16.3 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.7 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

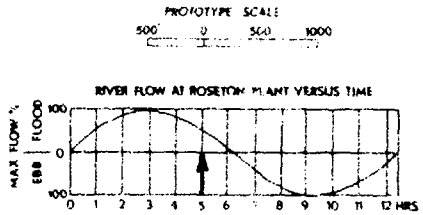
Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

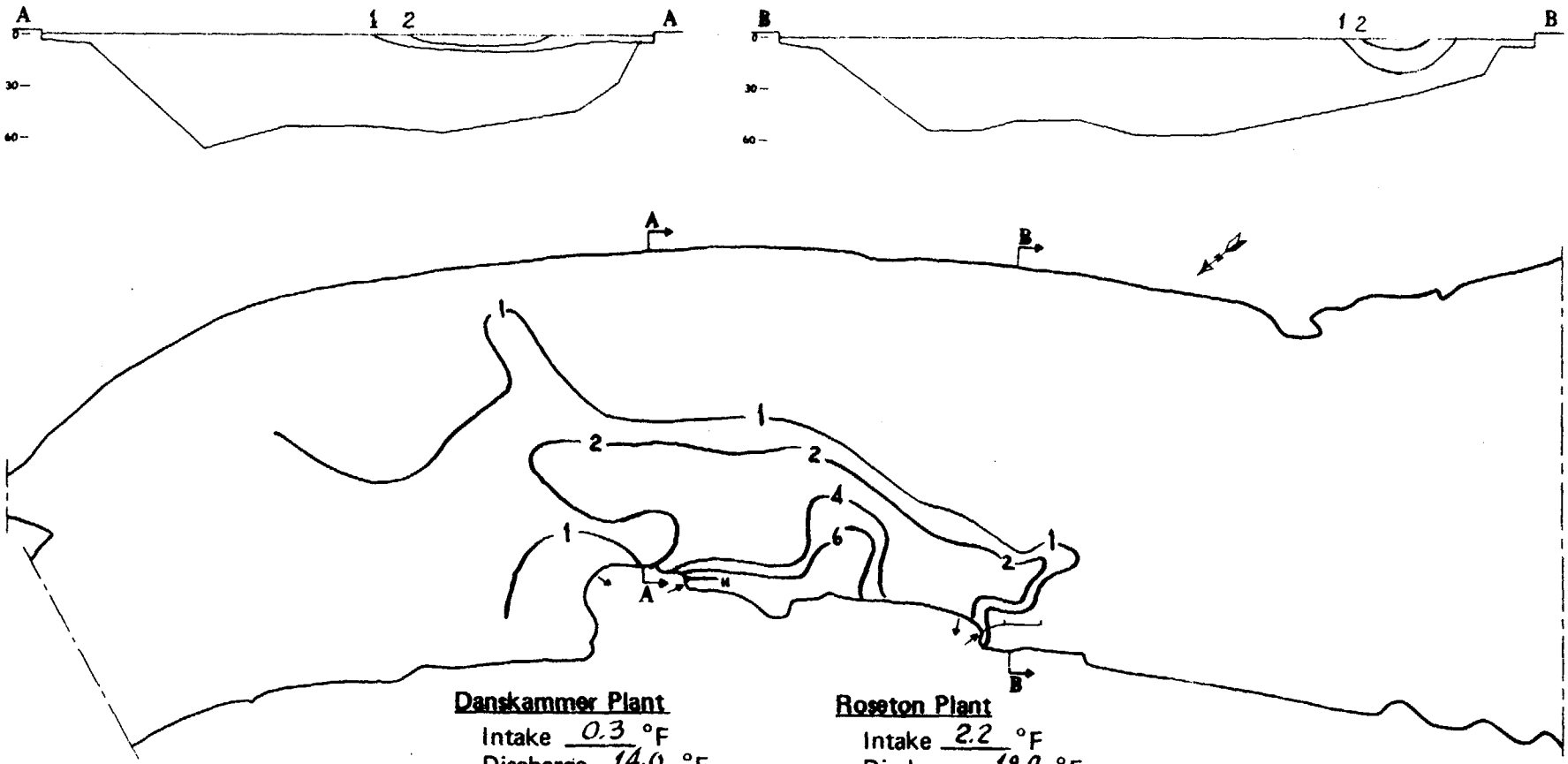


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A-7



Danskammer Plant

Intake 0.3 °F
Discharge 14.0 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 2.2 °F
Discharge 19.0 °F
ΔT 16.8 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 1.9 °F

River

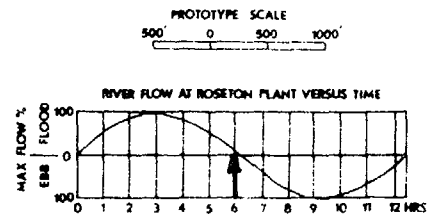
Fresh Water Flow 6000 cfs
Ambient Temperature 81.8 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

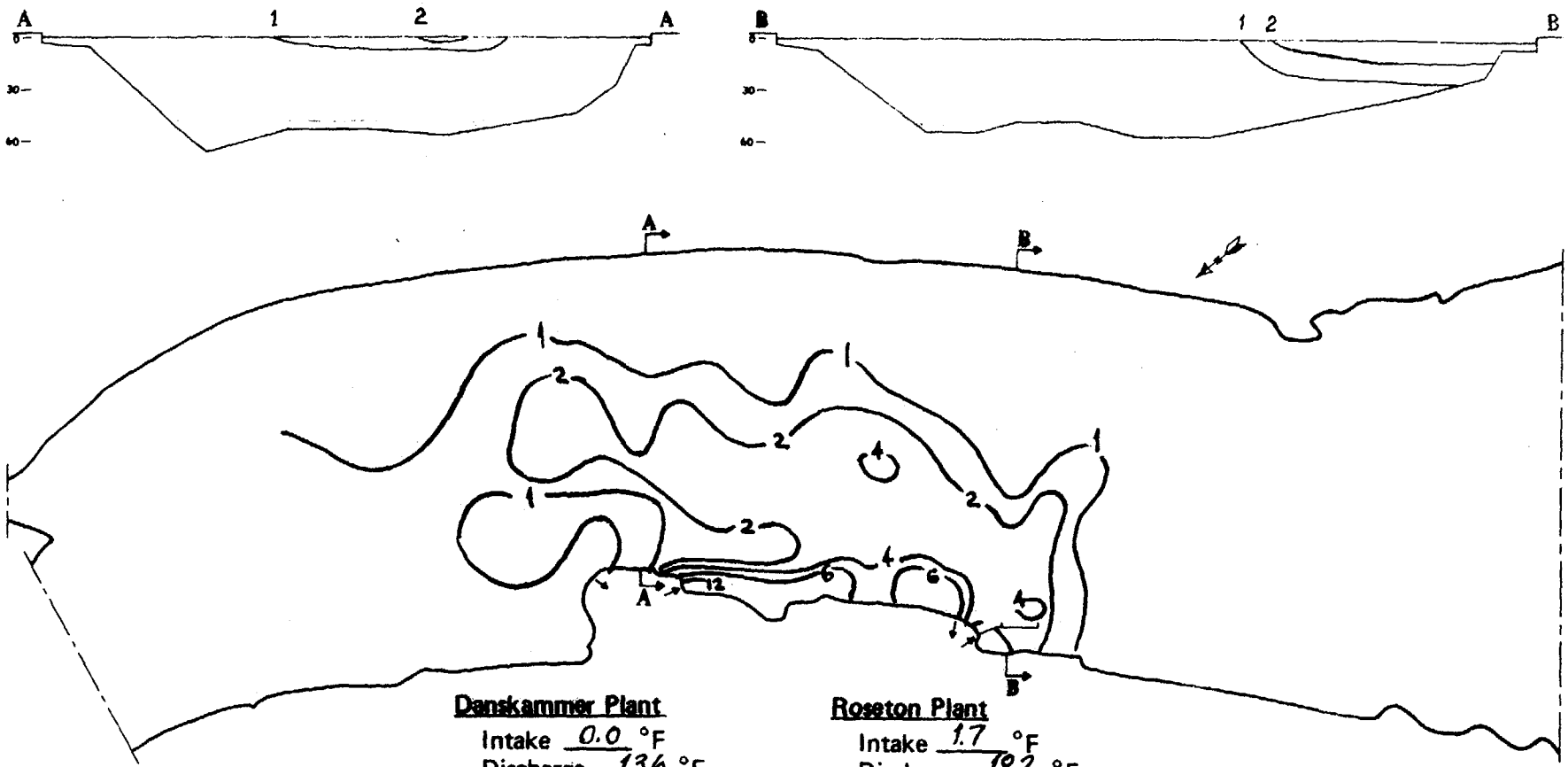


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 8



Danskammer Plant

Intake 0.0 °F
Discharge 13.6 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.7 °F
Discharge 18.2 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.8 °F
Thermal Equilibrium Box Temperature 1.8 °F

River

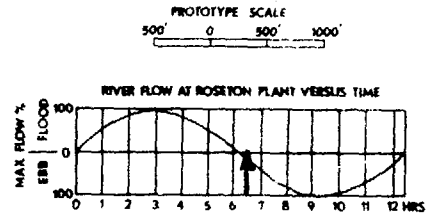
Fresh Water Flow 6000 cfs
Ambient Temperature 81.8 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 9

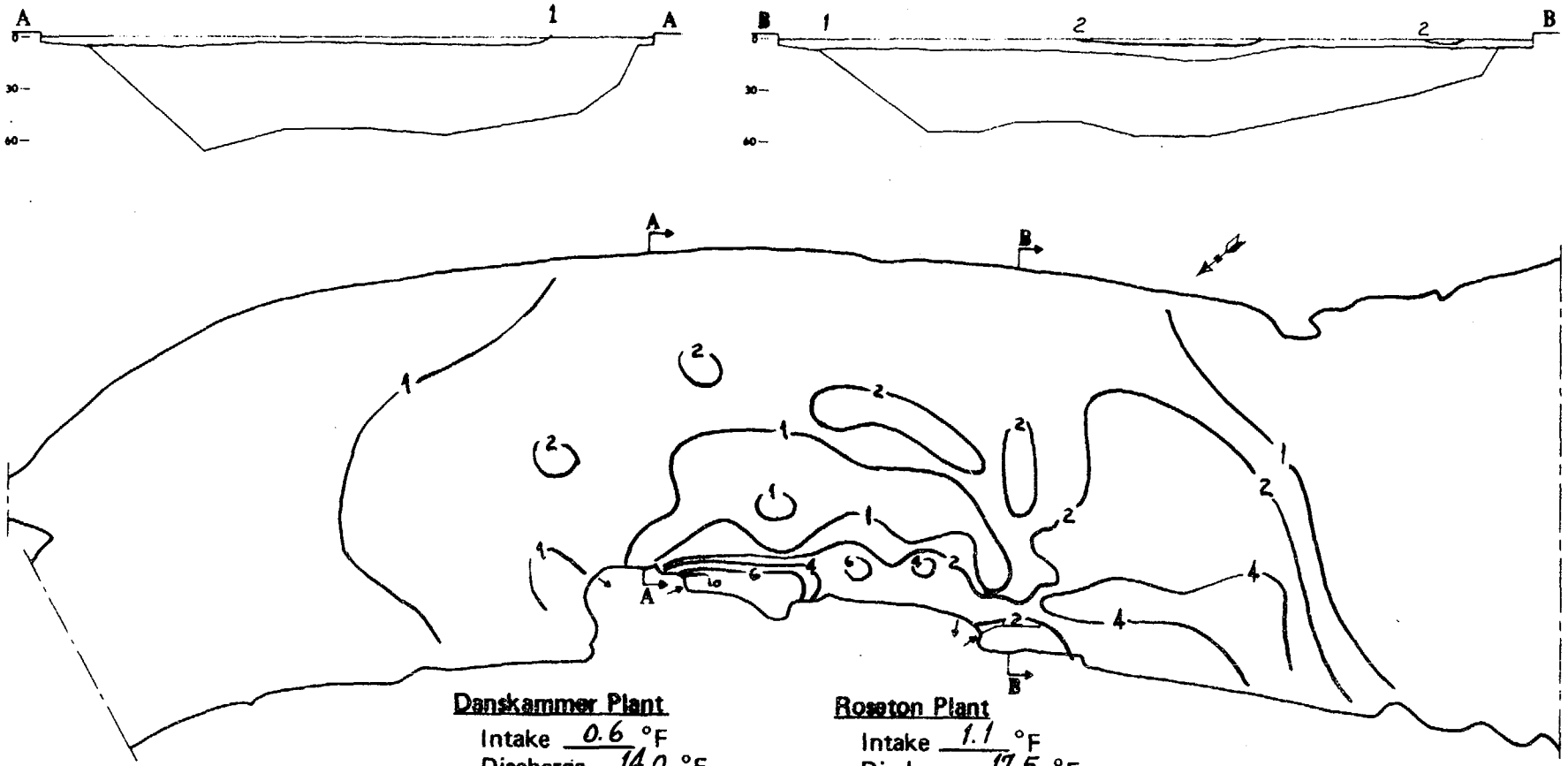


FIGURE A IO

Danskammer Plant

Intake 0.6 °F
Discharge 14.0 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.1 °F
Discharge 17.5 °F
ΔT 16.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

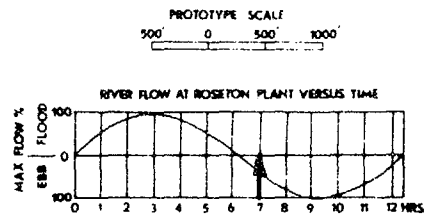
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.6 °F

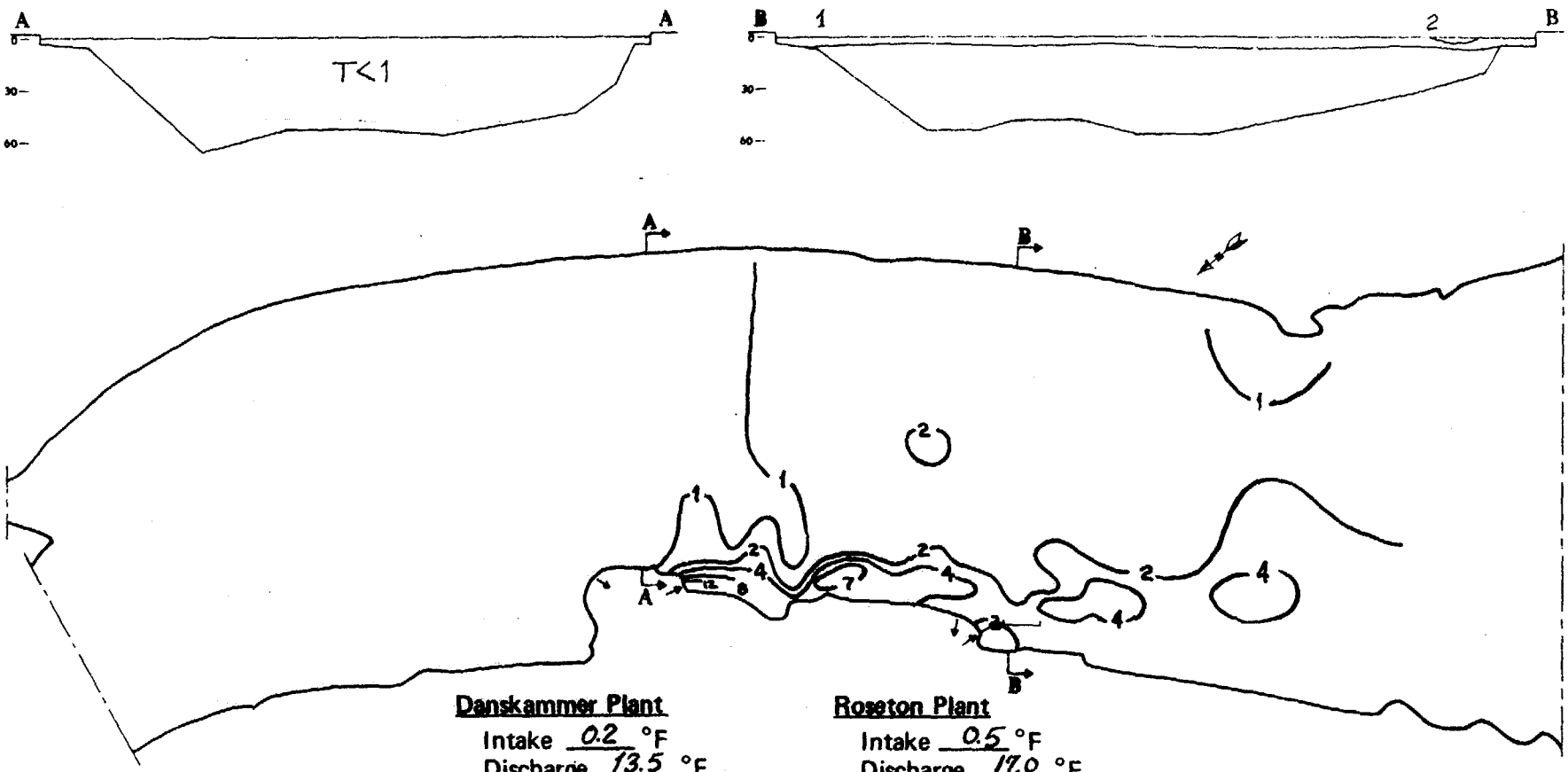
Date 12 JUNE 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake 0.2 °F
Discharge 13.5 °F
ΔT 13.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.5 °F
Discharge 17.0 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 79.5 °F
Thermal Equilibrium Box Temperature 1.9 °F

River

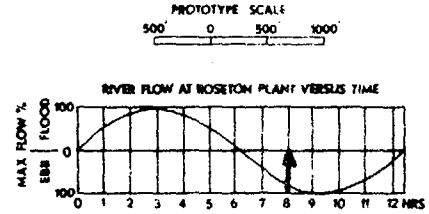
Fresh Water Flow 6000 cfs
Ambient Temperature 81.8 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 11

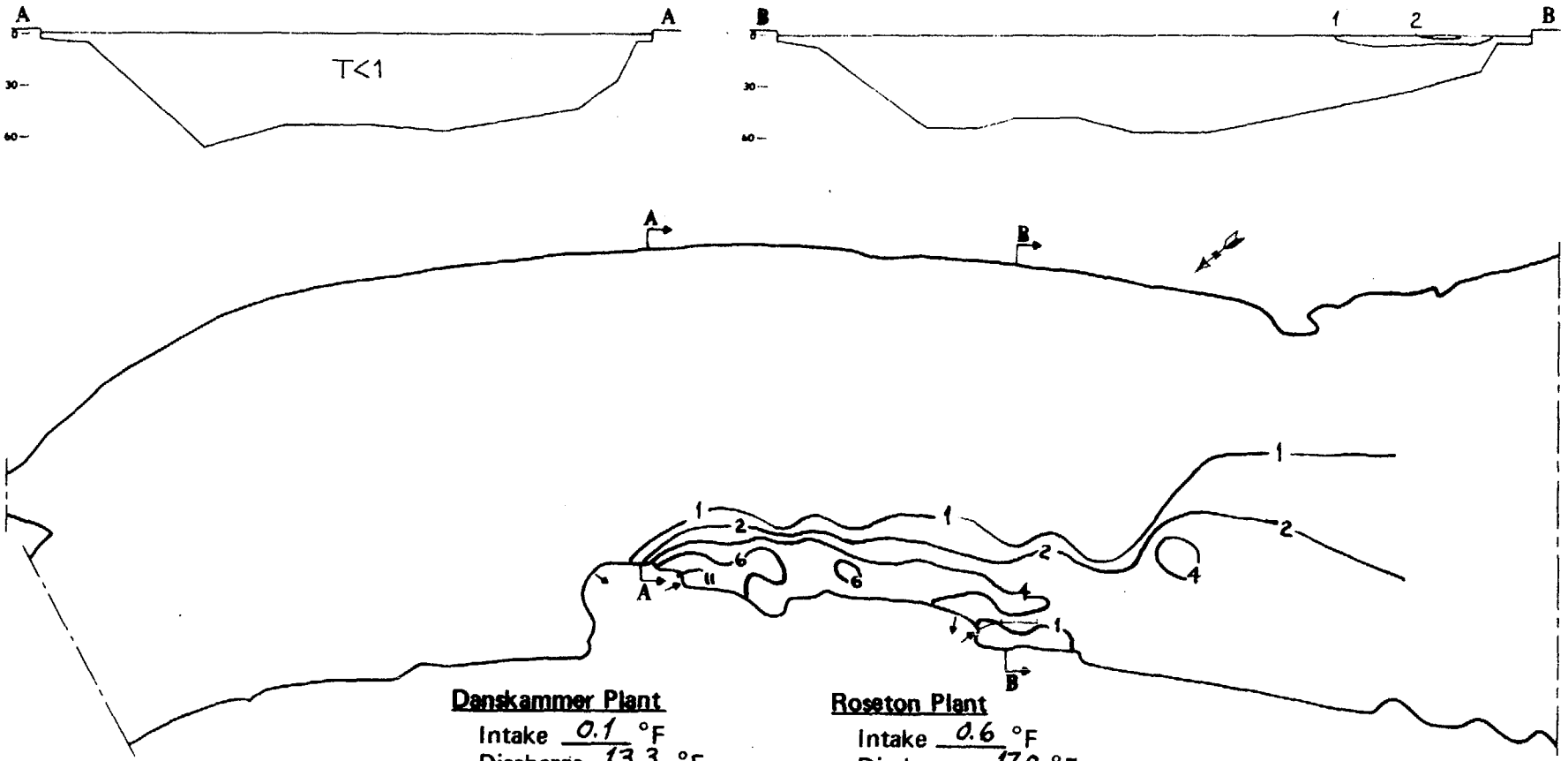


FIGURE A 12

Danskammer Plant

Intake 0.1 °F
Discharge 13.3 °F
ΔT 13.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 17.0 °F
ΔT 16.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

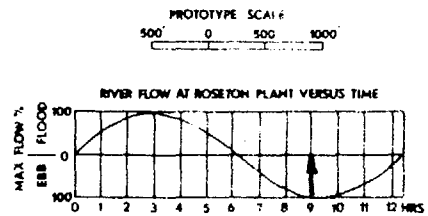
Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 79.0 °F
Thermal Equilibrium Box Temperature 1.8 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.8 °F

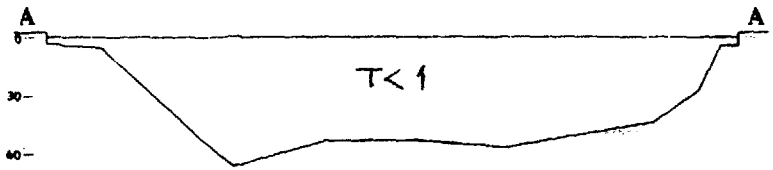
Date 12 JUNE 72



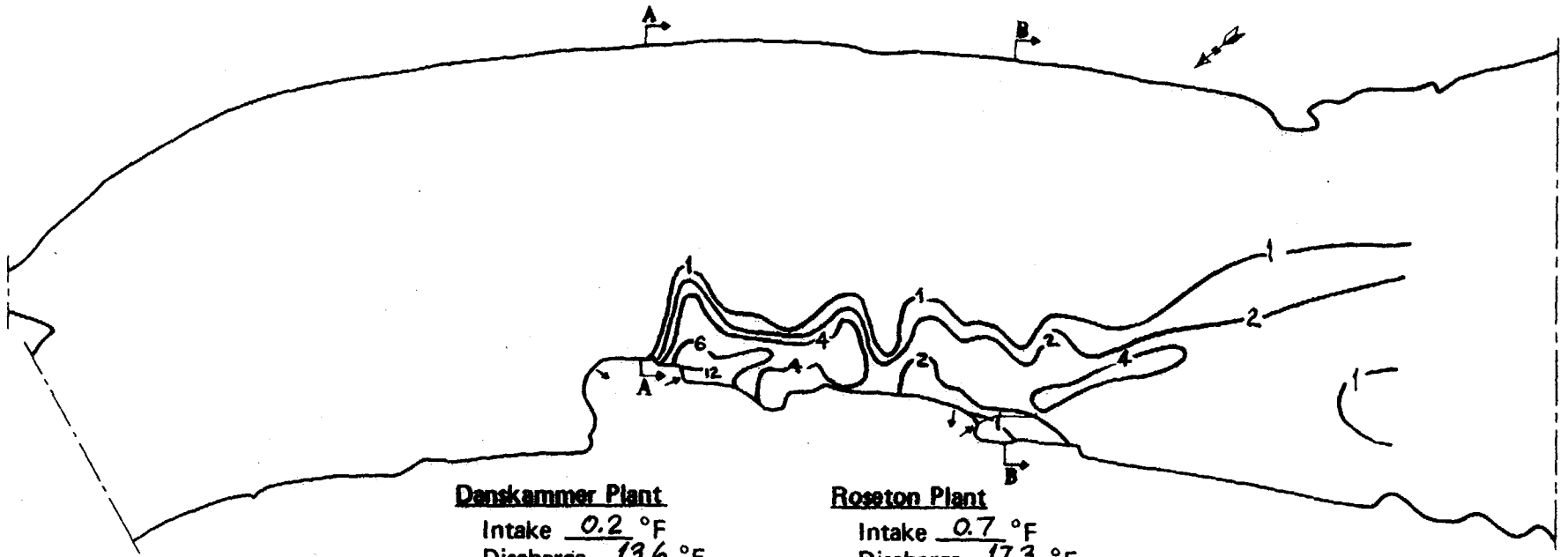
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.2 °F
Discharge 13.6 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 17.3 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 80.3 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

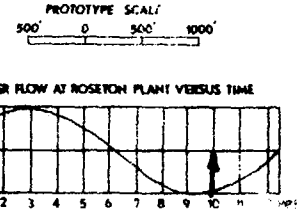
Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

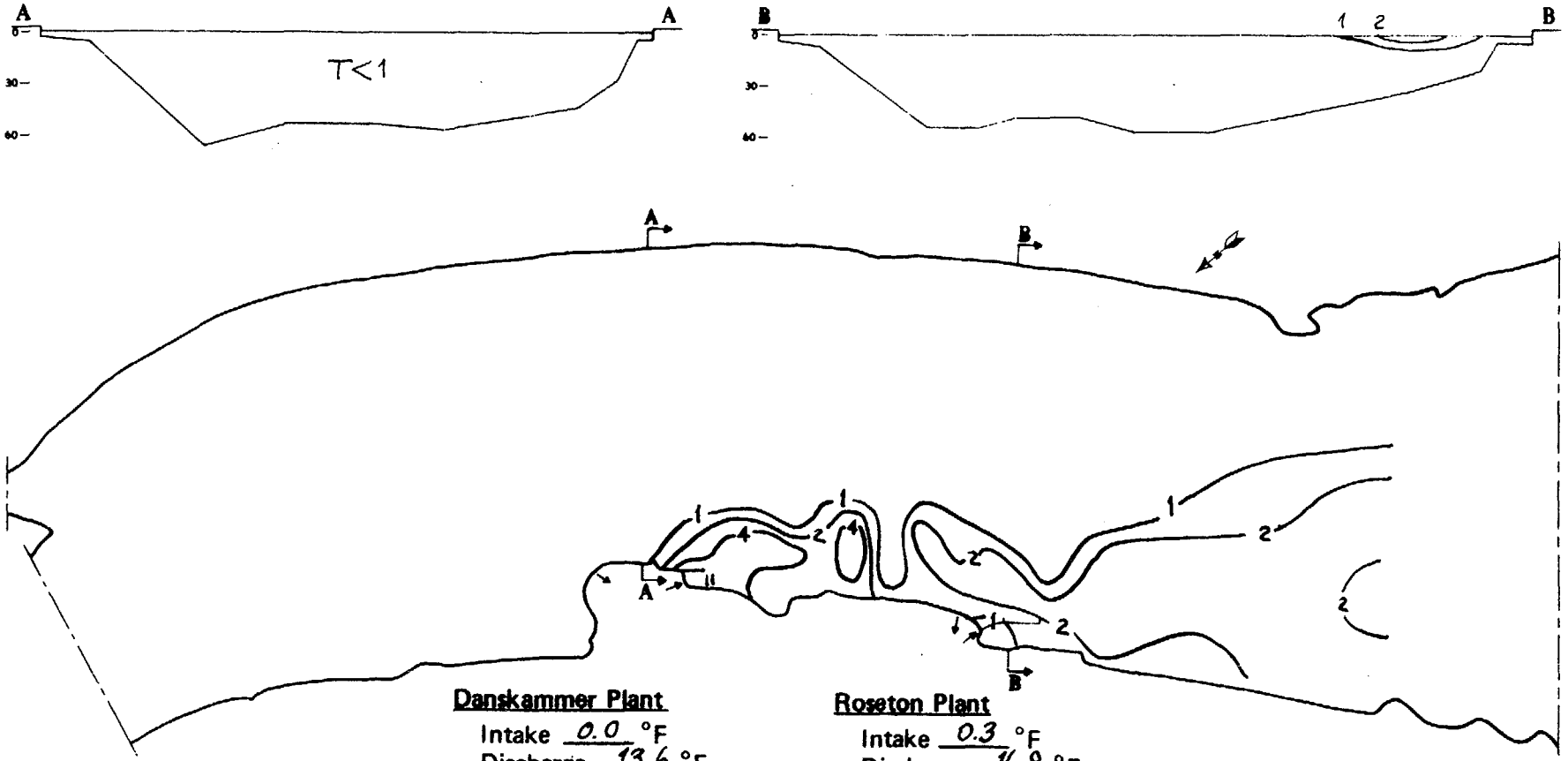


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 13



Danskammer Plant

Intake 0.0 °F
Discharge 13.6 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 16.9 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 79.9 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

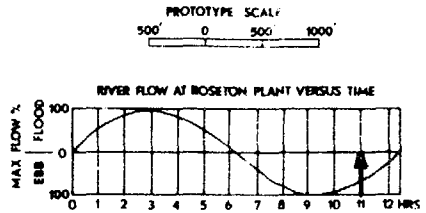
Fresh Water Flow 6000 cfs
Ambient Temperature 81.8°F

Date 12 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

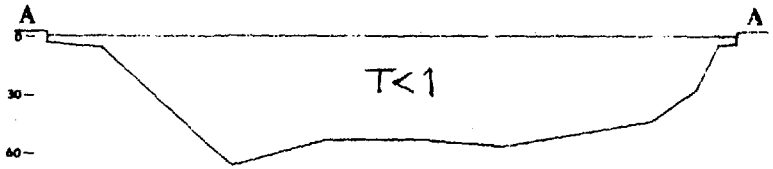


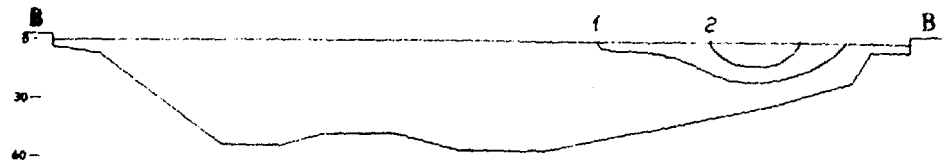
TEMPERATURE RISE ABOVE RIVER AMBIENT

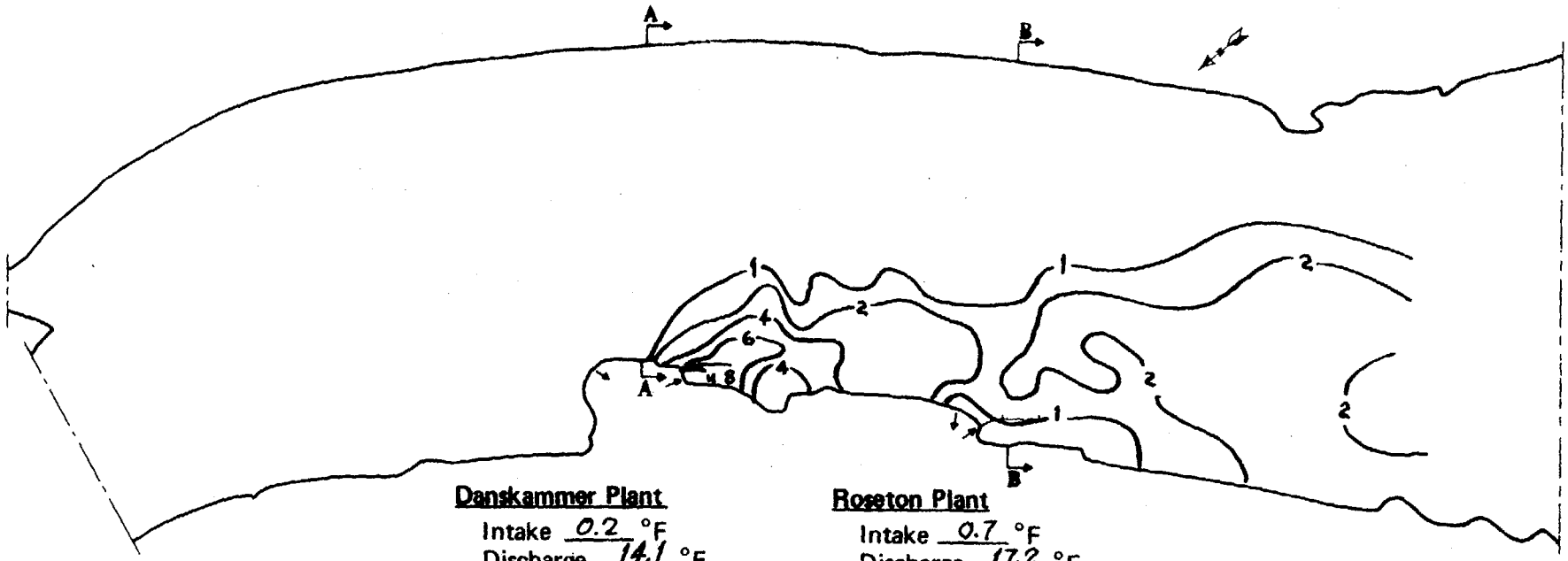
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 14







Danskammer Plant

Intake 0.2 °F
Discharge 14.1 °F
ΔT 13.9 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 17.2 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 80.4 °F
Thermal Equilibrium Box Temperature 2.0 °F

River

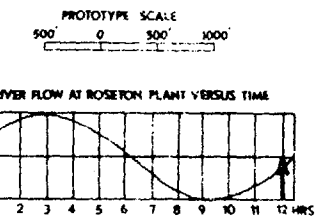
Fresh Water Flow 6000 cfs
Ambient Temperature 81.7 °F

Date 12 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 15

DANSKAMMER

LOAD	80%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	13.5 F

ROSETON

LOAD	85%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	14.4 F
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	81.0 F
FRESH WATER FLOW	6000 CFS

TEST DATE 15 JUNE 1972

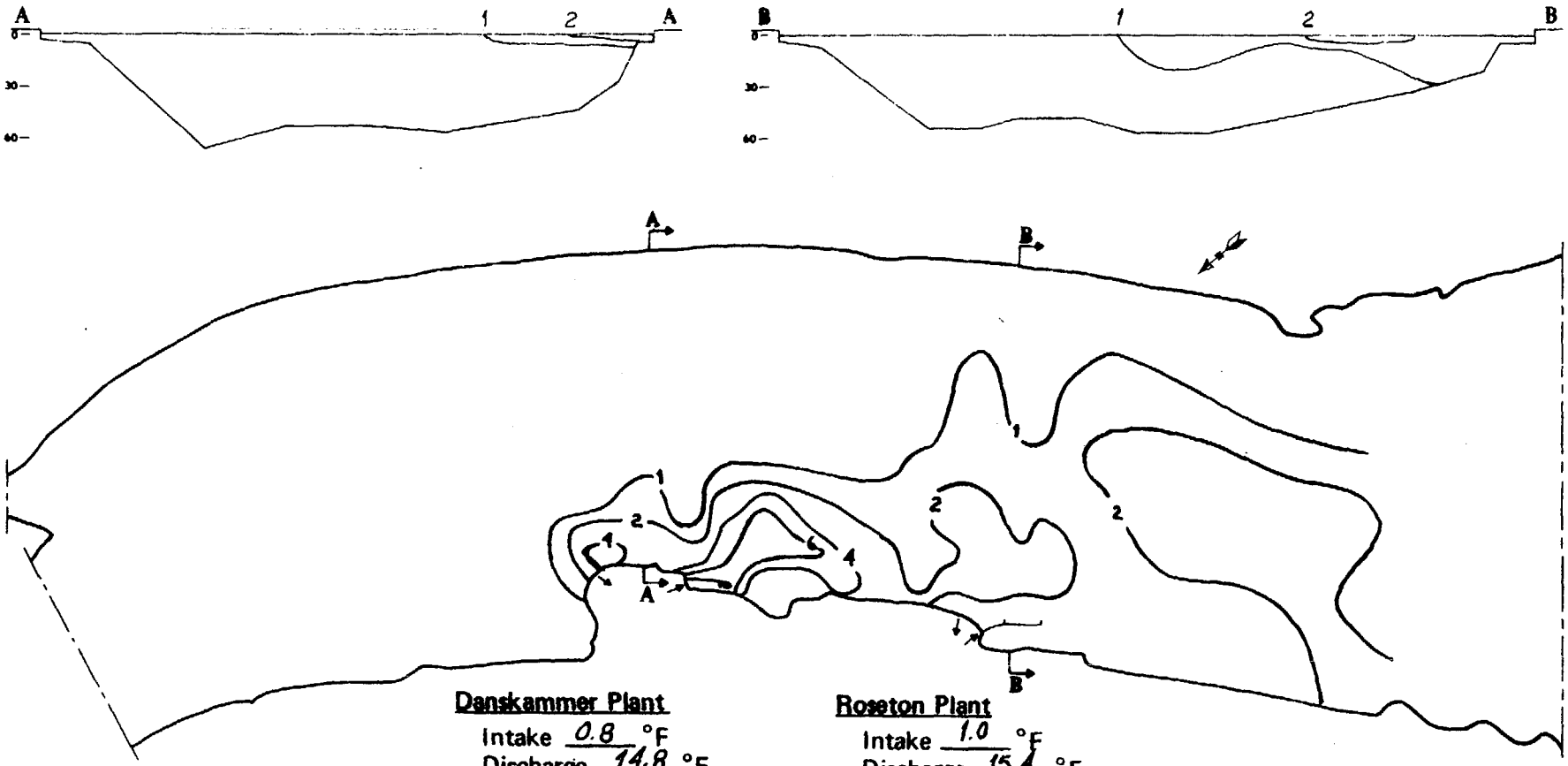


FIGURE A 16

Danskammer Plant

Intake 0.8 °F
Discharge 14.8 °F
ΔT 14.0 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.0 °F
Discharge 15.4 °F
ΔT 14.1 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 81.9 °F
Thermal Equilibrium Box Temperature 0.7 °F

River

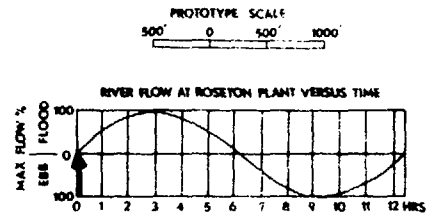
Fresh Water Flow 6000 cfs
Ambient Temperature 80.8°F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

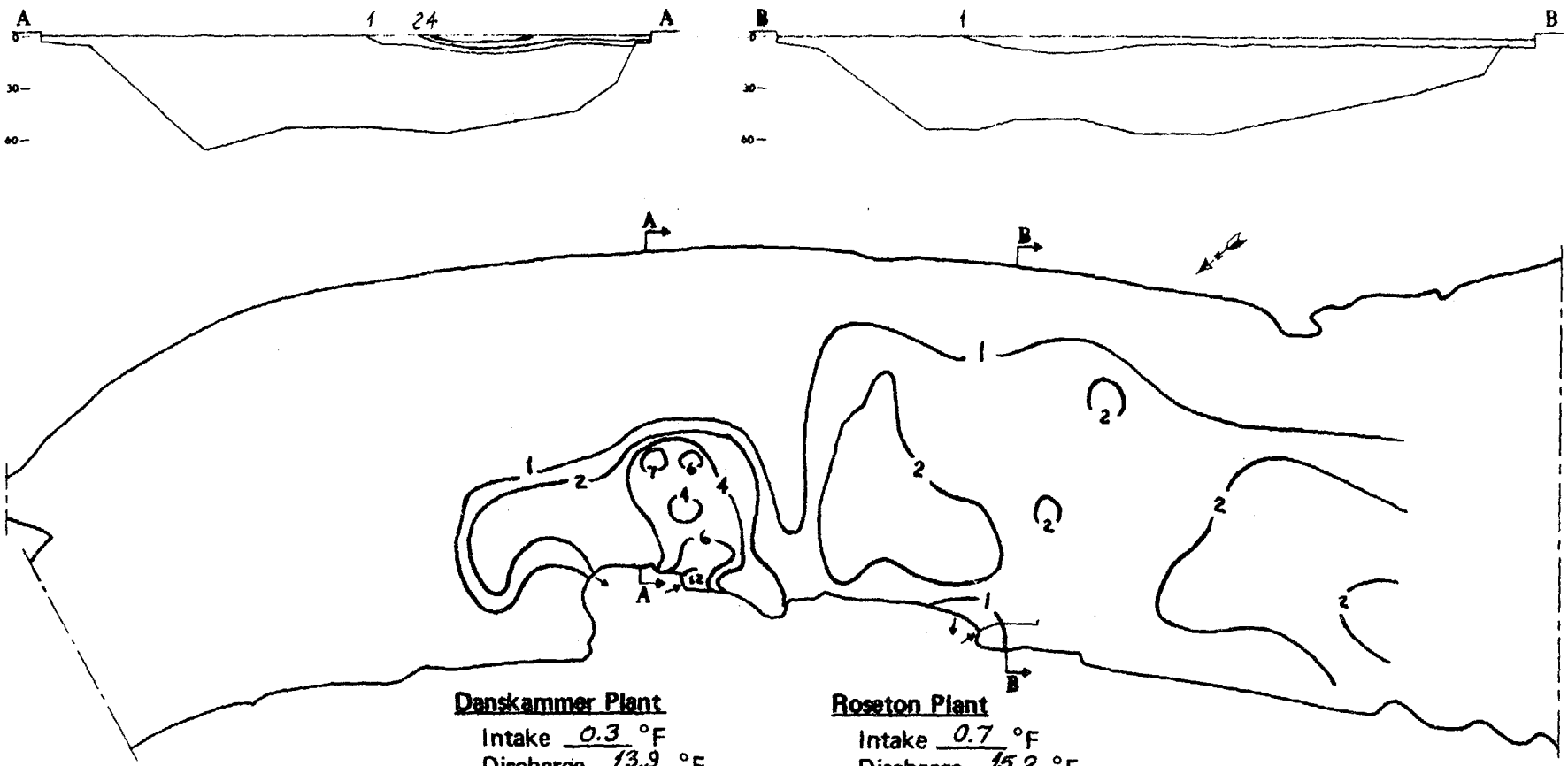
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.3 °F
Discharge 13.9 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 15.2 °F
ΔT 14.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 82.2 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

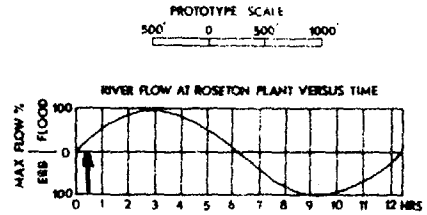
Fresh Water Flow 6000 cfs
Ambient Temperature 80.9° F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 17

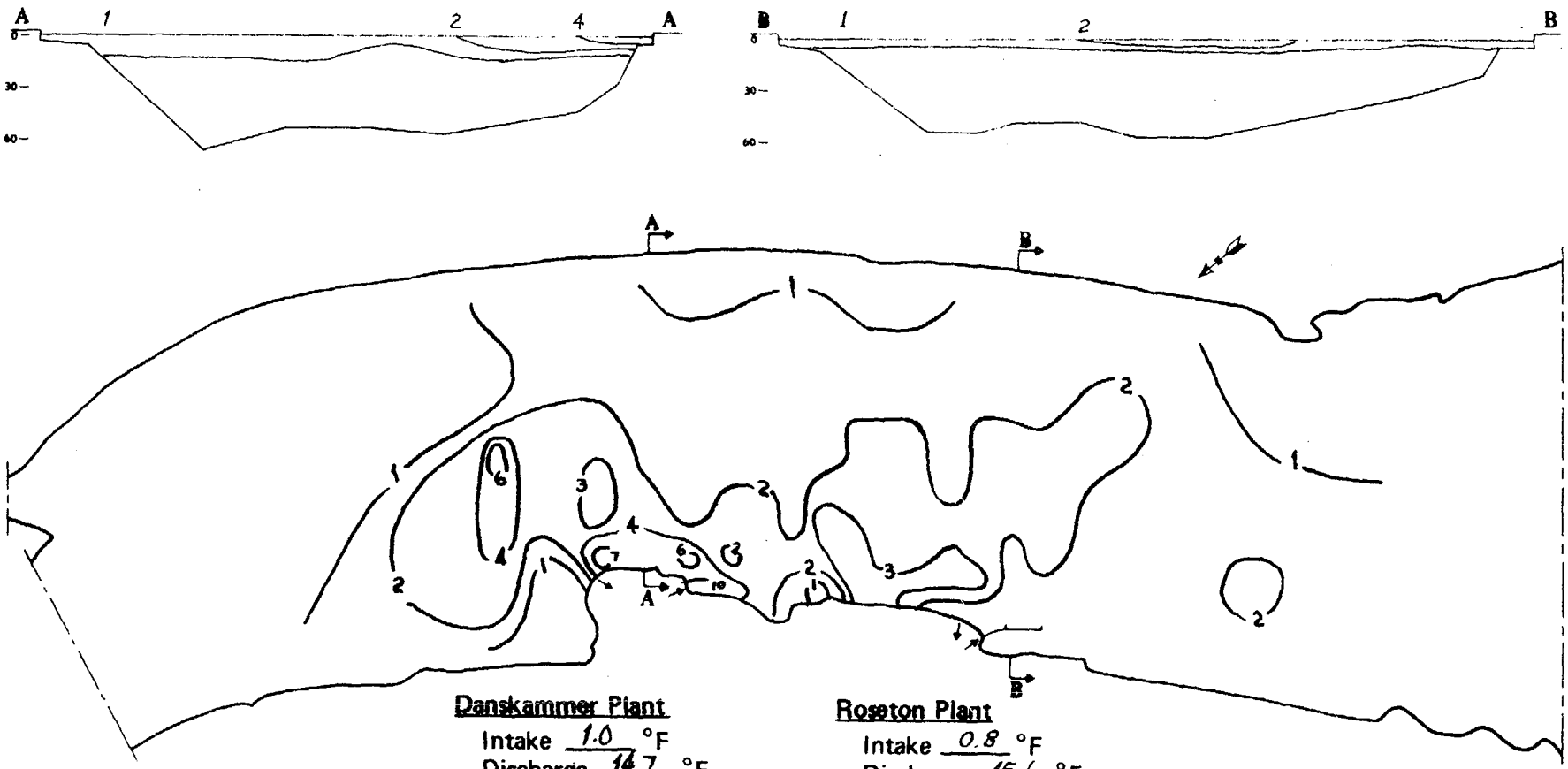


FIGURE A 18

Danskammer Plant

Intake 1.0 °F
Discharge 14.7 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 15.6 °F
ΔT 14.8 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 82.4 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

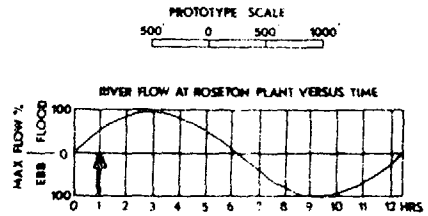
Fresh Water Flow 6000 cfs
Ambient Temperature 80.9° F

Date 15 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

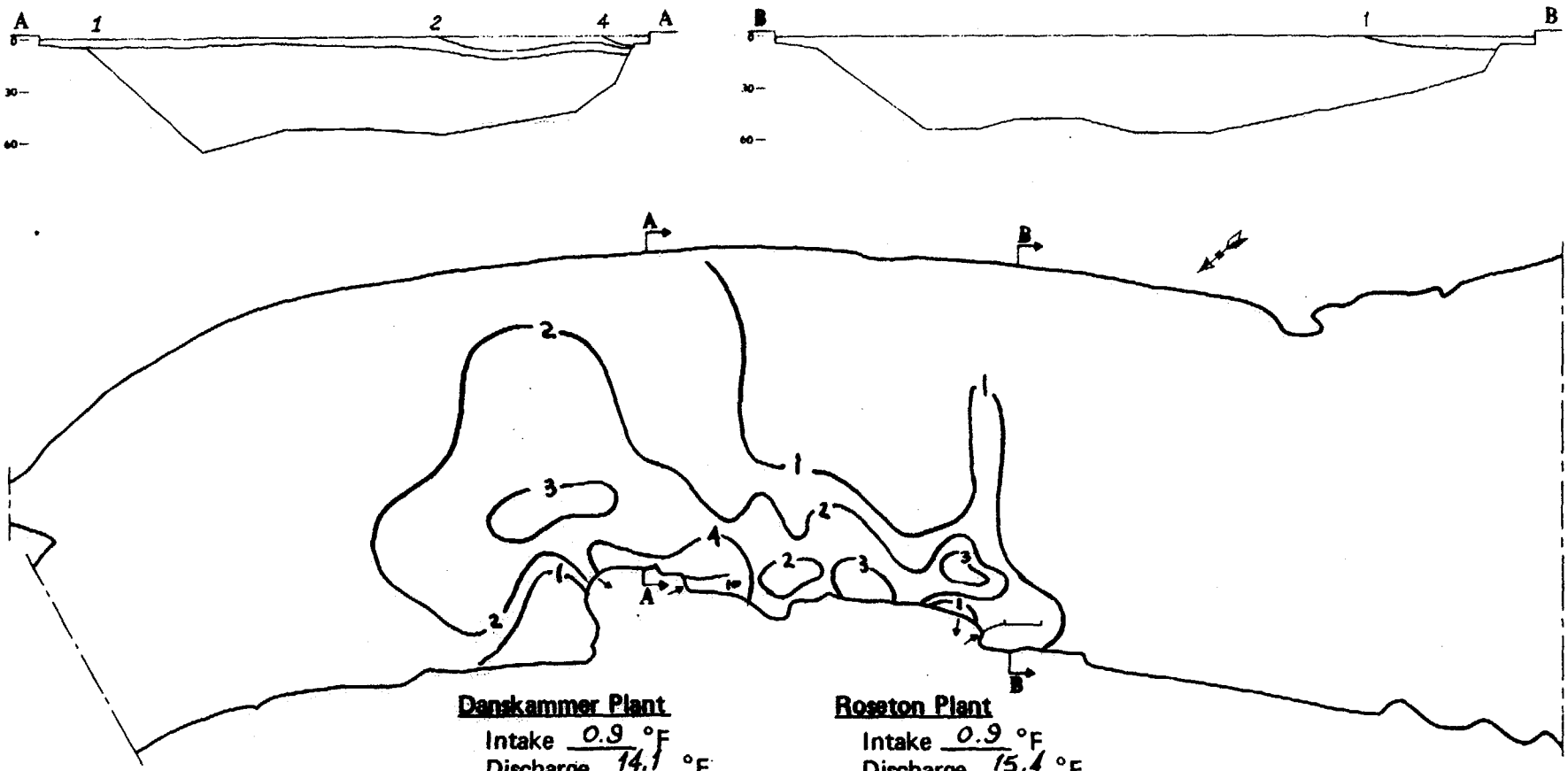
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer--Roseton Power Stations

ARL



Danskammer Plant

Intake 0.9 °F
Discharge 14.1 °F
ΔT 13.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 15.4 °F
ΔT 14.5 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 82.9 °F
Thermal Equilibrium Box Temperature 1.0 °F

River

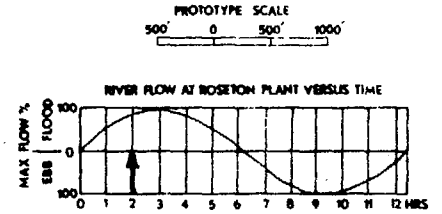
Fresh Water Flow 6000 cfs
Ambient Temperature 80.9 °F

Date 15 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

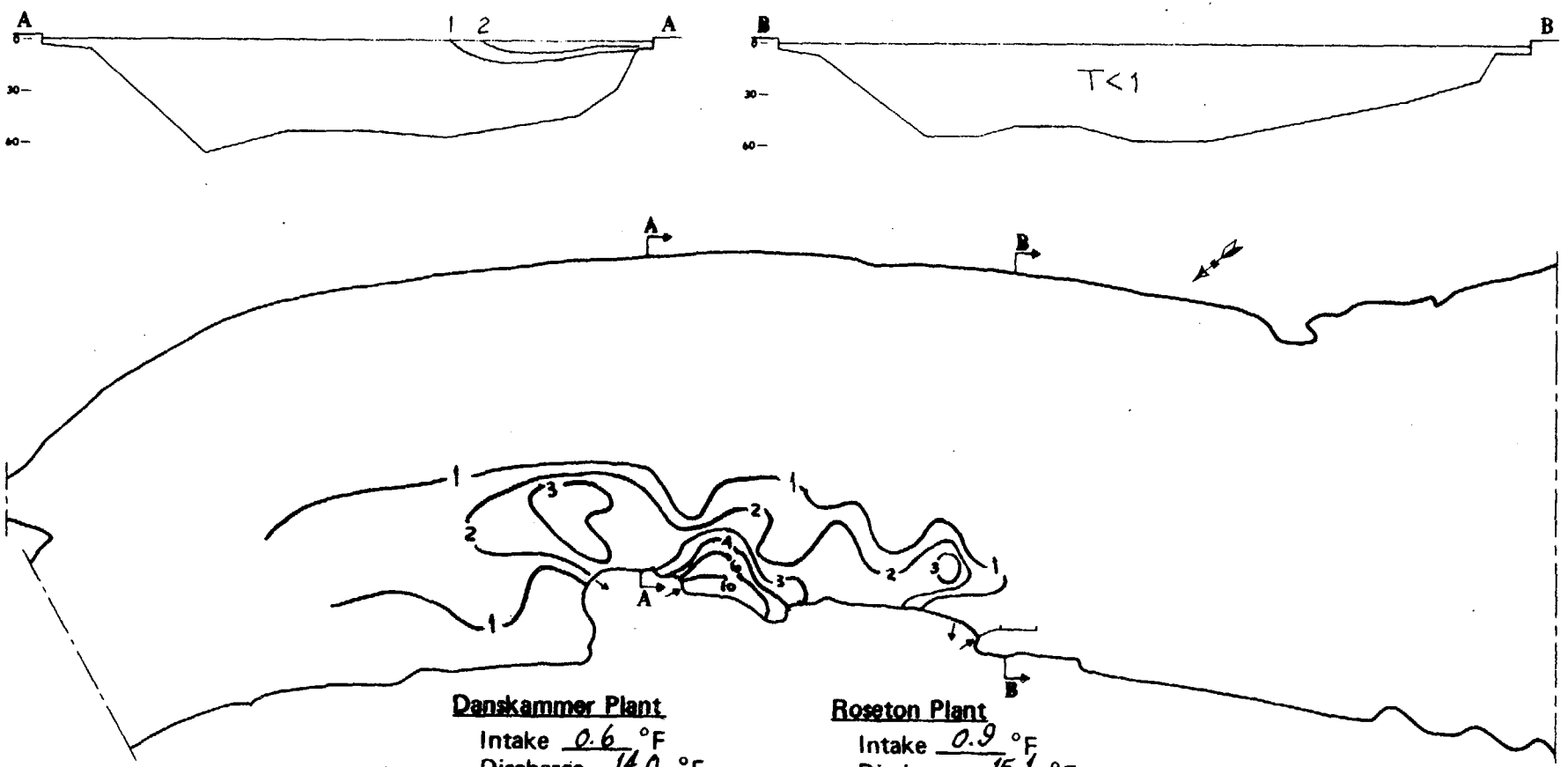


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 19



Danskammer Plant

Intake 0.6 °F
Discharge 14.0 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 15.1 °F
ΔT 14.2 °F
Flow 1400 cfs
** Outfall Configuration 18

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

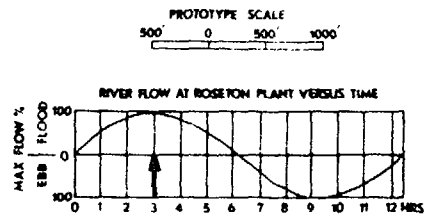
Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.0 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.0 °F

Date 15 June 72 p.m.

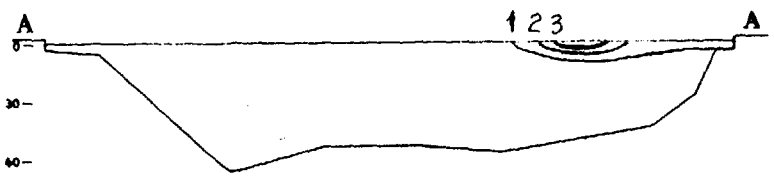


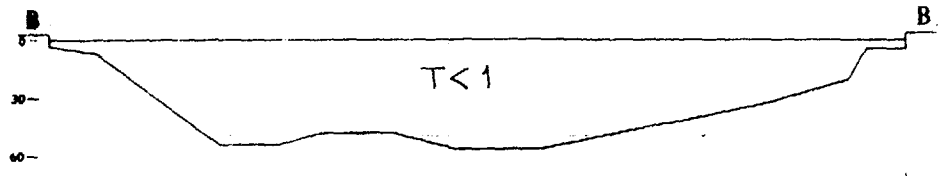
TEMPERATURE RISE ABOVE RIVER AMBIENT

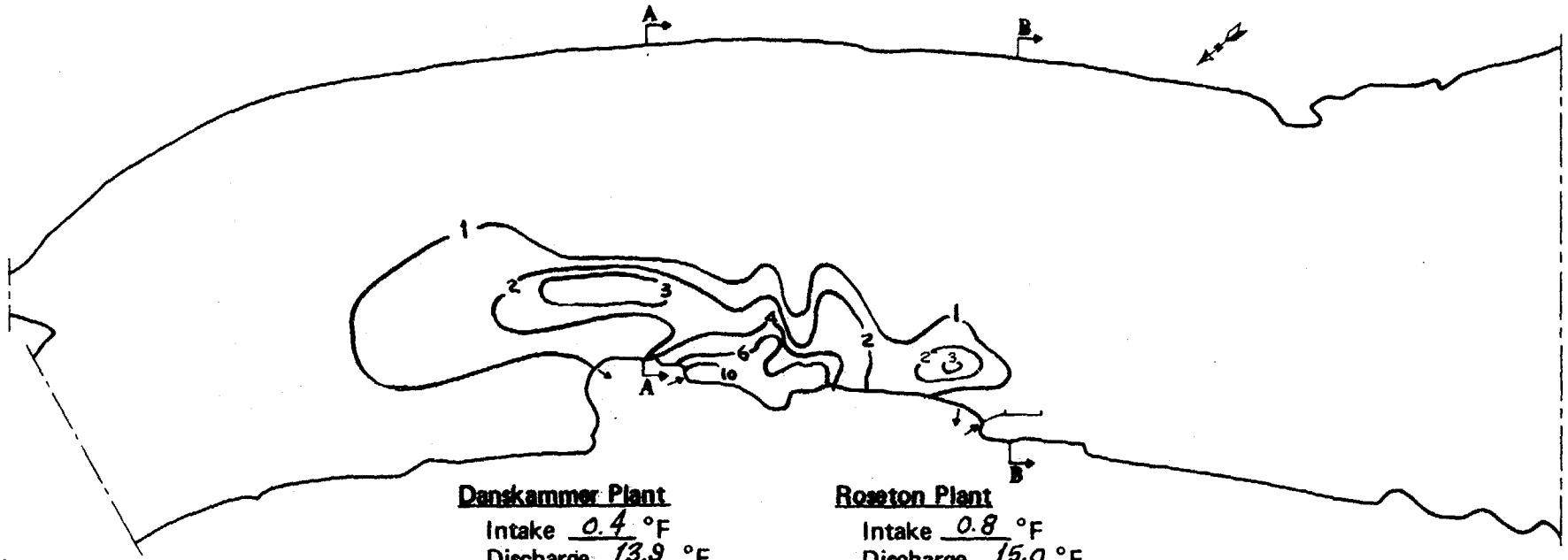
Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 20







Danskammer Plant

Intake 0.4 °F
Discharge 13.9 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 15.0 °F
ΔT 14.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.2 °F

River

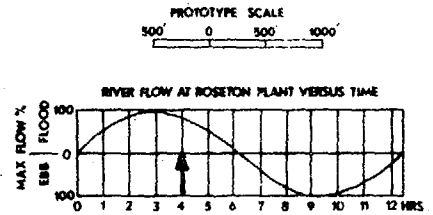
Fresh Water Flow 6000 cfs
Ambient Temperature 81.0 °F

Date 15 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 21

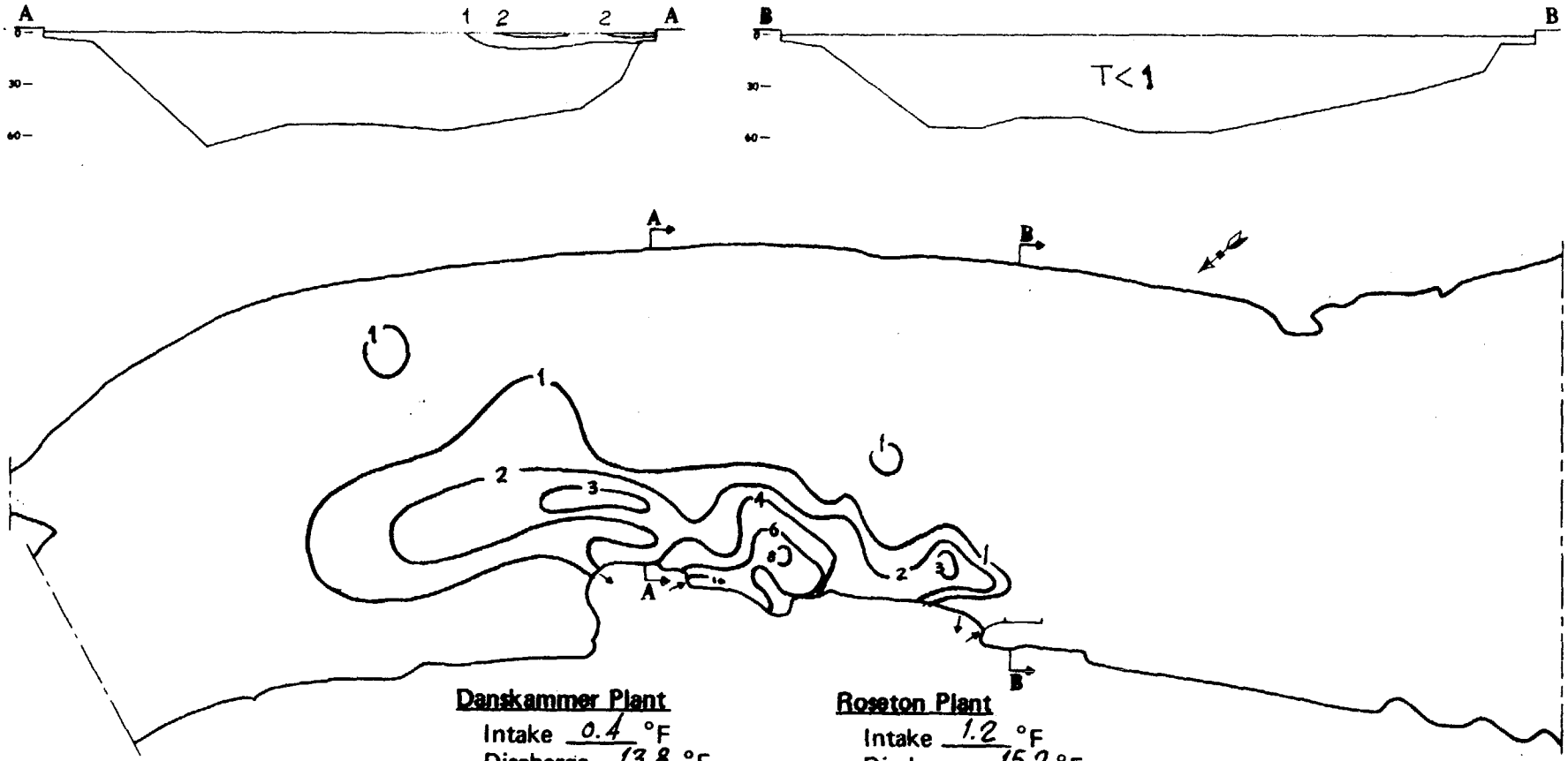


FIGURE A 22

Danskammer Plant

Intake 0.4 °F
Discharge 13.8 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.2 °F
Discharge 15.2 °F
ΔT 14.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

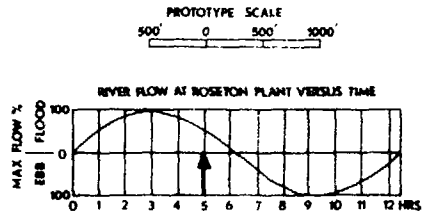
Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.4 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.0 °F

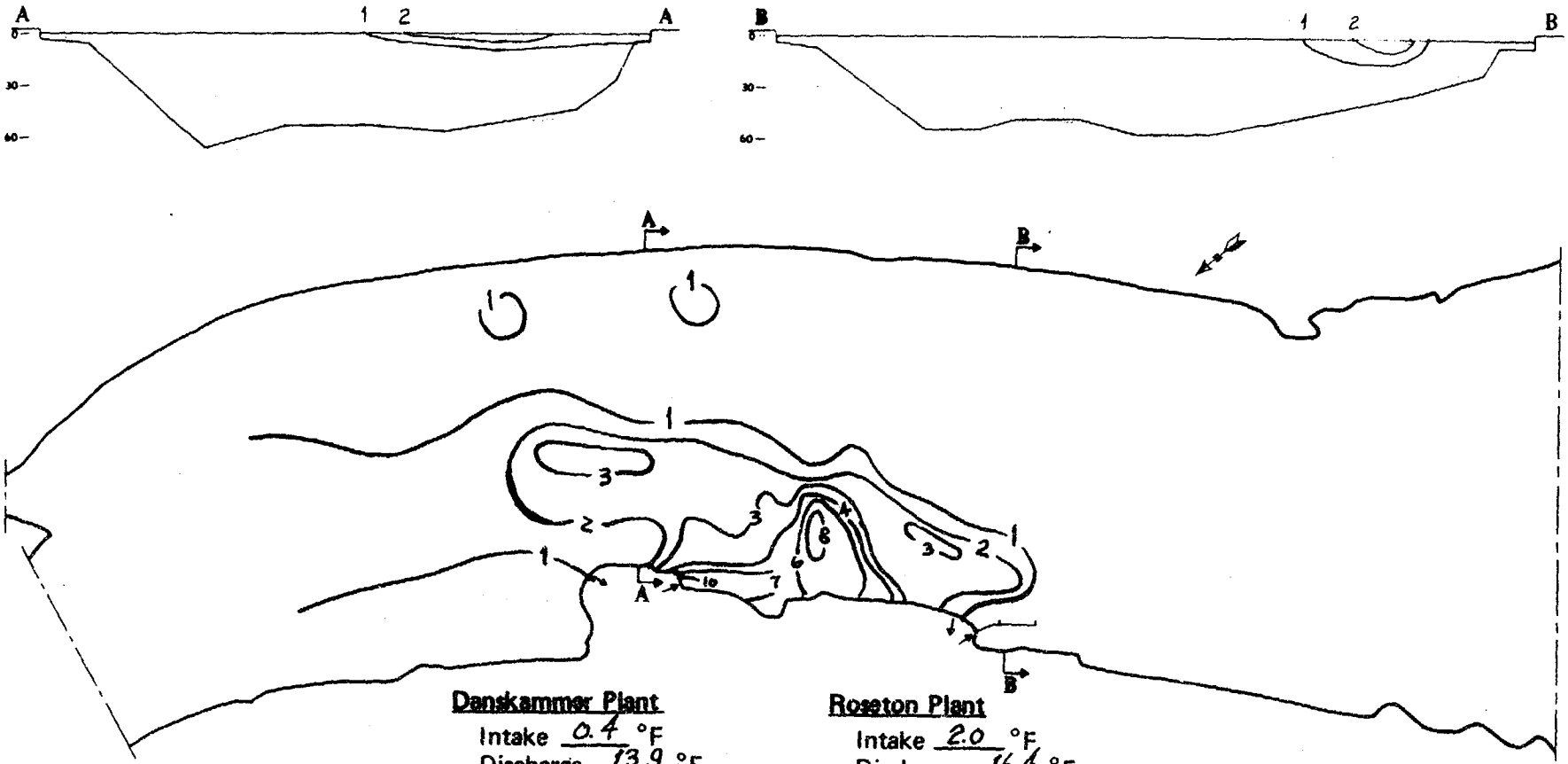
Date 15 JUNE 72 p.m.



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.4 °F
Discharge 13.9 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 2.0 °F
Discharge 16.4 °F
ΔT 14.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.4 °F

River

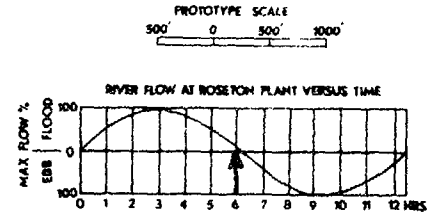
Fresh Water Flow 6000 cfs
Ambient Temperature 81.1 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

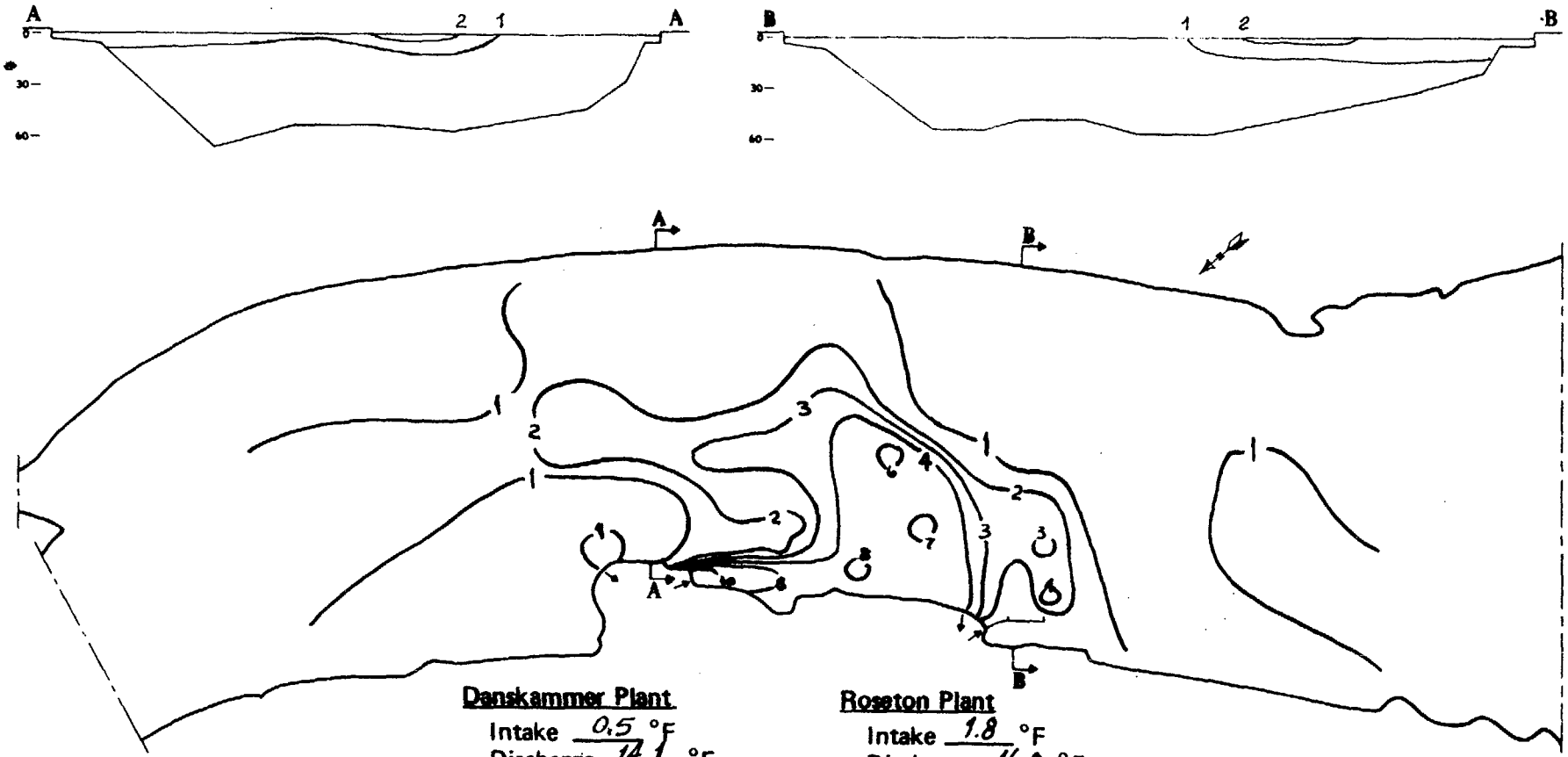


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 23



Danskammer Plant

Intake 0.5 °F
Discharge 14.1 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.8 °F
Discharge 16.0 °F
ΔT 14.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 83.1 °F
Thermal Equilibrium Box Temperature 1.4 °F

River

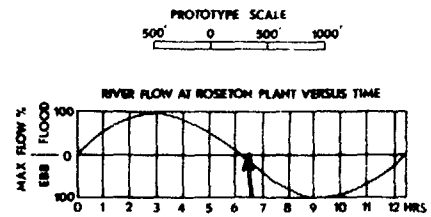
Fresh Water Flow 6000 cfs
Ambient Temperature 81.1 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

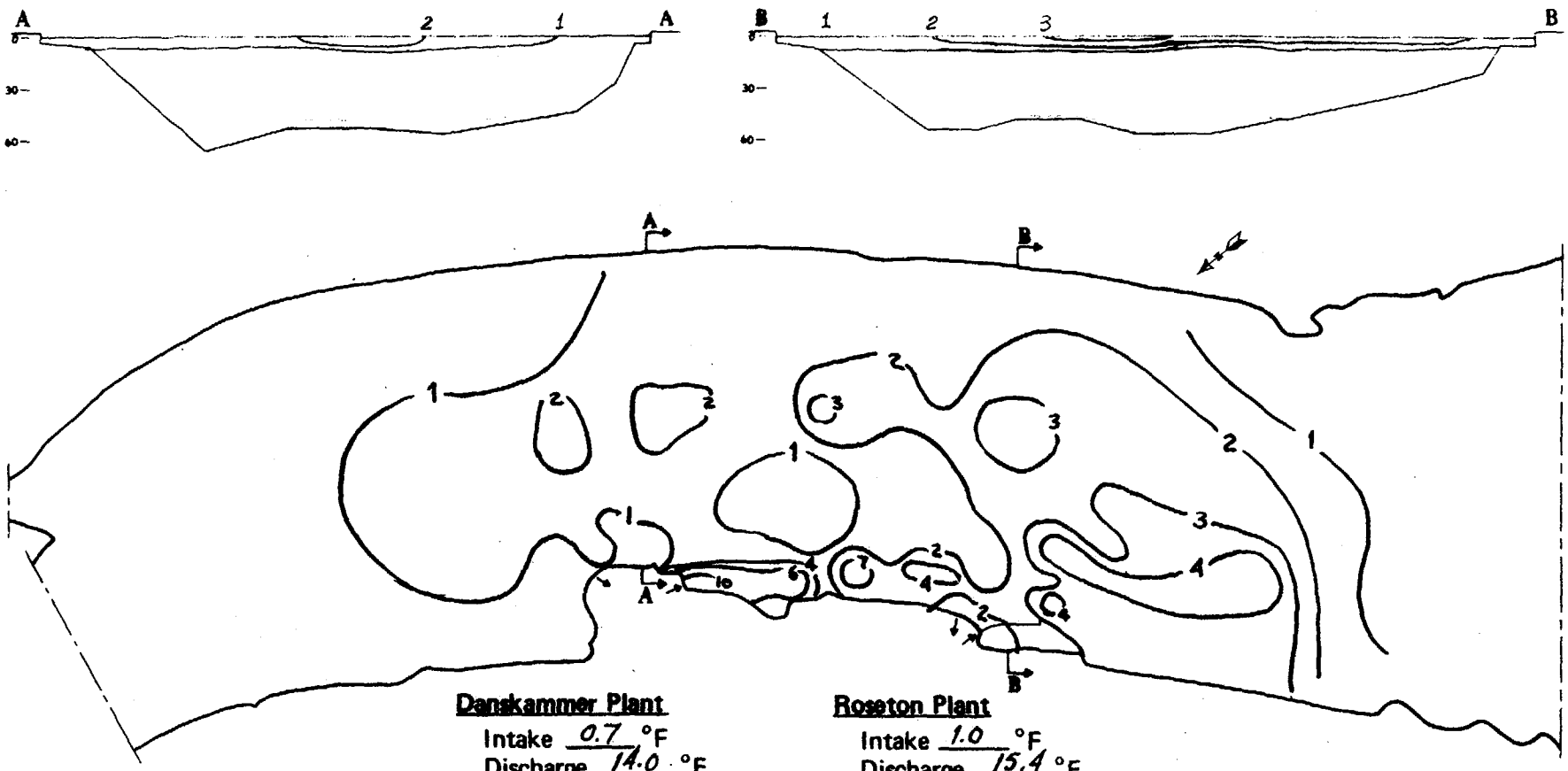


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 24



Danskammer Plant

Intake 0.7 °F
Discharge 14.0 °F
ΔT 13.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.0 °F
Discharge 15.4 °F
ΔT 14.4 °F
Flow 1400 cfs
**Outfall Configuration 16

Room Atmosphere

Relative Humidity 85 %
Dry Bulb Temperature 83.3 °F
Thermal Equilibrium Box Temperature 1.5 °F

River

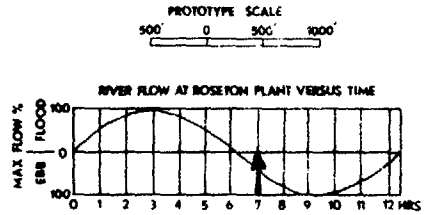
Fresh Water Flow 6000 cfs
Ambient Temperature 81.1 °F

Date 15 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

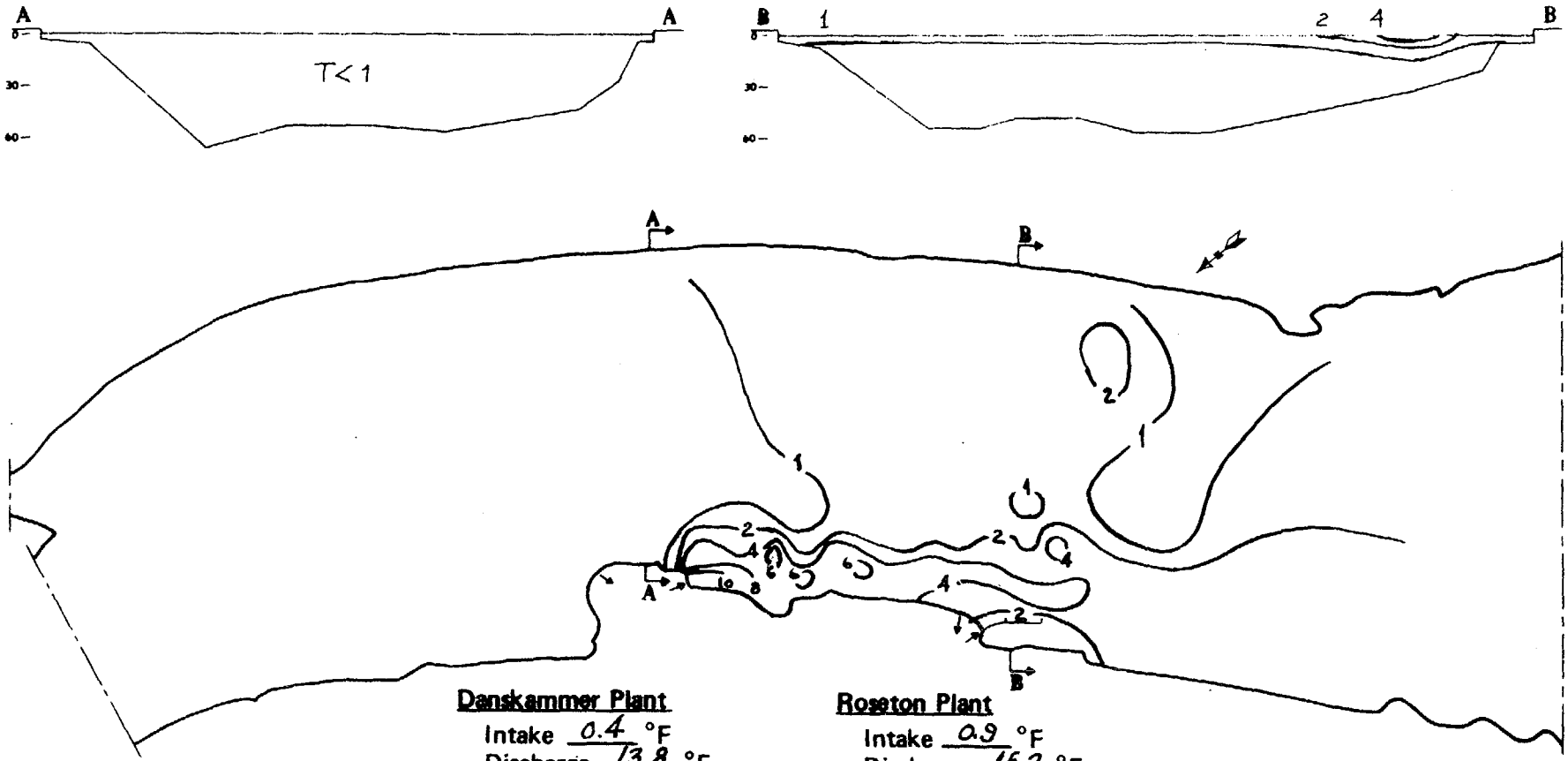


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 25



Danskammer Plant

Intake 0.4 °F
Discharge 13.8 °F
ΔT 13.4° F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.9 °F
Discharge 15.2 °F
ΔT 14.3 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 83.7 °F
Thermal Equilibrium Box Temperature 1.6 °F

River

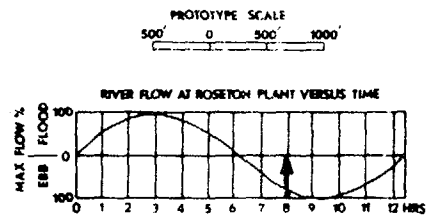
Fresh Water Flow 6000 cfs
Ambient Temperature 81.2 °F

Date 15 JUNE 72. p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

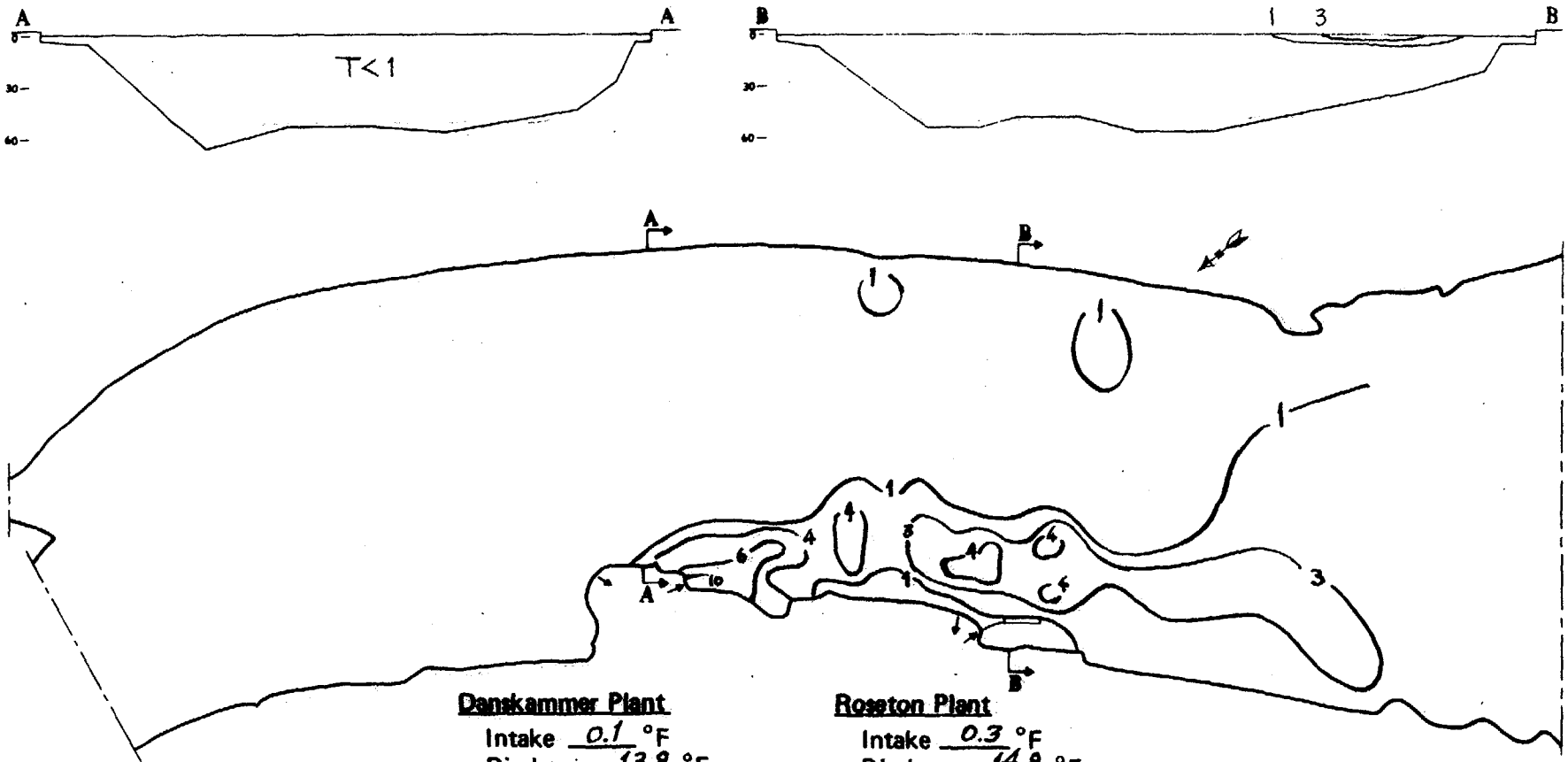


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 26



Danskammer Plant

Intake 0.1 °F
Discharge 13.8 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.8 °F
ΔT 14.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 84 %
Dry Bulb Temperature 83.7 °F
Thermal Equilibrium Box Temperature 1.6 °F

River

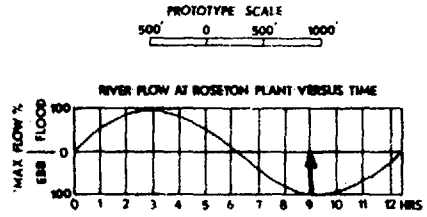
Fresh Water Flow 6000 cfs
Ambient Temperature 81.2 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

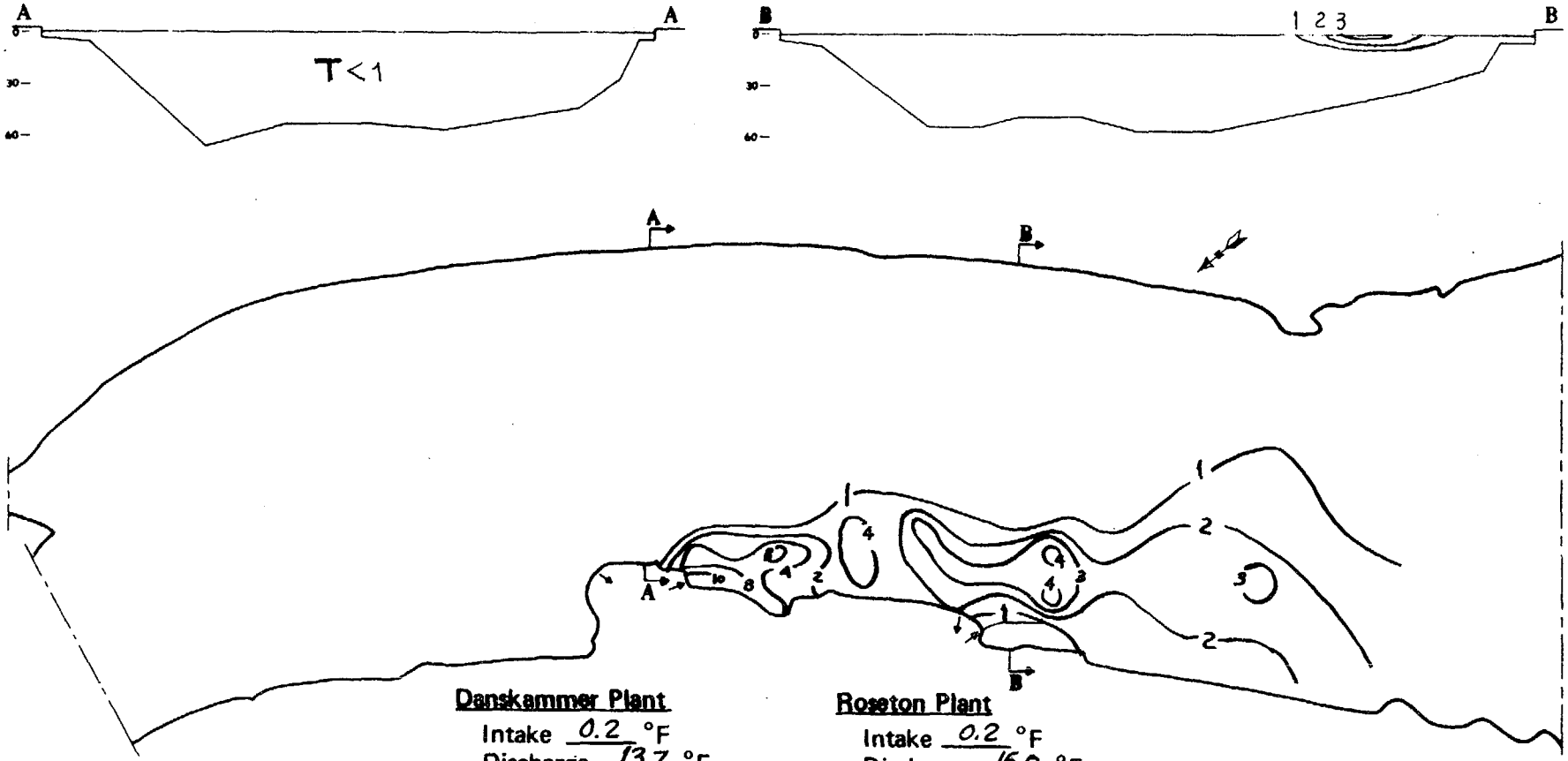


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 27



Danskammer Plant

Intake 0.2 °F
Discharge 13.7 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.2 °F
Discharge 15.0 °F
ΔT 14.8 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 84 %
Dry Bulb Temperature 83.5 °F
Thermal Equilibrium Box Temperature 1.7 °F

River

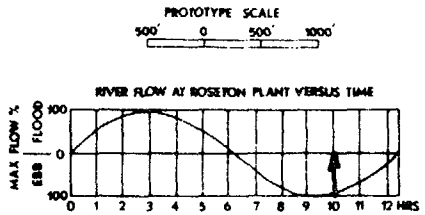
Fresh Water Flow 6000 cfs
Ambient Temperature 81.2 °F

Date 15 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

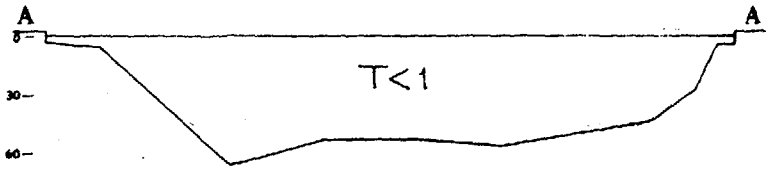


TEMPERATURE RISE ABOVE RIVER AMBIENT

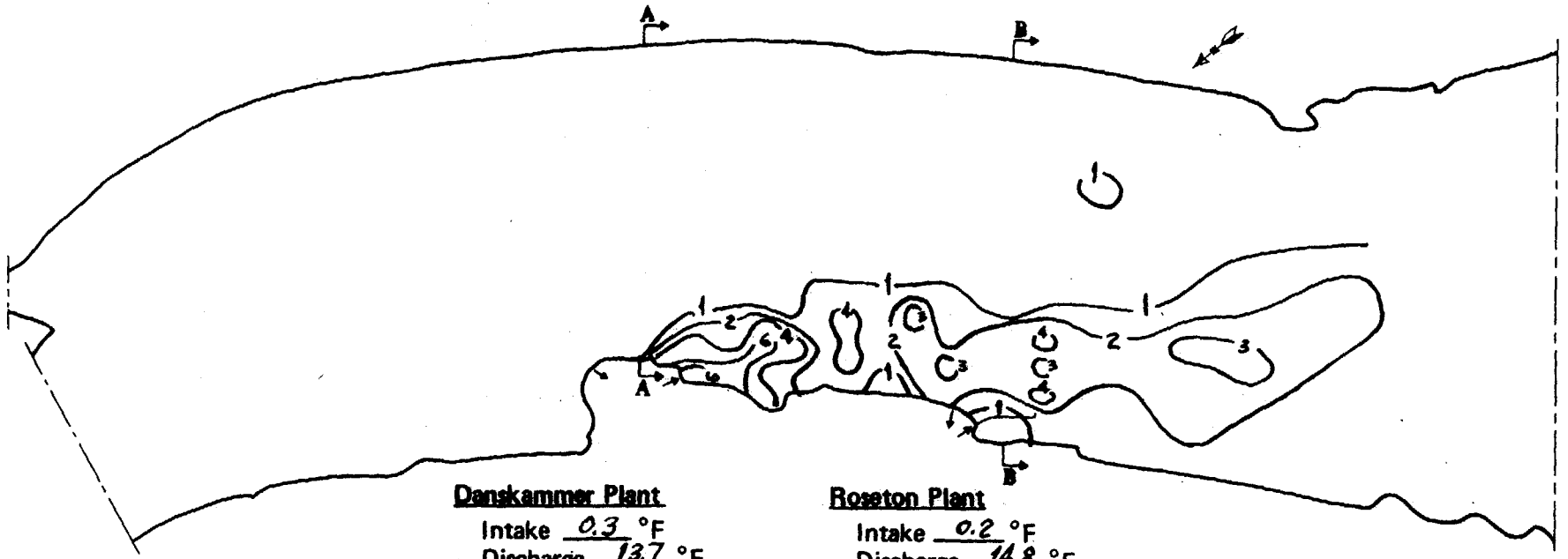
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 28







Danskammer Plant

Intake 0.3 °F
Discharge 13.7 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.2 °F
Discharge 14.8 °F
ΔT 14.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 83 %
Dry Bulb Temperature 83.8 °F
Thermal Equilibrium Box Temperature 1.8 °F

River

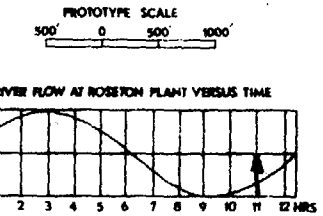
Fresh Water Flow 6000 cfs
Ambient Temperature 81.3 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 29

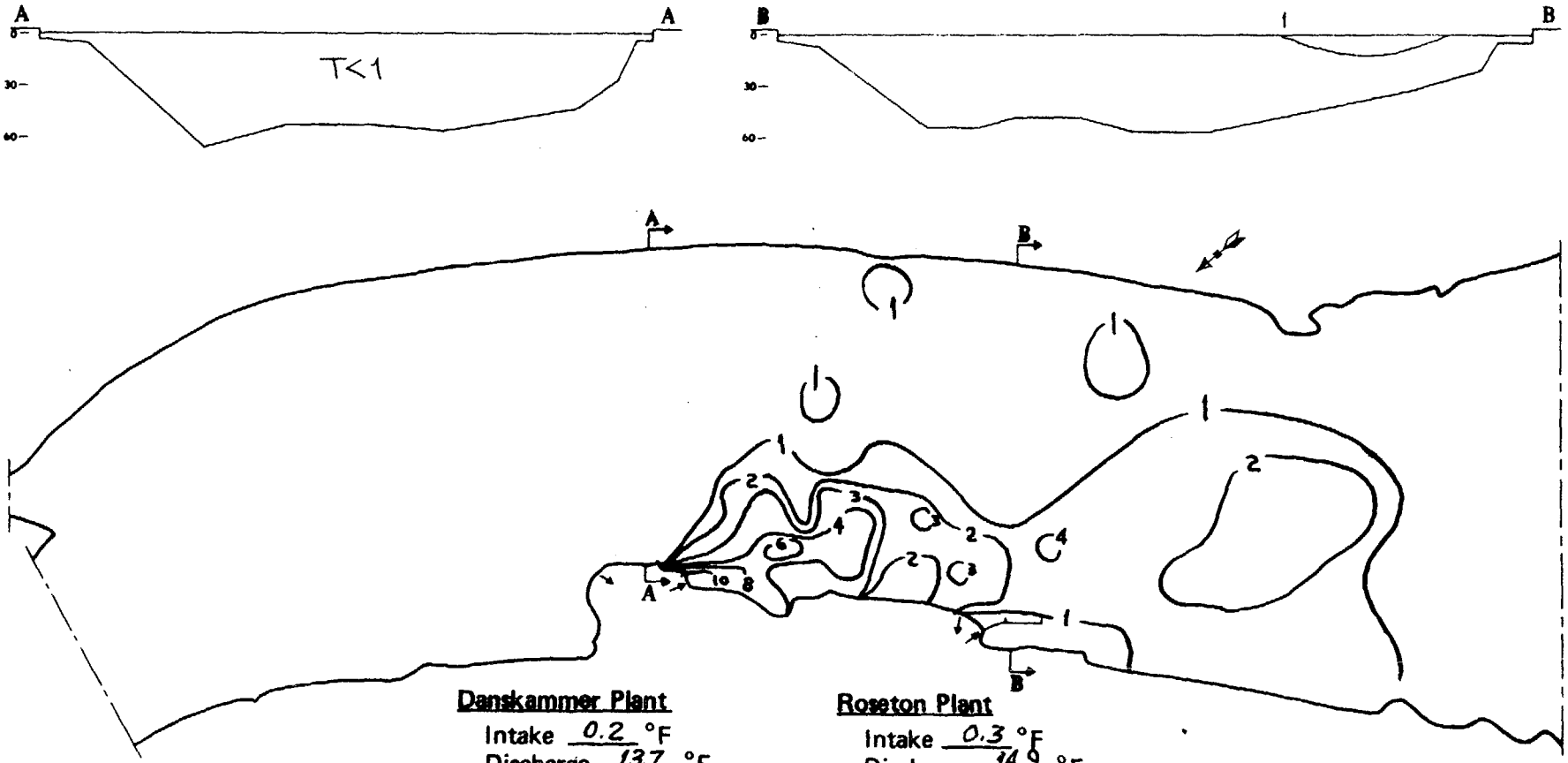


FIGURE A 30

Danskammer Plant

Intake 0.2 °F
Discharge 13.7 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.9 °F
ΔT 14.6 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 84 %
Dry Bulb Temperature 84.1 °F
Thermal Equilibrium Box Temperature 1.8 °F

River

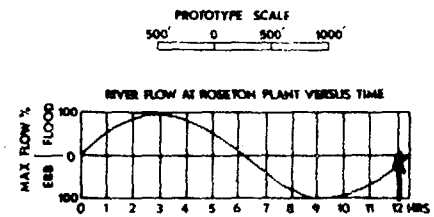
Fresh Water Flow 6000 cfs
Ambient Temperature 84.3 °F

Date 15 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

DANSKAMMER

LOAD	80%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	13.5 F

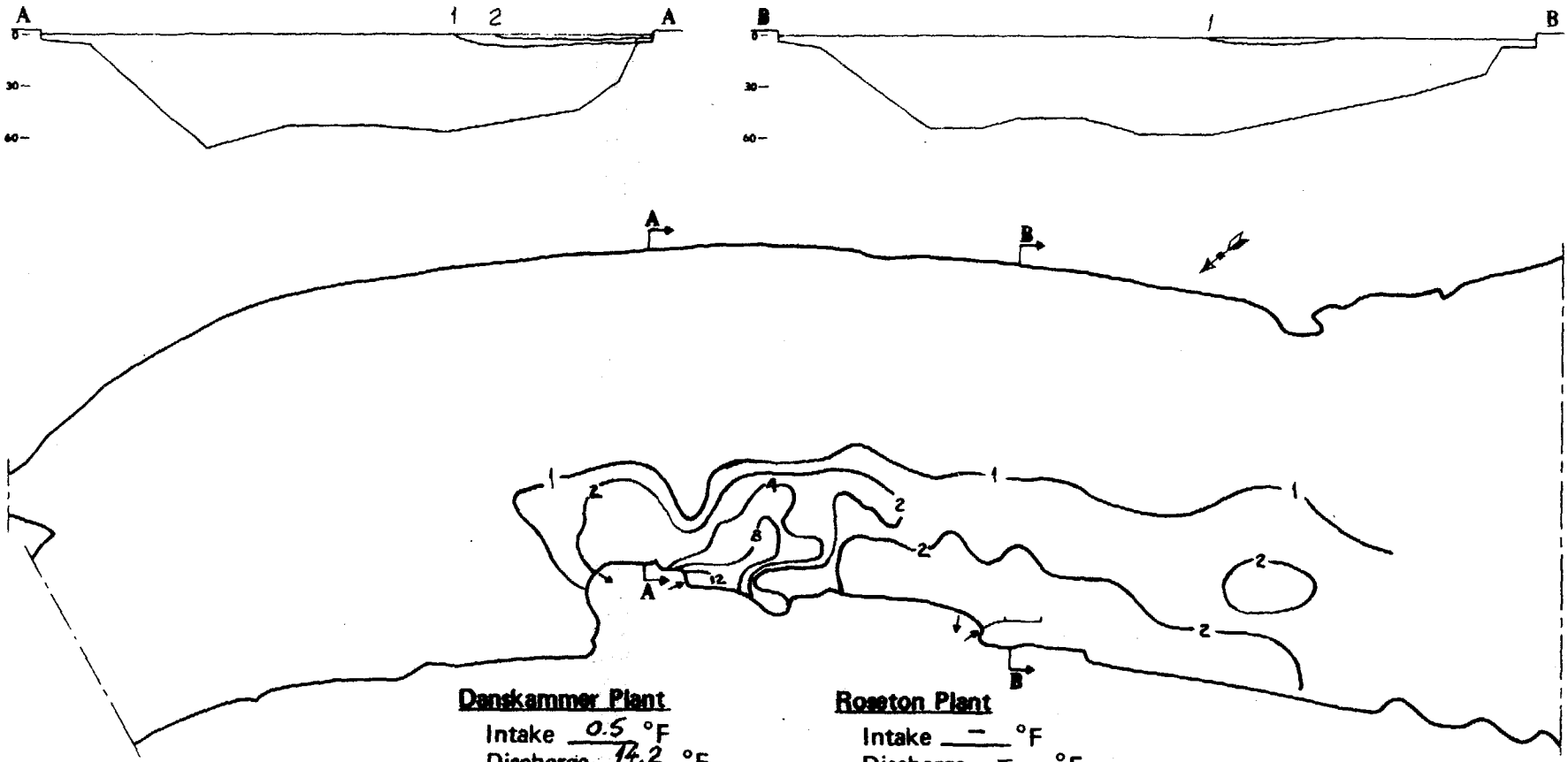
ROSETON NOT OPERATING

LOAD	
DISCHARGE DESIGN	
DISCHARGE FLOW	
TEMPERATURE RISE	
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	82.0 F
FRESH WATER FLOW	6000 CFS

TEST DATE 16 JUNE 1972



Danskammer Plant

Intake 0.5 °F
Discharge 14.2 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.7 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

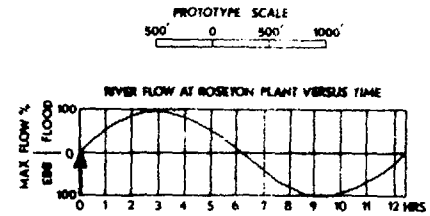
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 31

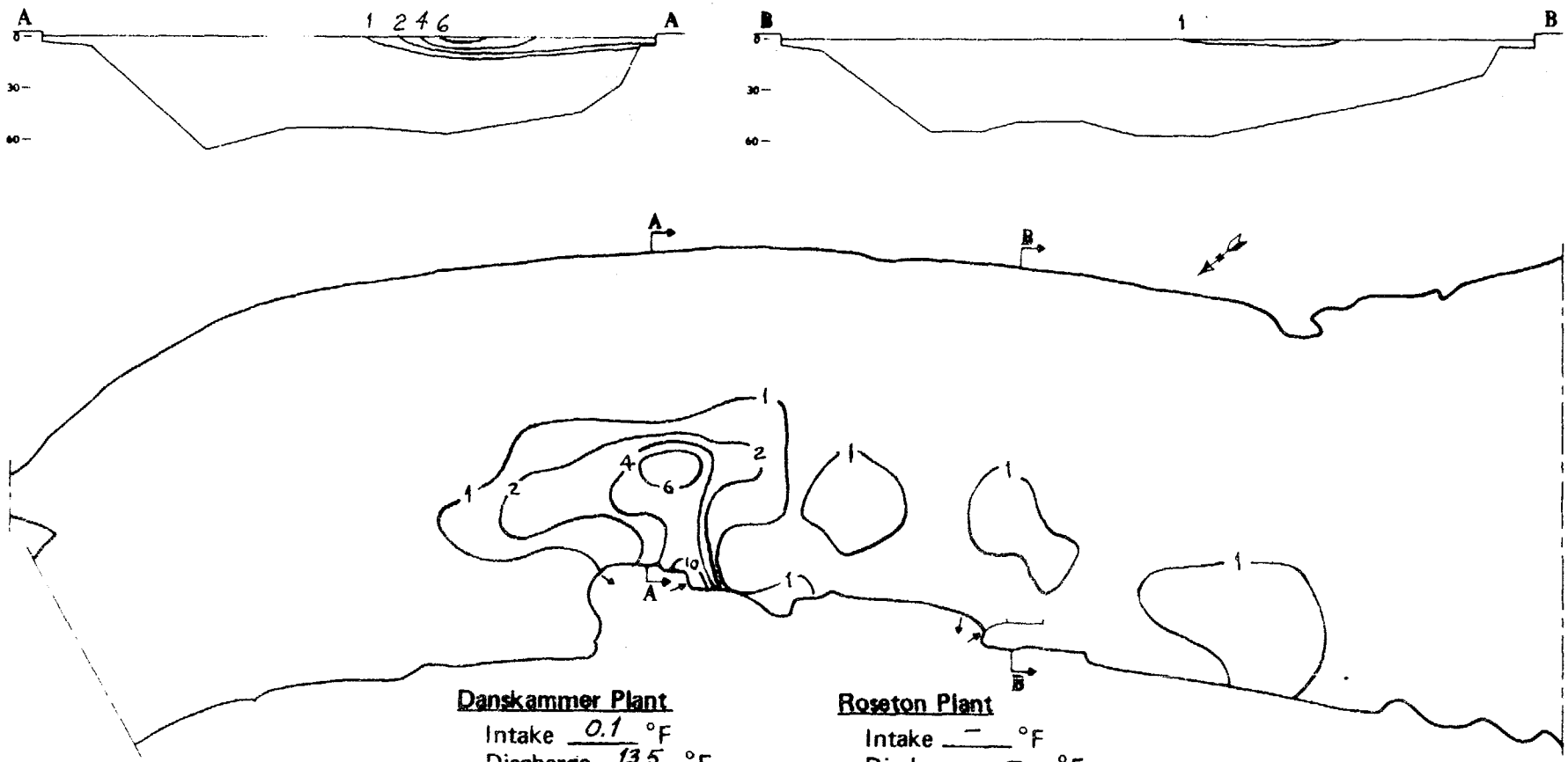


FIGURE A 32

Danskammer Plant

Intake 0.1 °F
Discharge 13.5 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.6 °F
Thermal Equilibrium Box Temperature 0.6 °F

River

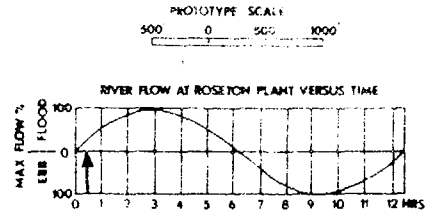
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

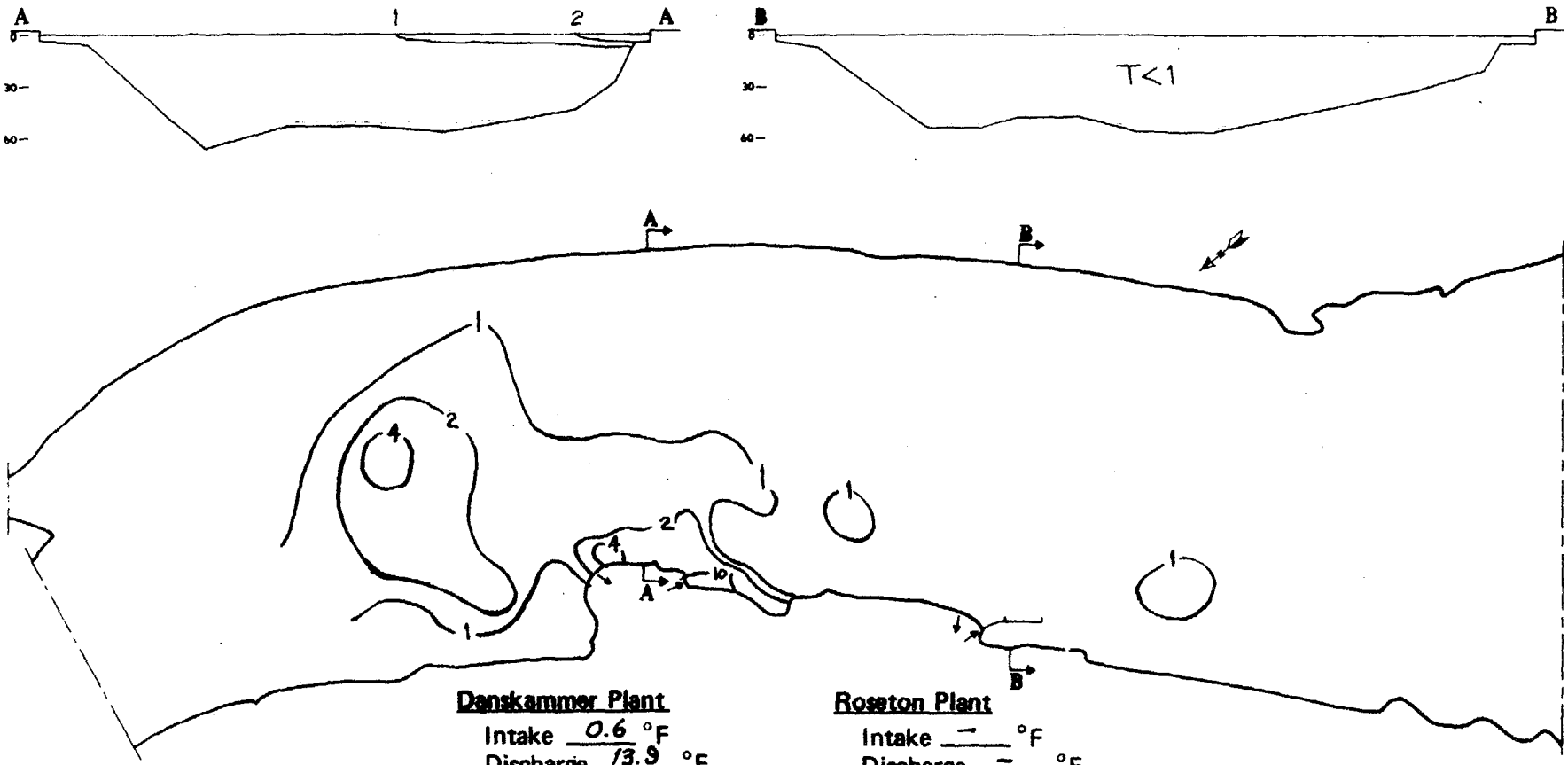
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.6 °F
Discharge 13.9 °F
ΔT 13.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.6 °F
Thermal Equilibrium Box Temperature 0.7 °F

River

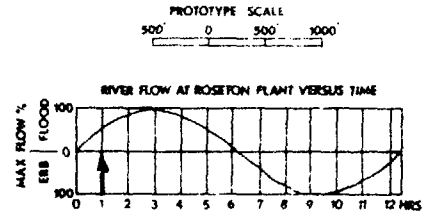
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

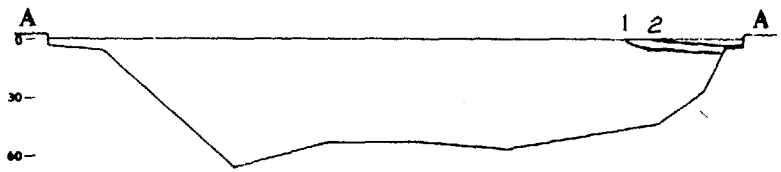


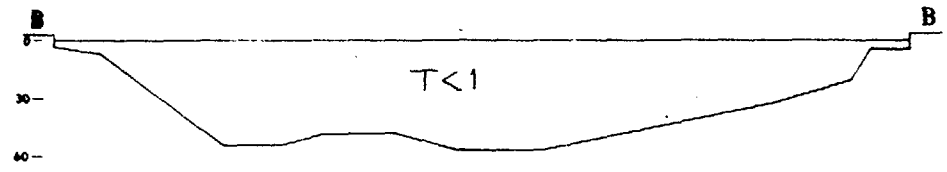
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 33





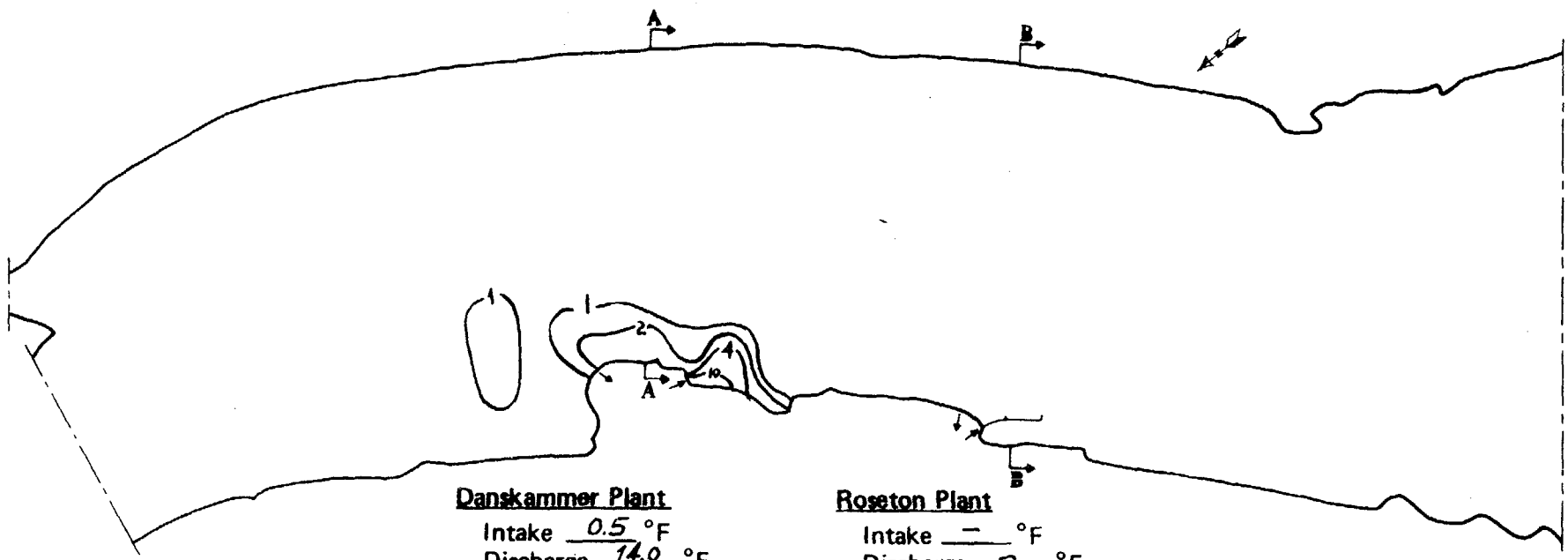


FIGURE A 34

Danskammer Plant

Intake 0.5 °F
Discharge 14.0 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.6 °F
Thermal Equilibrium Box Temperature 08 °F

River

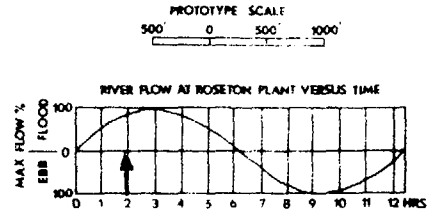
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

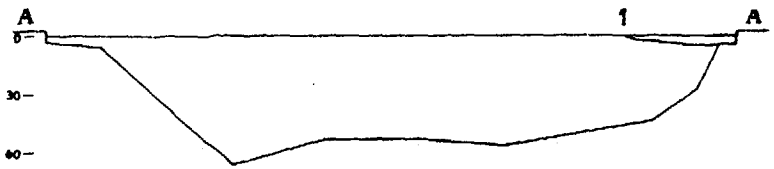
A. With Barge
B. Without Barge

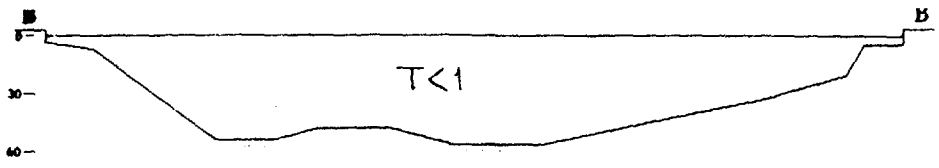


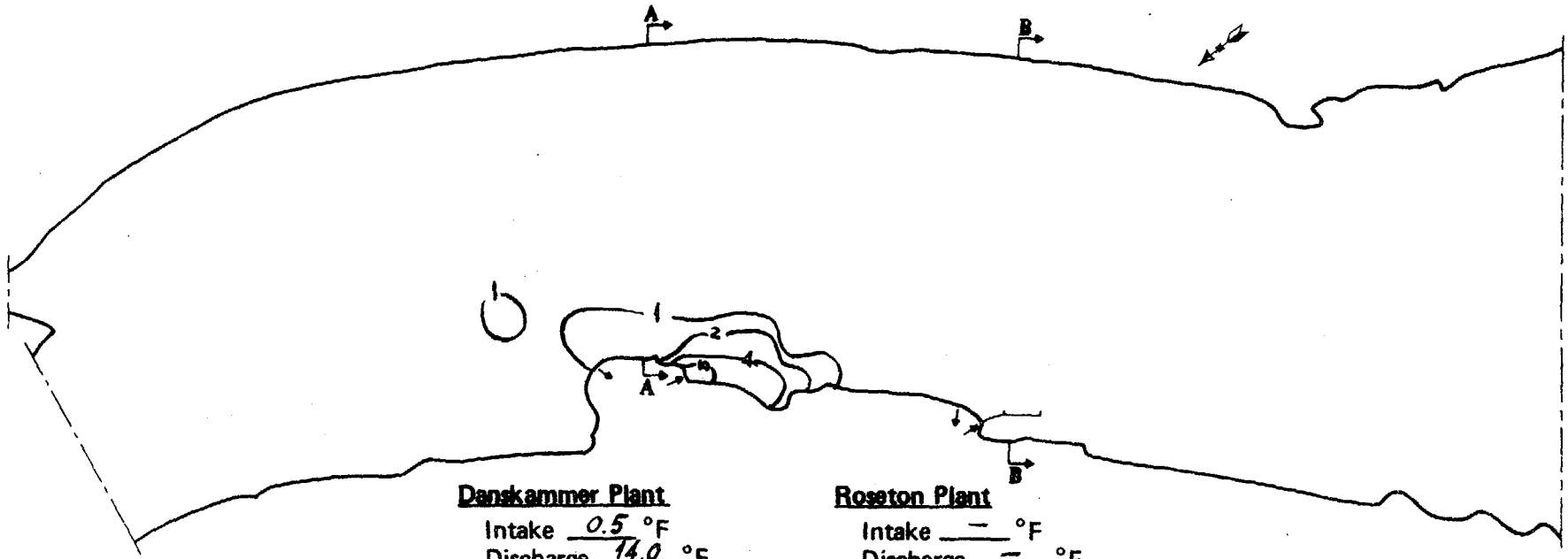
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.5 °F
Discharge 14.0 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

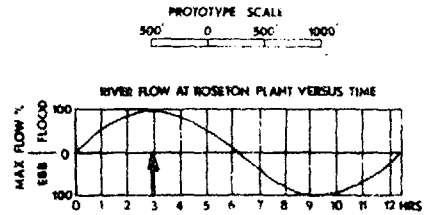
Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.6 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 82.0° F

Date 16 June 72



*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

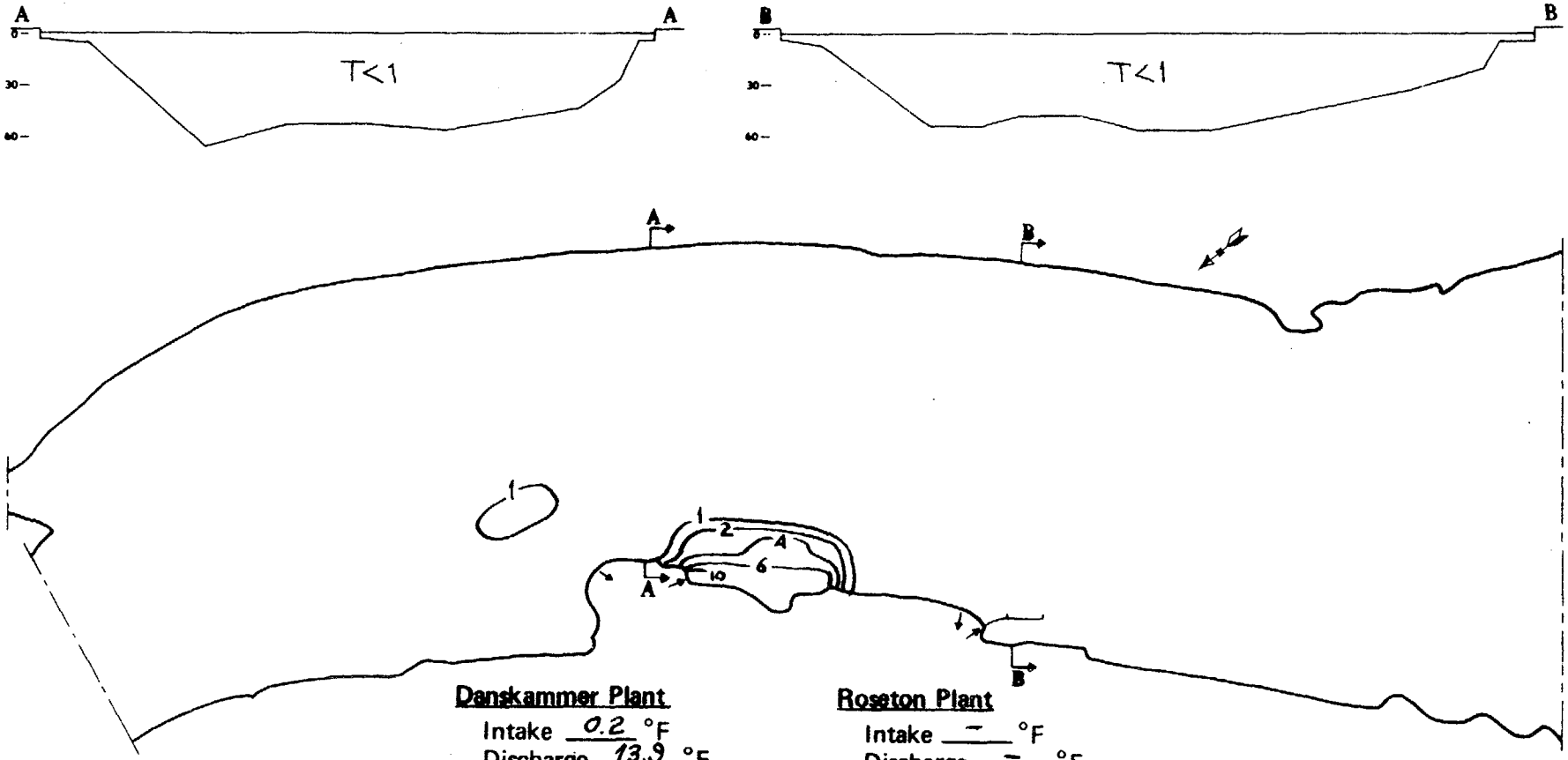
A. With Barge
B. Without Barge

TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer--Roseton Power Stations

ARL

FIGURE A 35



Danskammer Plant

Intake 0.2 °F
Discharge 13.9 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 82.5 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

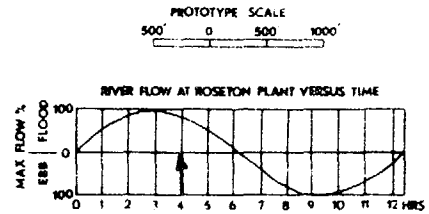
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0° F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

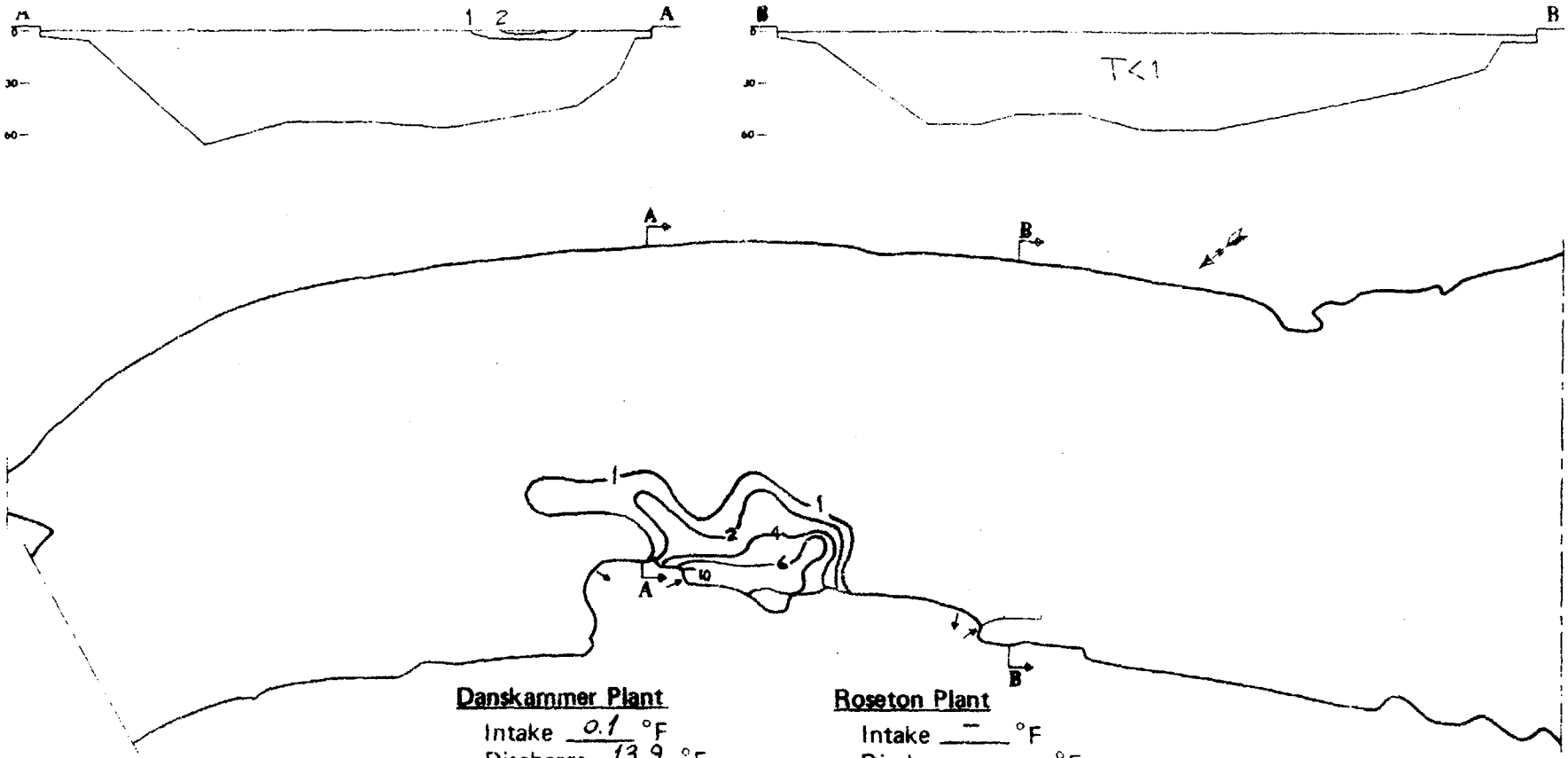


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 36



Danskammer Plant

Intake 0.1 °F
Discharge 13.9 °F
ΔT 13.8 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 82.2 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

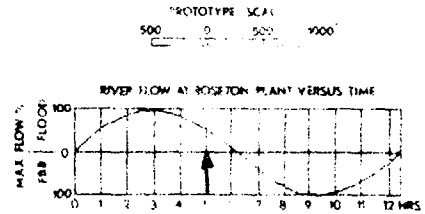
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1 All 14 Ports

A. With Barge
B. Without Barge



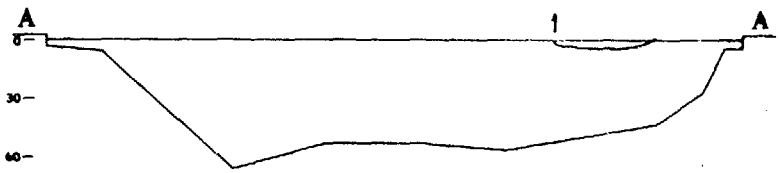
TEMPERATURE RISE ABOVE RIVER AMBIENT

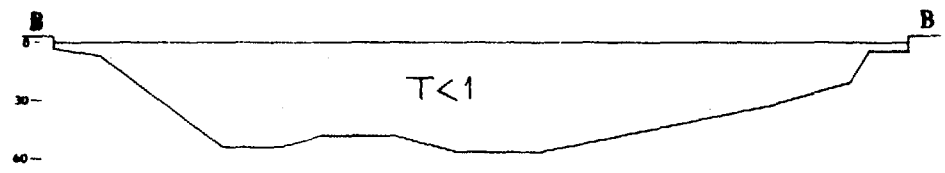
Hydrothermal Model Studies

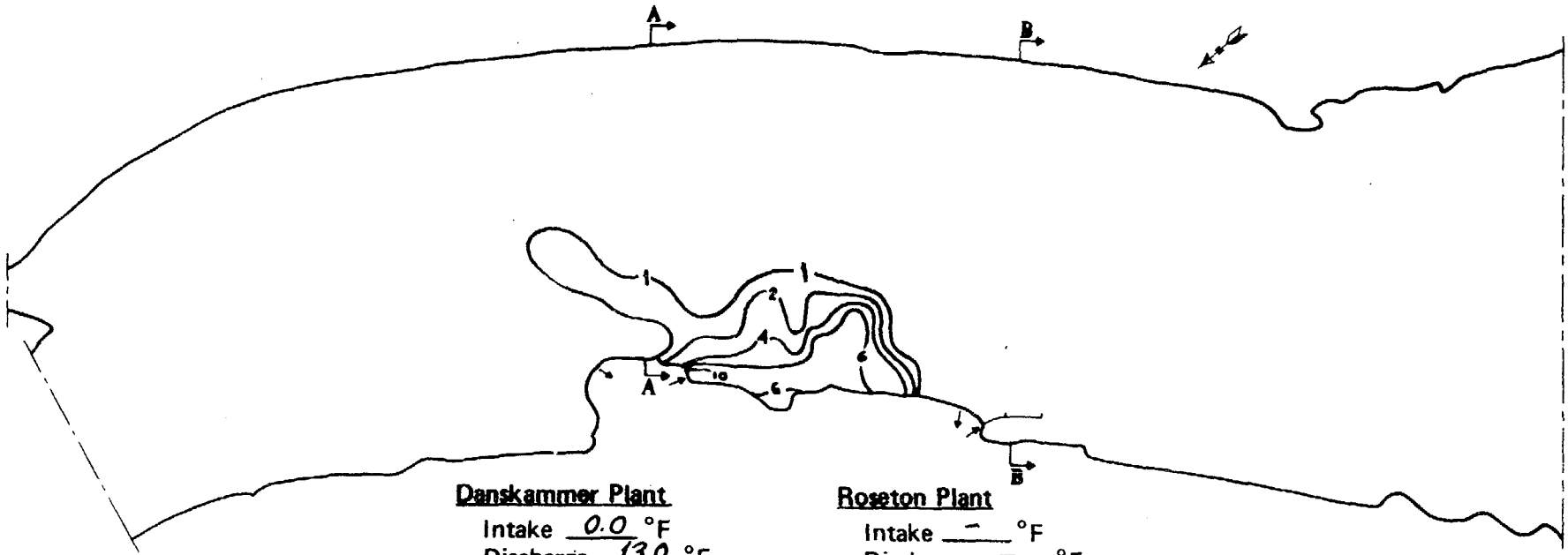
Danskammer–Roseton Power Stations

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FIGURE A 37







Danskammer Plant

Intake 0.0 °F
Discharge 13.0 °F
ΔT 13.0 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 82.2 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

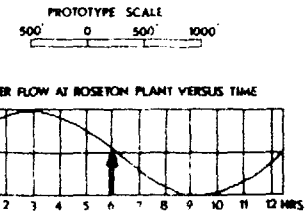
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0° F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

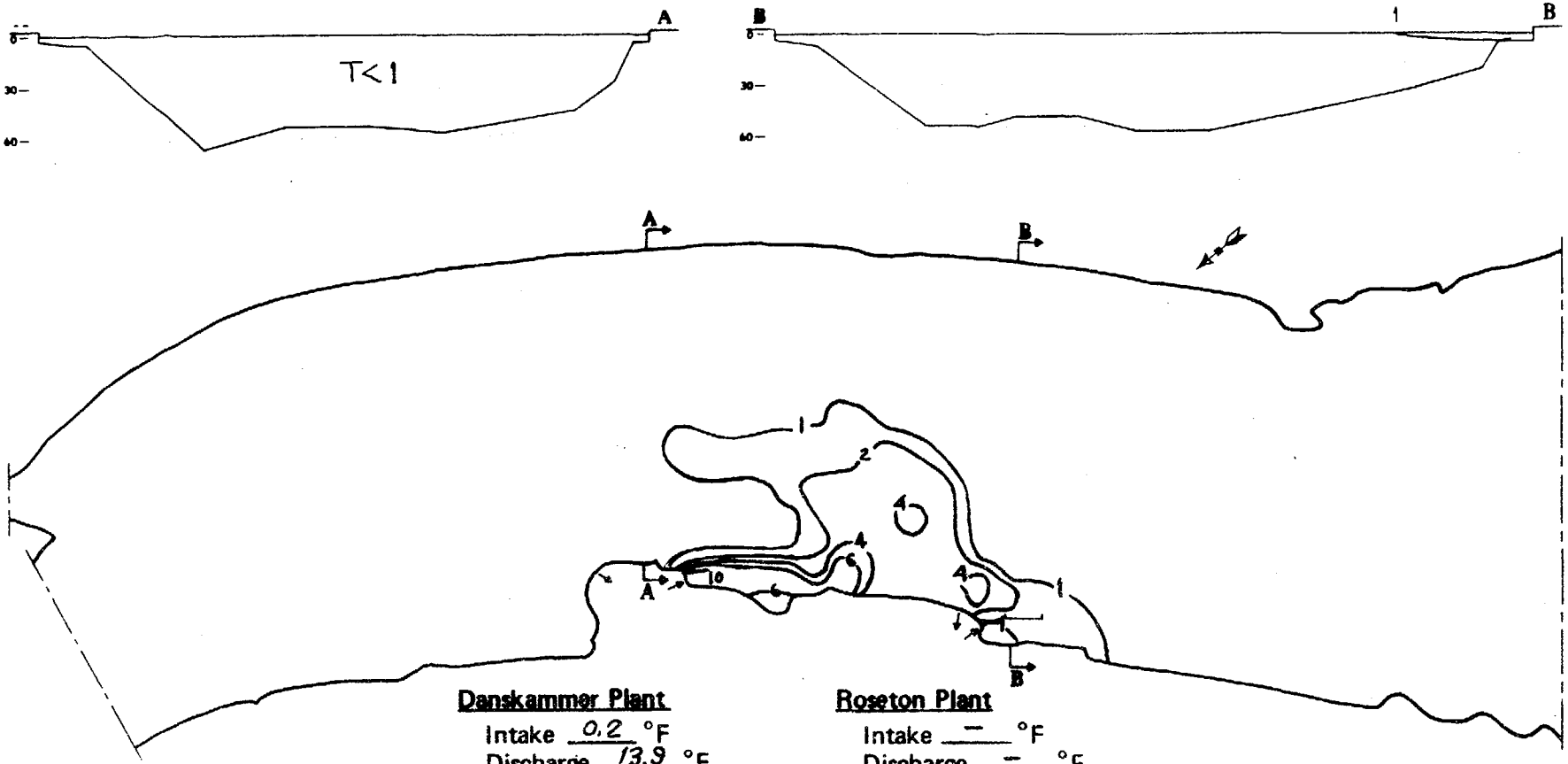


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 38



Danskammer Plant

Intake 0.2 °F
Discharge 13.9 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 81.9 °F
Thermal Equilibrium Box Temperature 0.9 °F

River

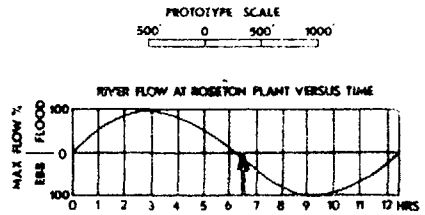
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0° F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



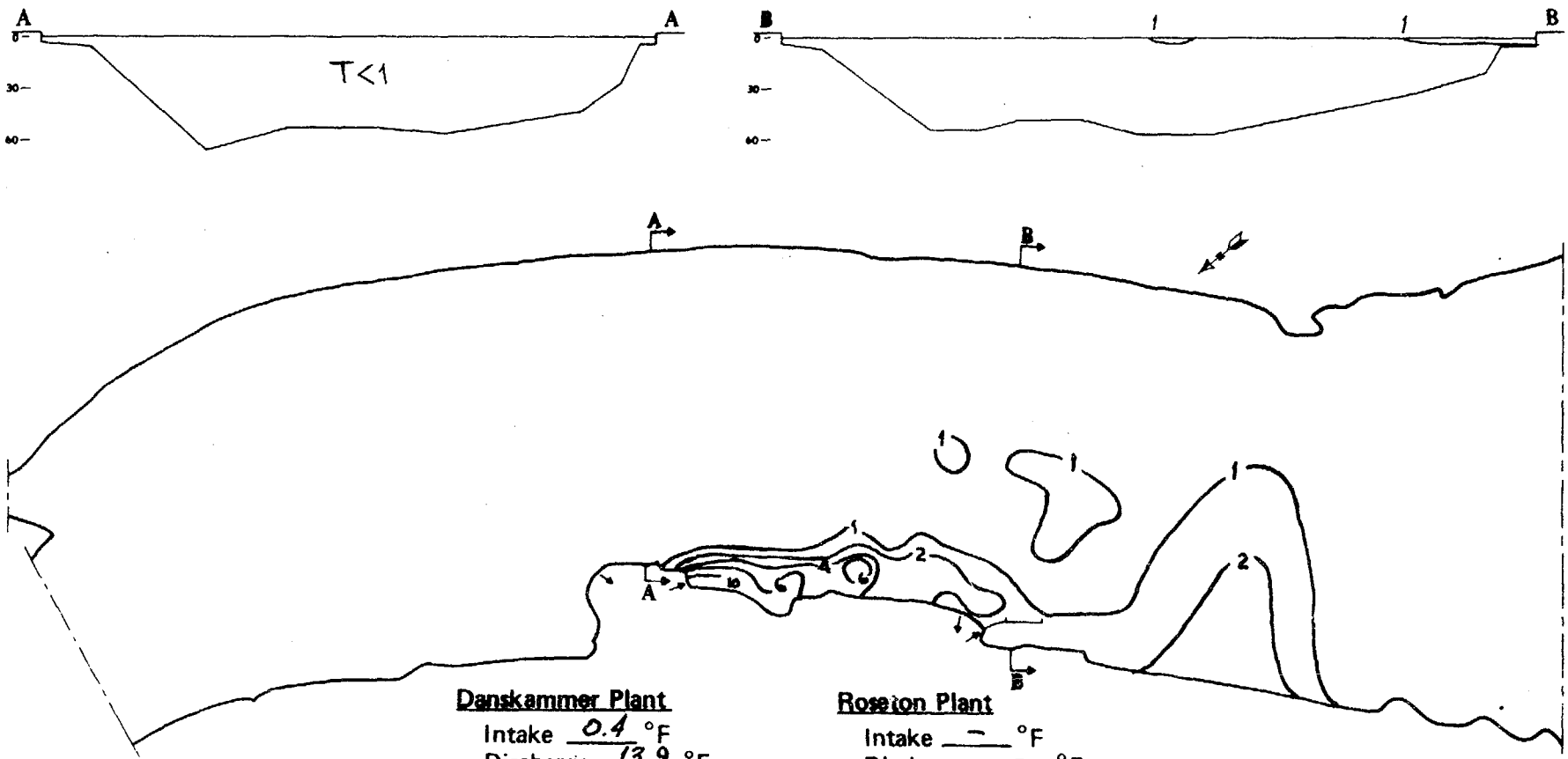
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 39

FIGURE A 40



Danskammer Plant

Intake 0.4 °F
Discharge 13.9 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 82.0 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

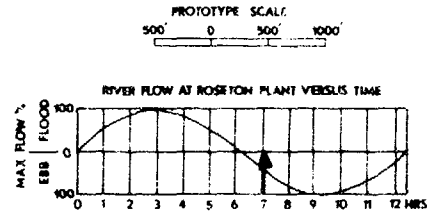
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

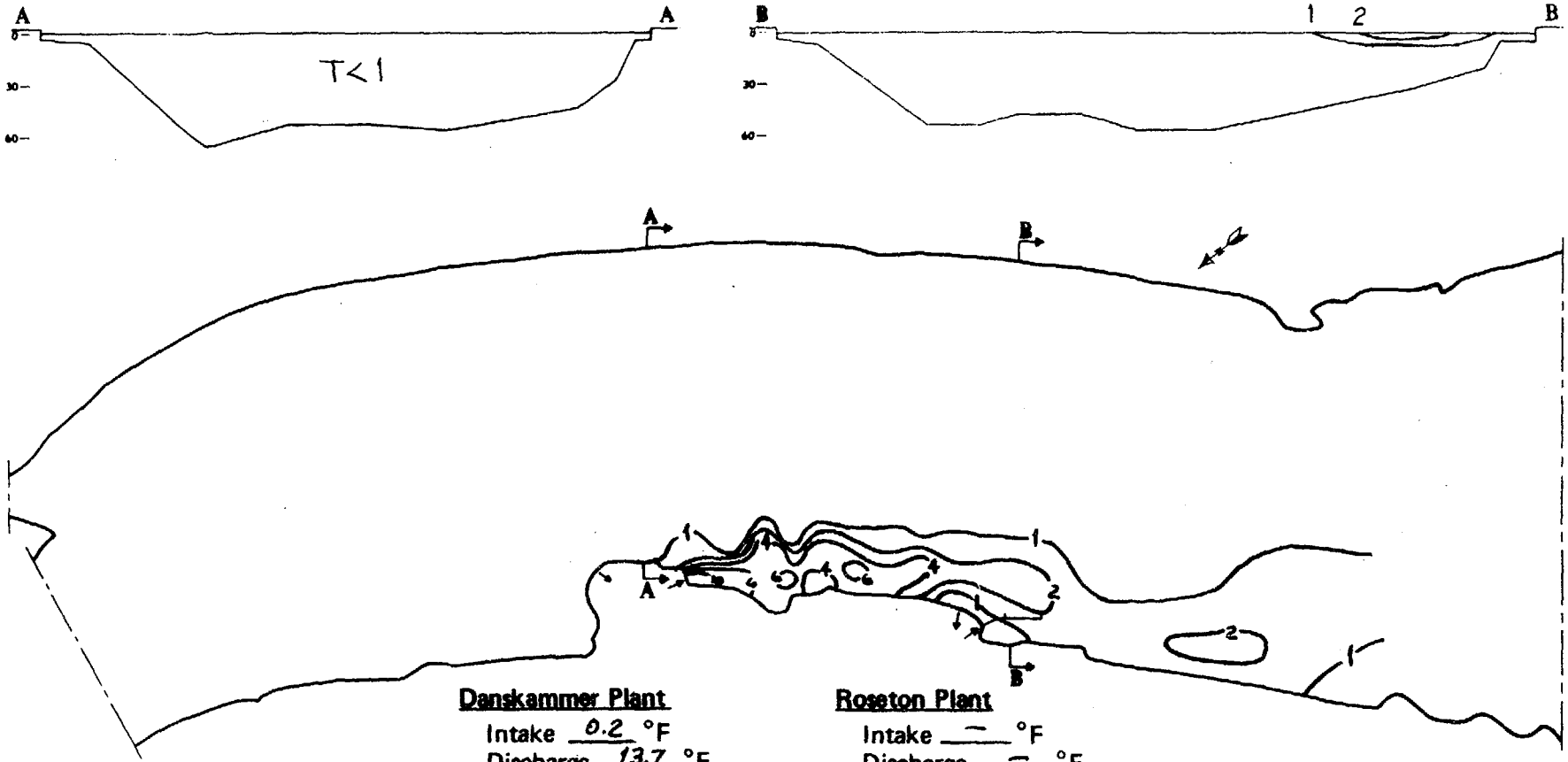
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.2 °F
Discharge 13.7 °F
ΔT 13.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 81.8 °F
Thermal Equilibrium Box Temperature 0.9 °F

River

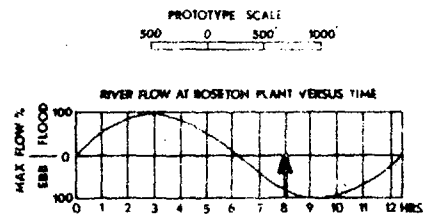
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0° F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 41

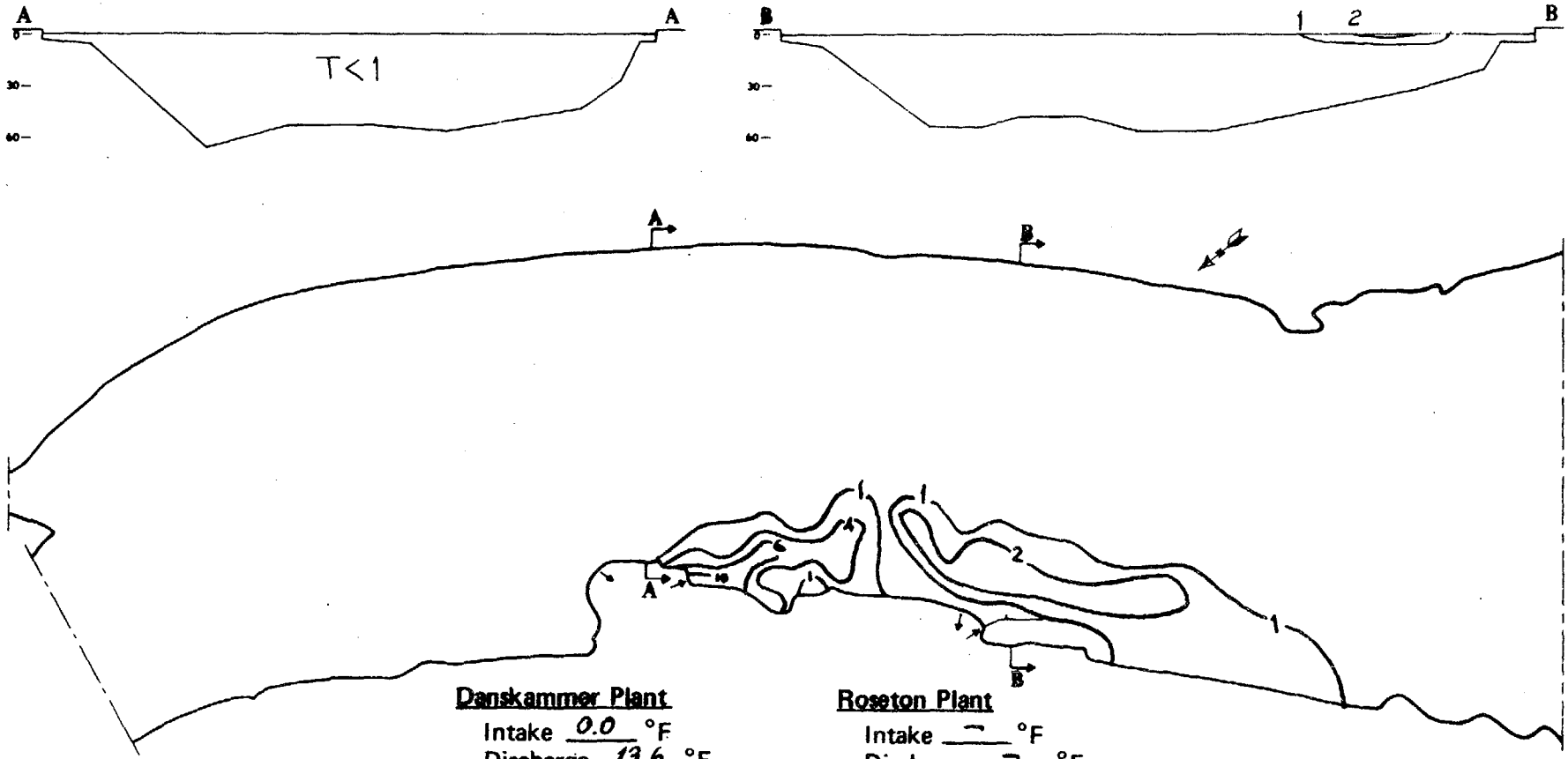


FIGURE A 42

Danskammer Plant

Intake 0.0 °F
Discharge 13.6 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 81.5 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

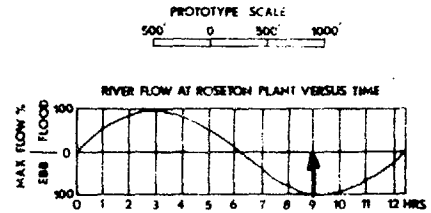
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

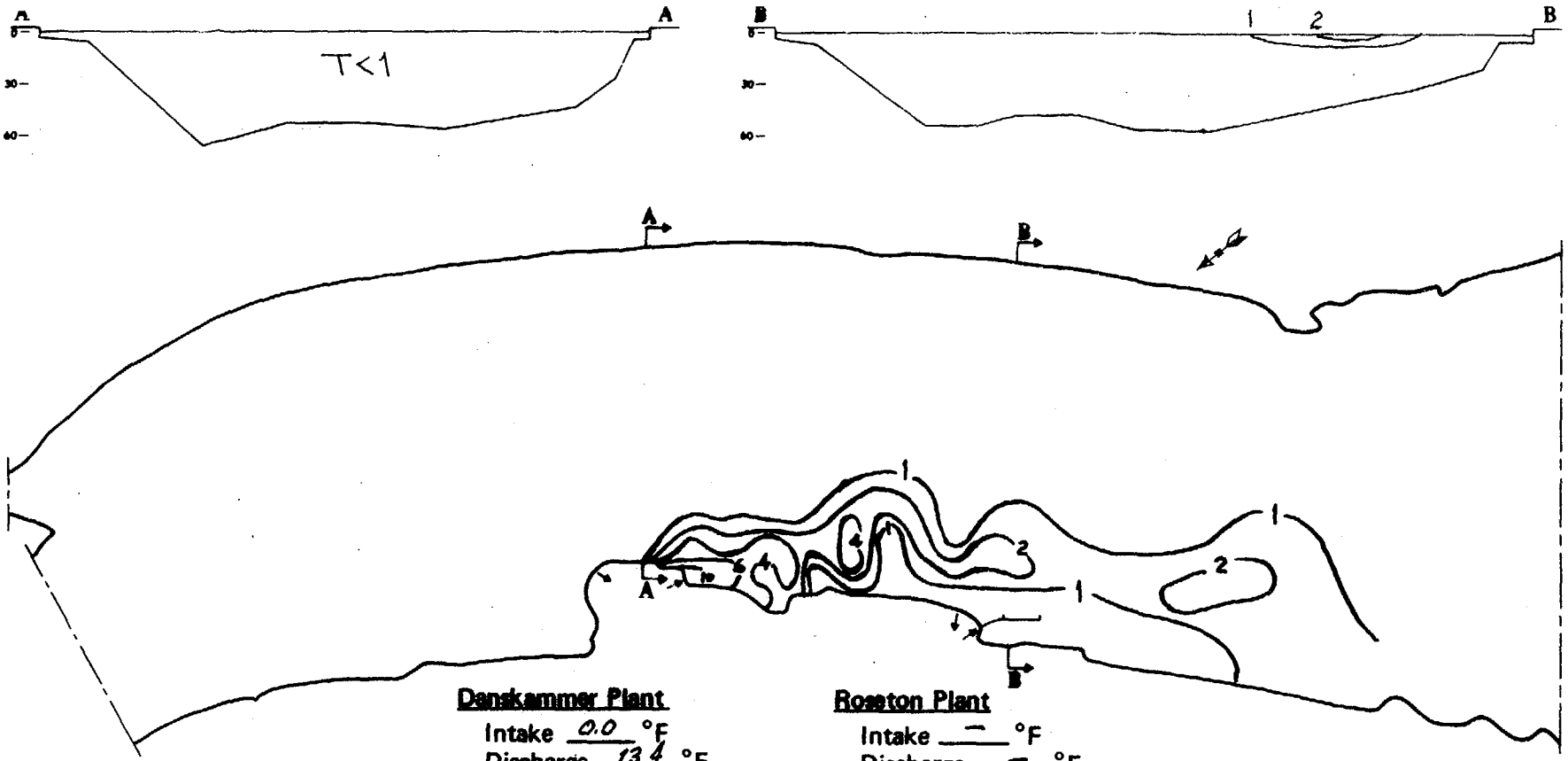
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake 0.0 °F
Discharge 13.4 °F
ΔT 13.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 81.4 °F
Thermal Equilibrium Box Temperature 79.8 °F

River

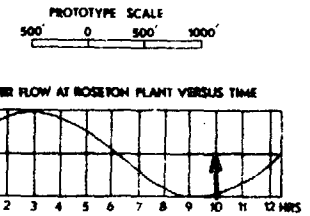
Fresh Water Flow 6000 cfs
Ambient Temperature 82.0 °F

Date 16 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 43

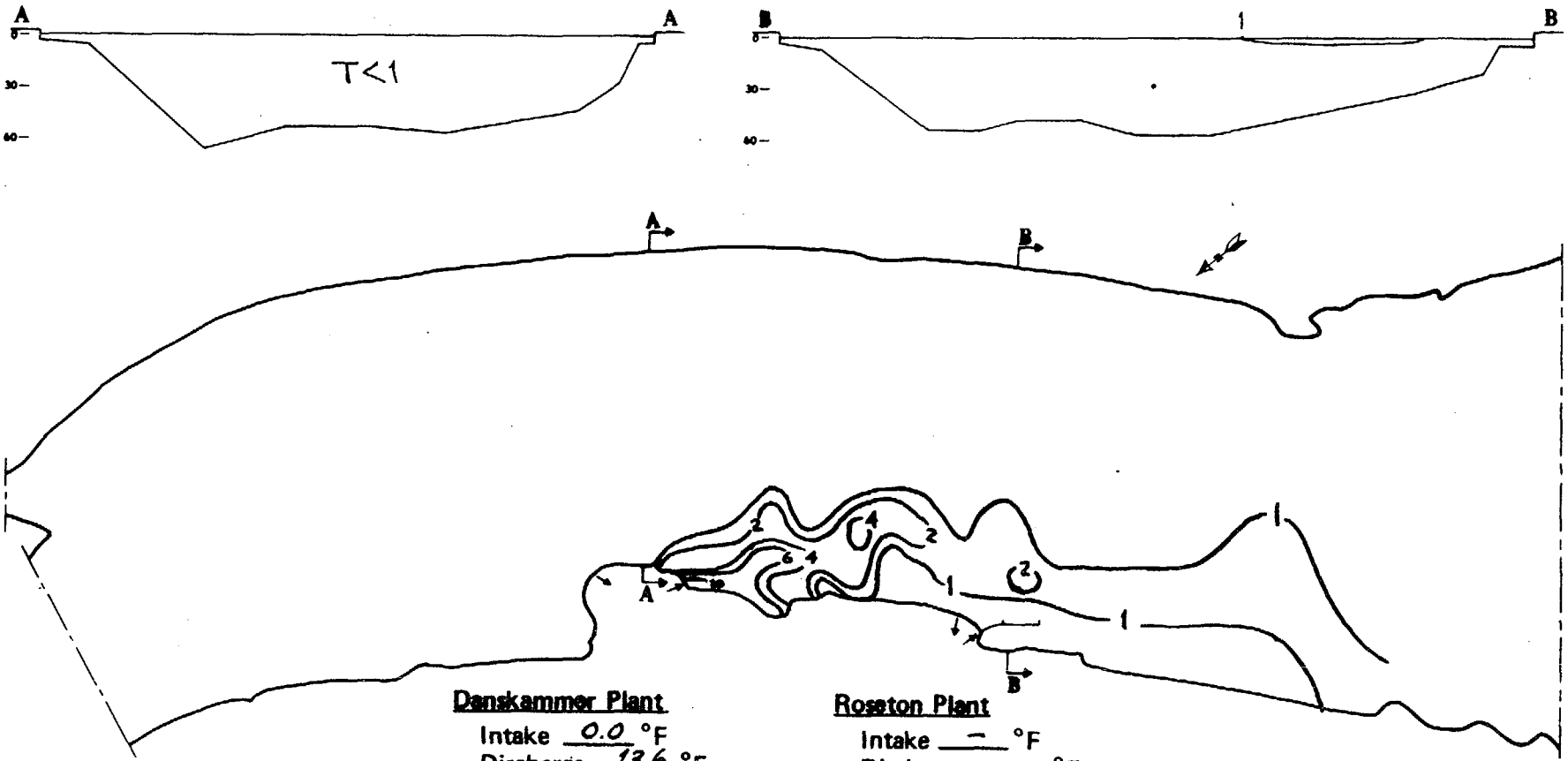


FIGURE A 44

Danskammer Plant

Intake 0.0 °F
Discharge 13.6 °F
ΔT 13.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

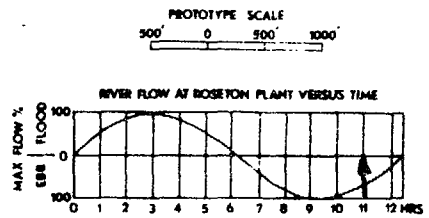
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 81.4 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 82.1 °F

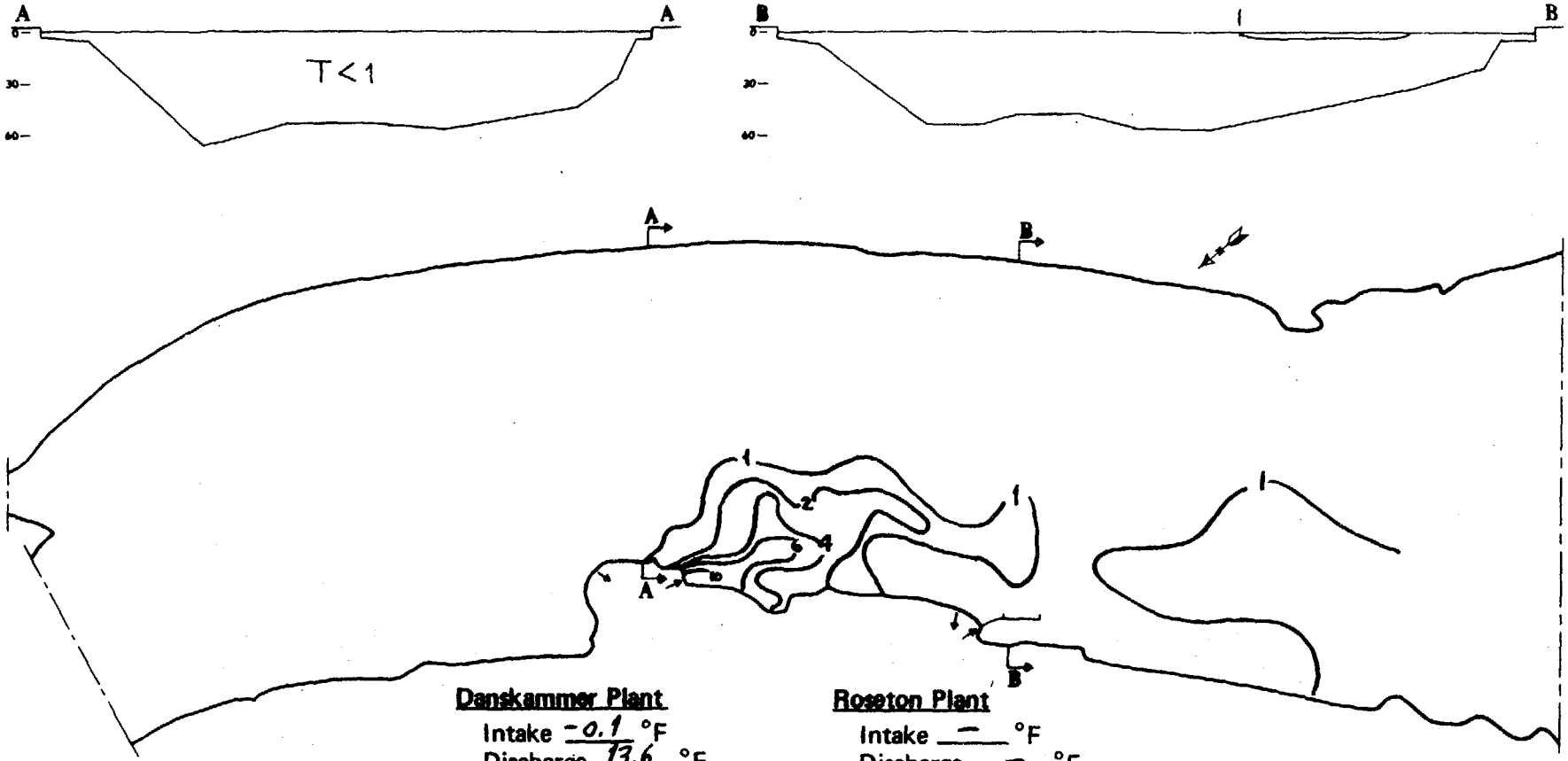
Date 16 June 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake -0.1 °F
Discharge 13.6 °F
ΔT 13.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 81.3 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

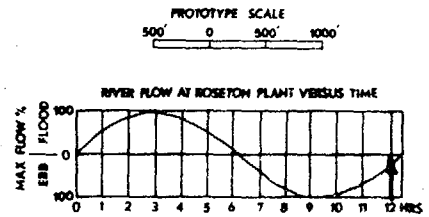
Fresh Water Flow 6000 cfs
Ambient Temperature 82.1 °F

Date 16 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 45

DANSKAMMER

LOAD	60%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	10.3 F

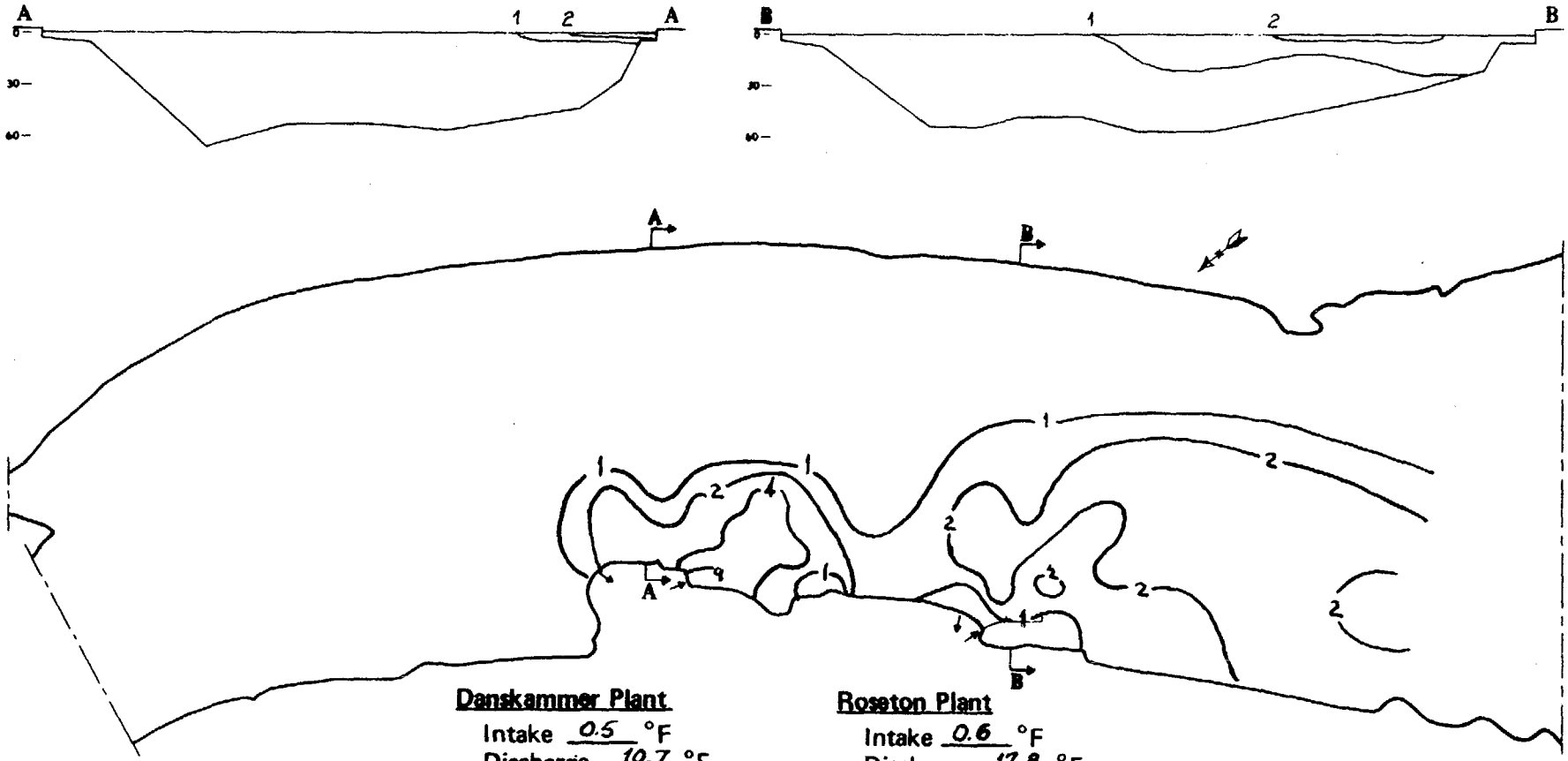
ROSETON

LOAD	100%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	18.1 F
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	75.6 F
FRESH WATER FLOW	6000 CFS

TEST DATE 13 JUNE 1972



Danskammer Plant

Intake 0.5 °F
Discharge 10.7 °F
ΔT 10.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 17.8 °F
ΔT 17.2 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature −0.2 °F

River

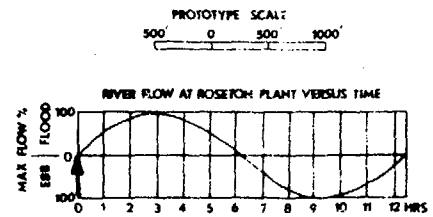
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6° F

Date 13 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

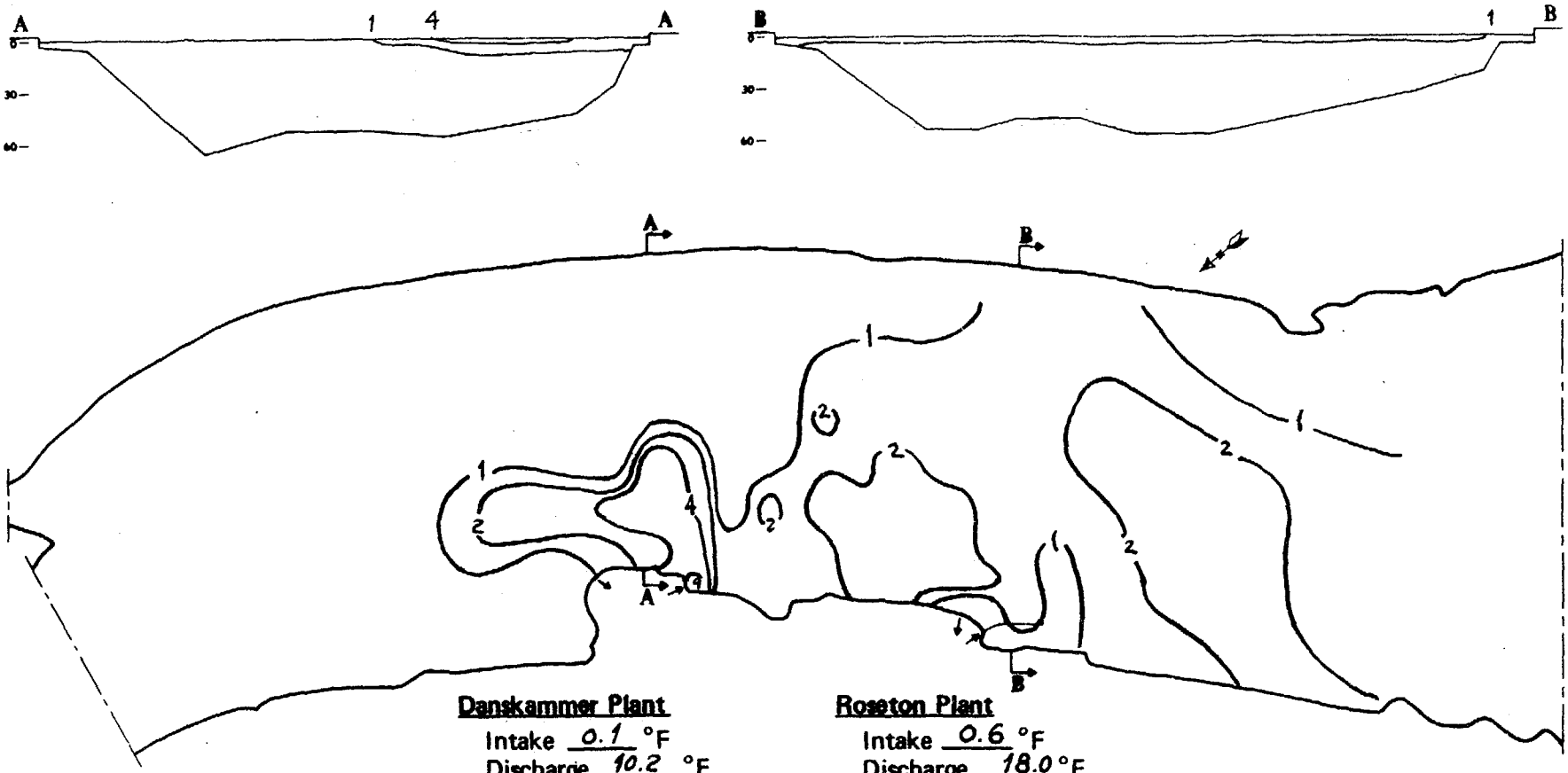


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 46



Danskammer Plant

Intake 0.1 °F
Discharge 10.2 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 18.0 °F
ΔT 17.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature 0.0 °F

River

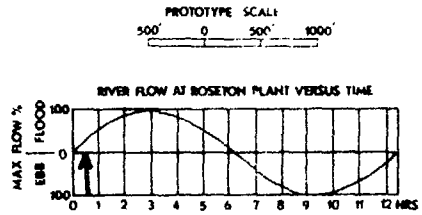
Fresh Water Flow 6000 cfs
Ambient Temperature 75.5 °F

Date 13 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 47

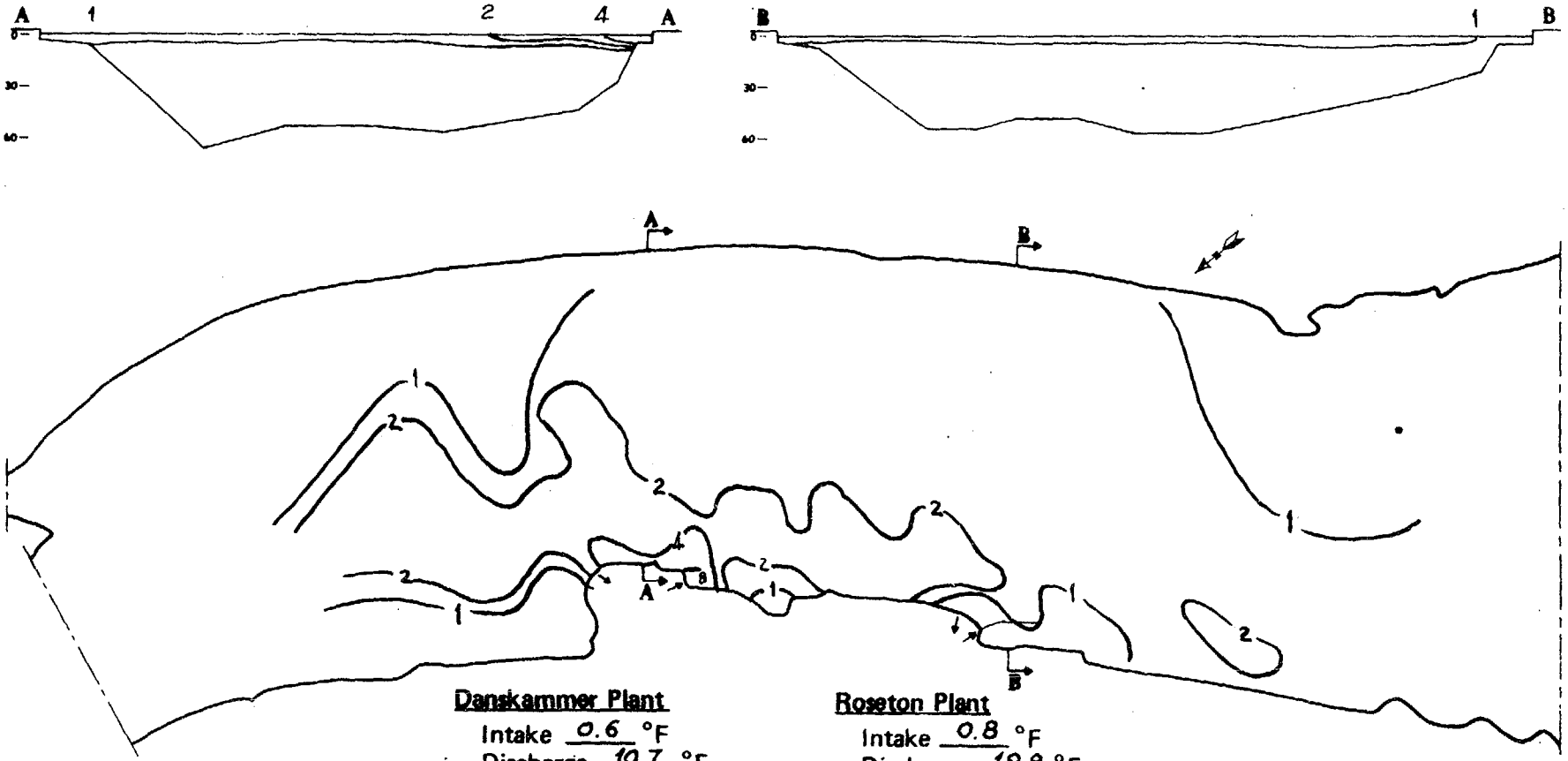


FIGURE A 48

Danskammer Plant

Intake 0.6 °F
Discharge 10.7 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 18.8 °F
ΔT 18.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

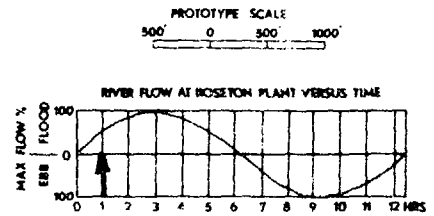
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 74.7 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 75.6°F

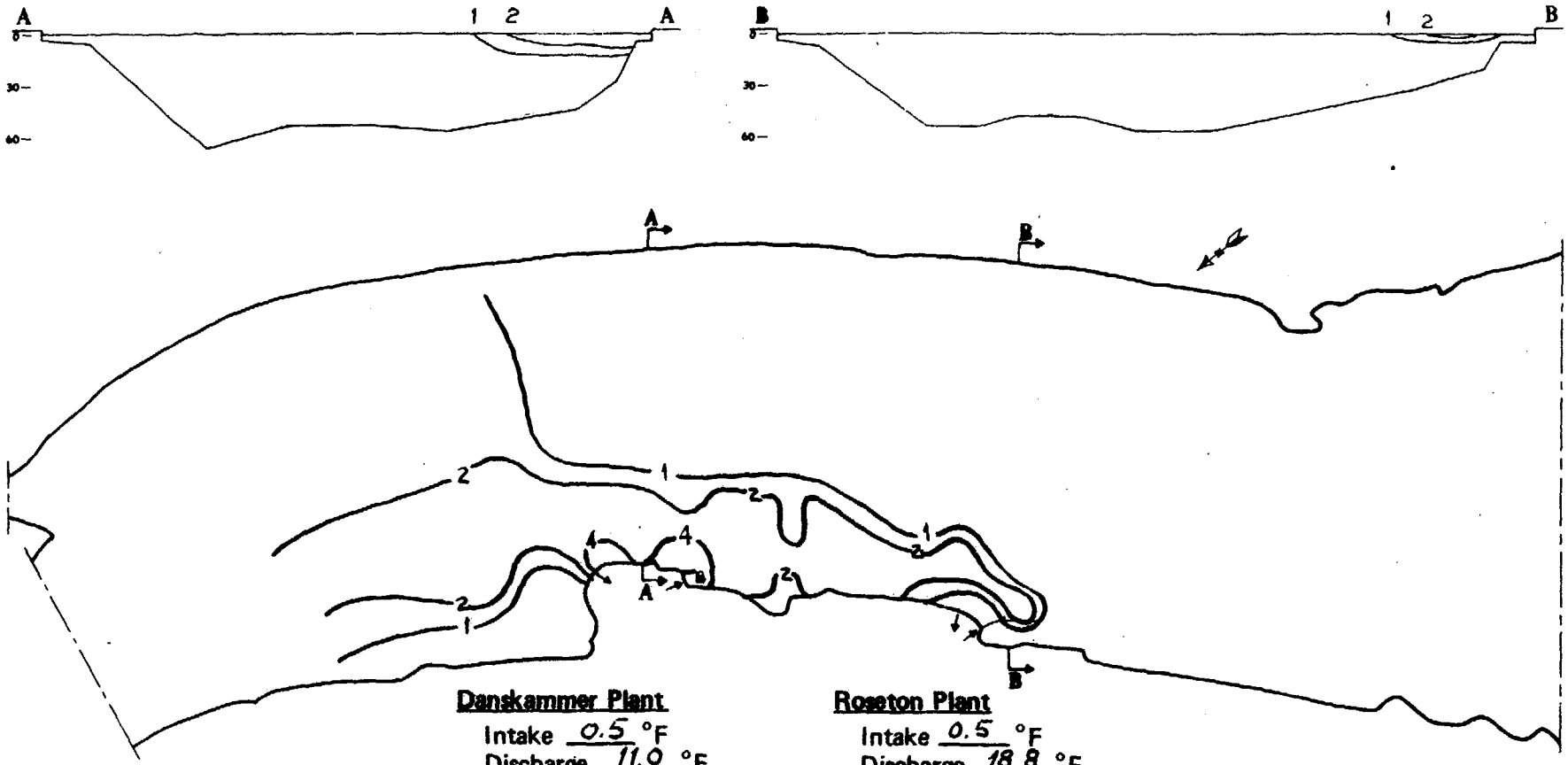
Date 13 JUNE 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.5 °F
Discharge 11.0 °F
ΔT 10.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.5 °F
Discharge 18.8 °F
ΔT 18.3 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

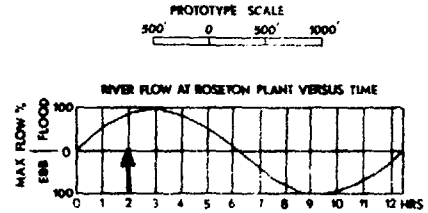
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

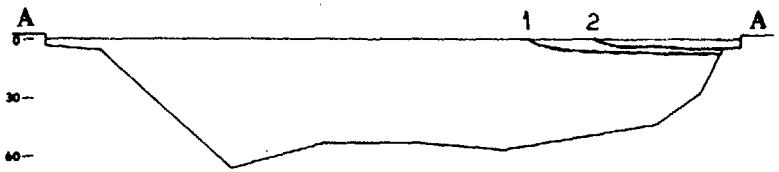


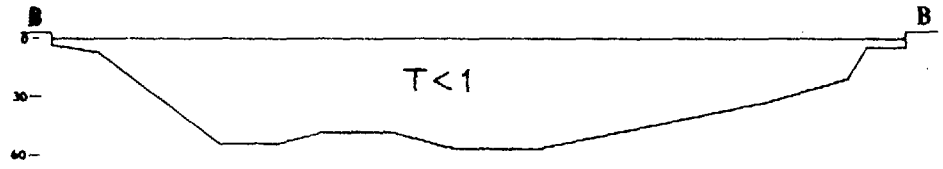
TEMPERATURE RISE ABOVE RIVER AMBIENT

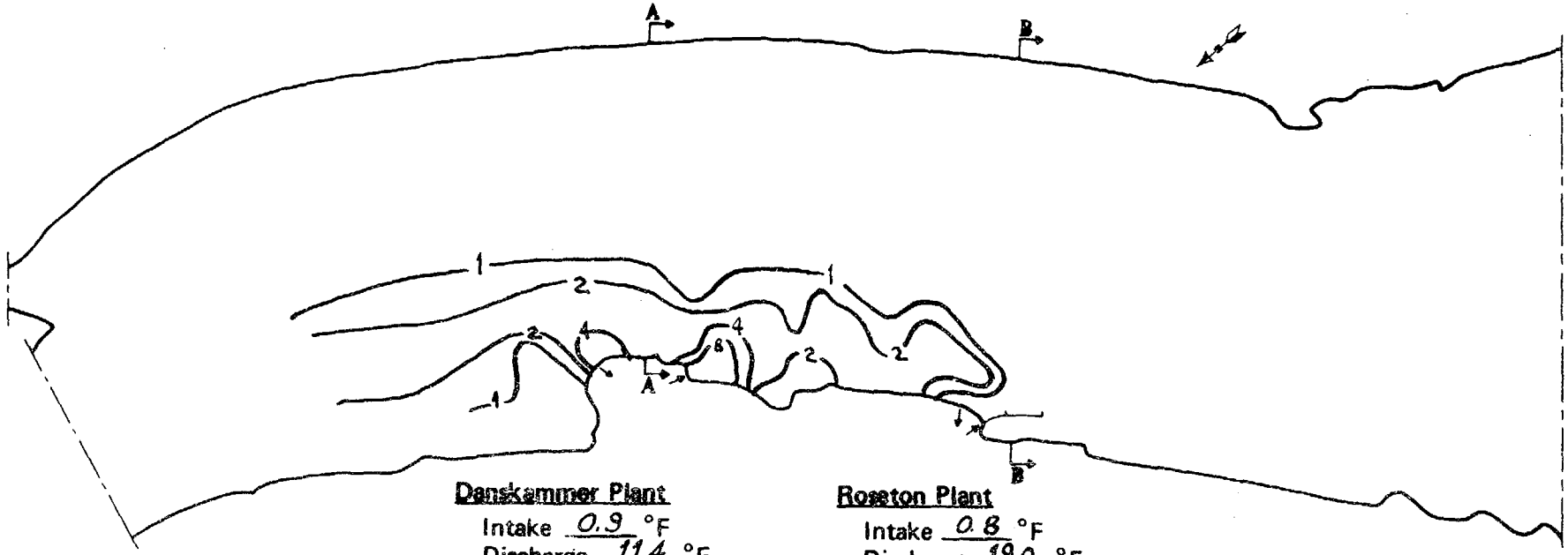
Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 49







Danskammer Plant

Intake 0.9 °F
Discharge 11.4 °F
ΔT 10.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 19.0 °F
ΔT 18.2 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature 0.0 °F

River

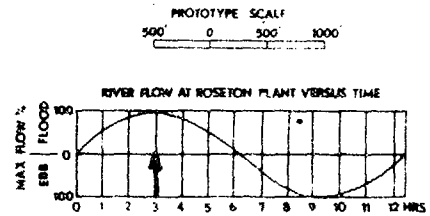
Fresh Water Flow 6000 cfs
Ambient Temperature 75.5 °F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

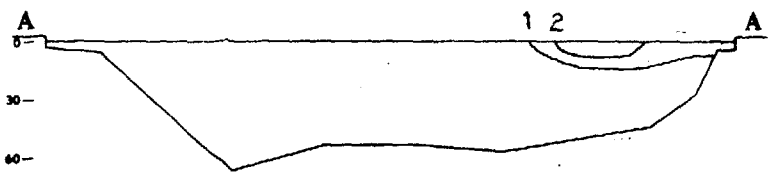


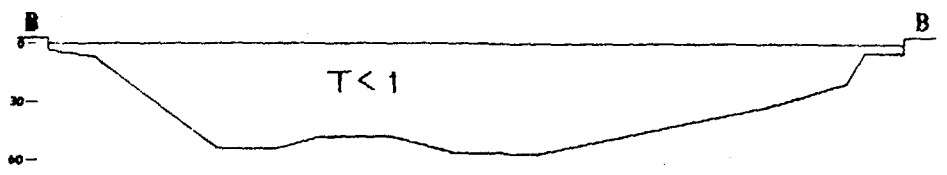
TEMPERATURE RISE ABOVE RIVER AMBIENT

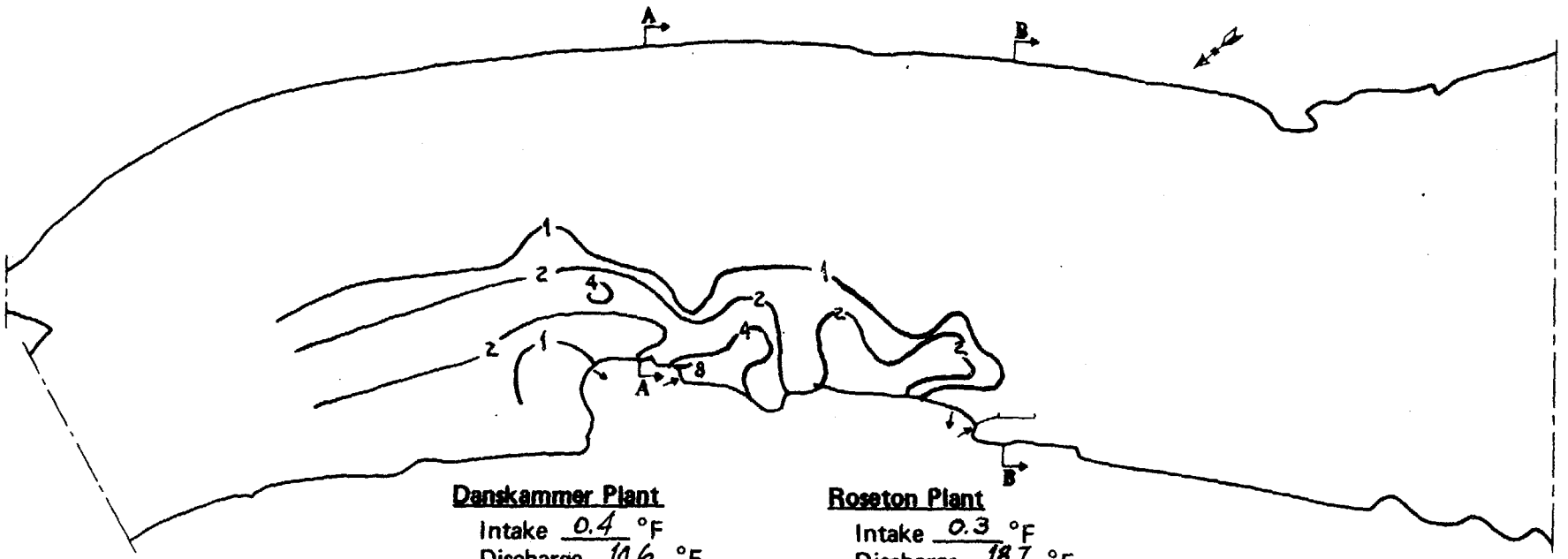
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 50







Danskammer Plant

Intake 0.4 °F
Discharge 10.6 °F
ΔT 10.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 18.7 °F
ΔT 18.4 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 74.4 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

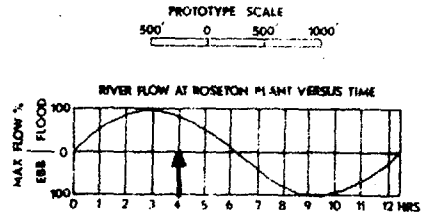
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

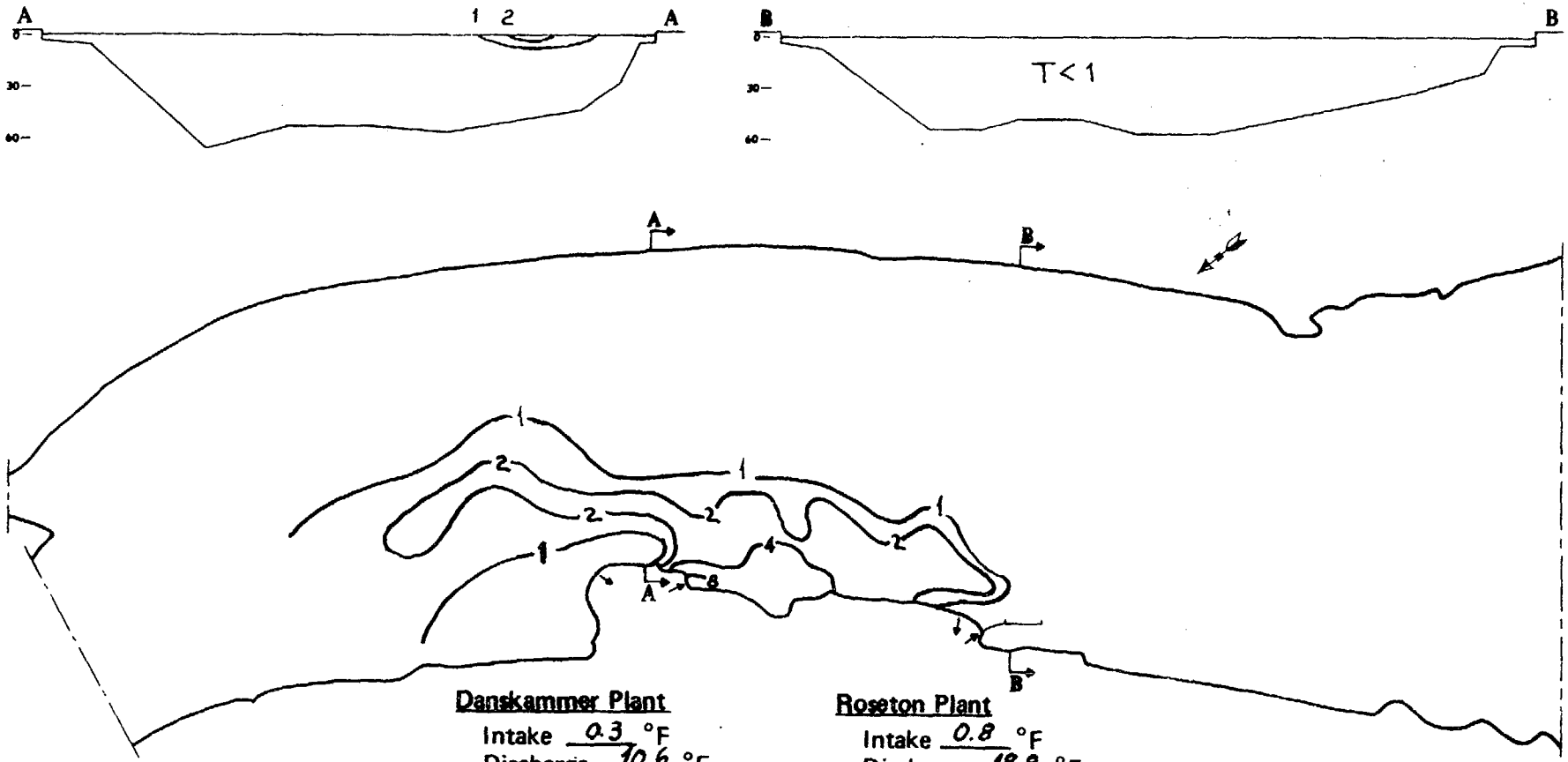


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 51



Danskammer Plant

Intake 0.3 °F
Discharge 10.6 °F
ΔT 10.3 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.8 °F
Discharge 18.8 °F
ΔT 18.0 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

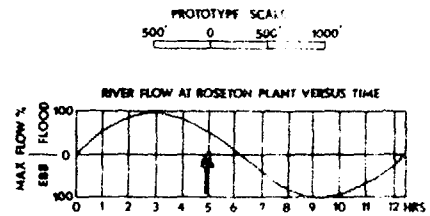
Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 74.4 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 JUNE 72

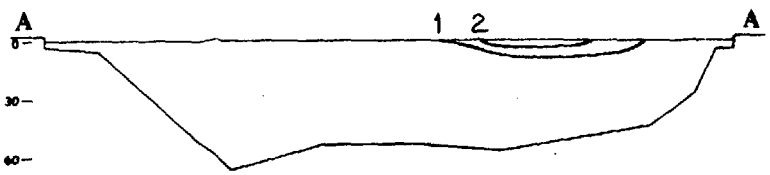


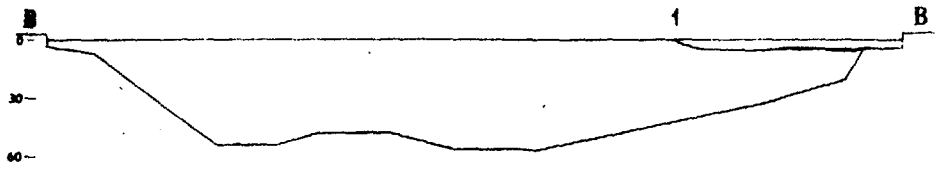
TEMPERATURE RISE ABOVE RIVER AMBIENT

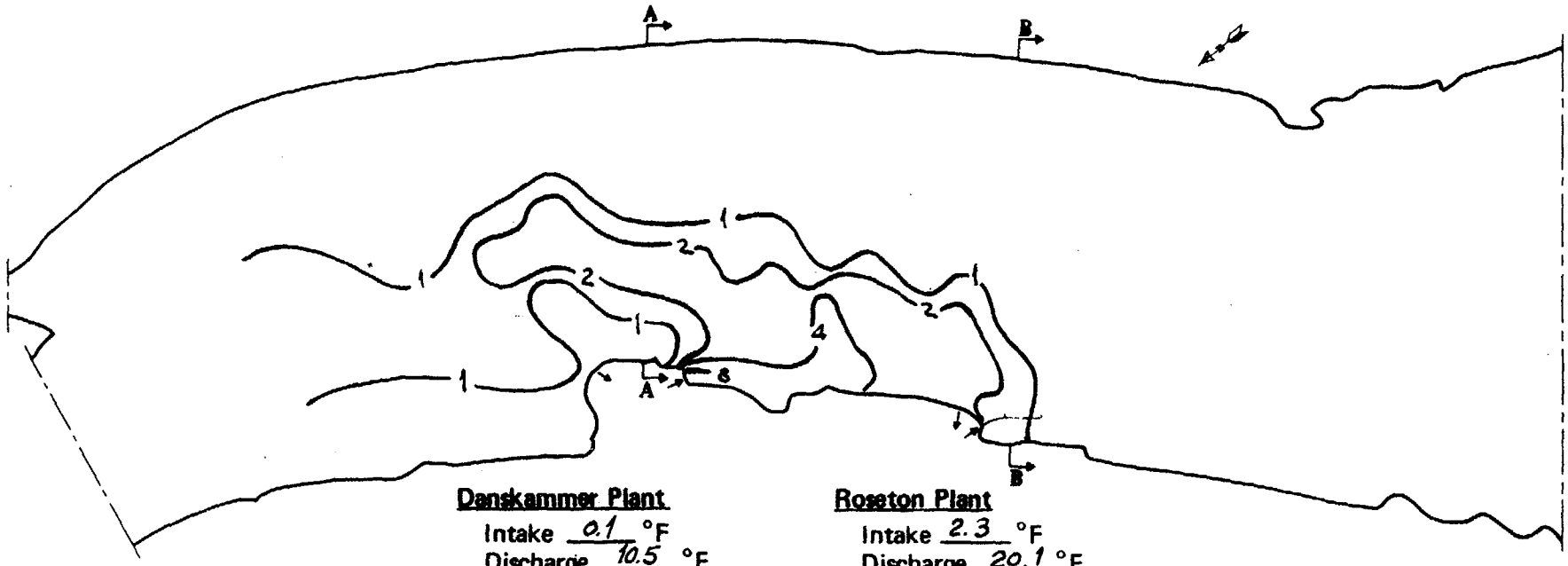
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 52







Danskammer Plant

Intake 0.1 °F
Discharge 10.5 °F
ΔT 10.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 2.3 °F
Discharge 20.1 °F
ΔT 17.8 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 74.2 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

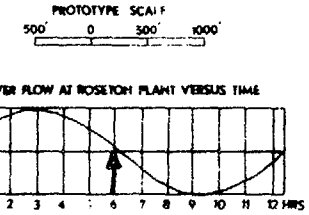
Fresh Water Flow 6000 cfs
Ambient Temperature 75.7°F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 53

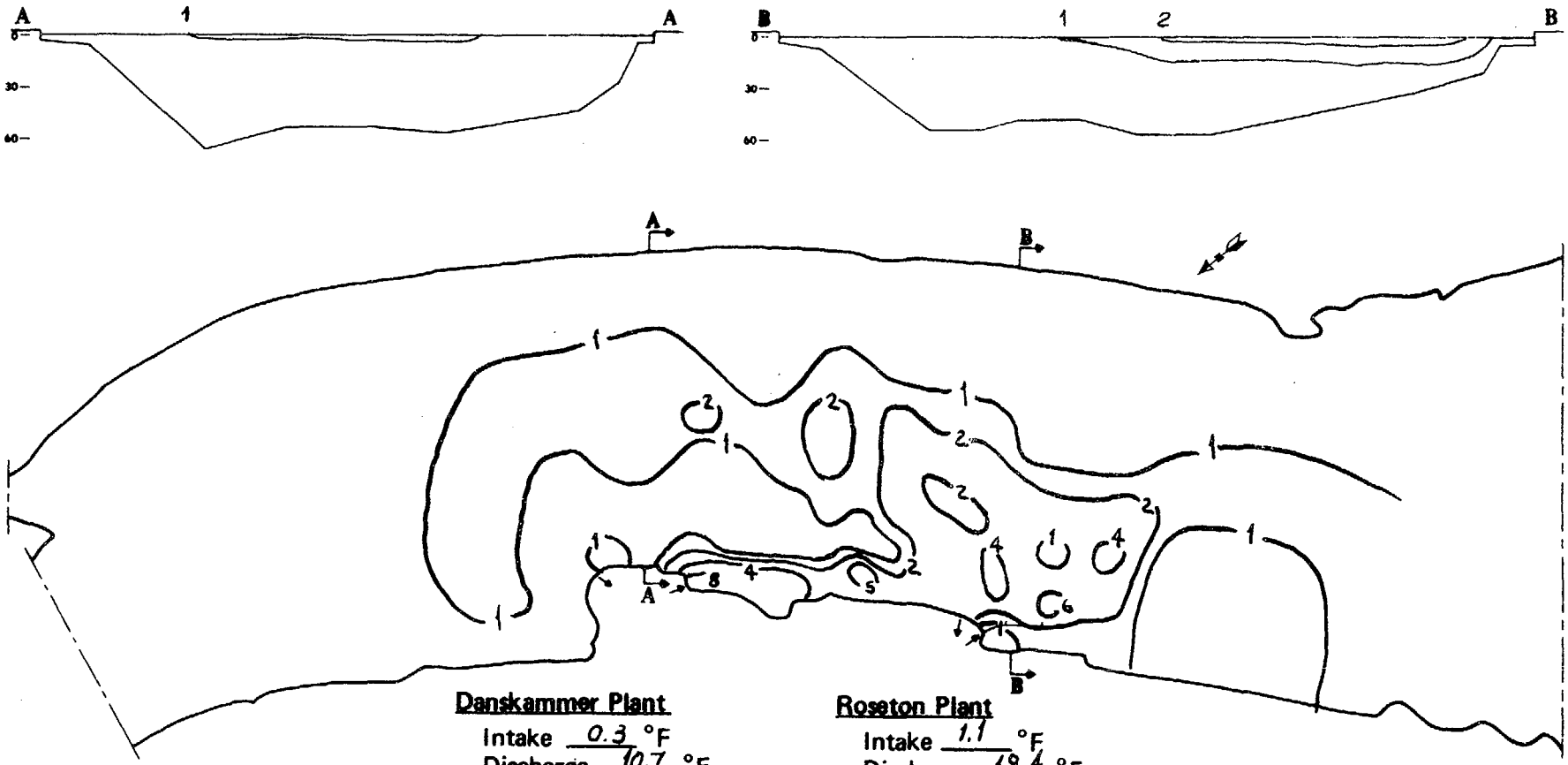


FIGURE A 54

Danskammer Plant

Intake 0.3 °F
Discharge 10.7 °F
ΔT 10.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.1 °F
Discharge 19.4 °F
ΔT 18.3 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 74.4 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

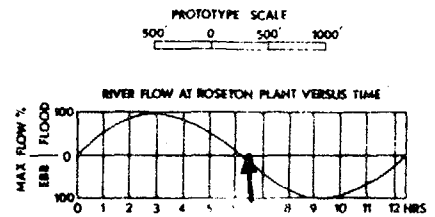
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

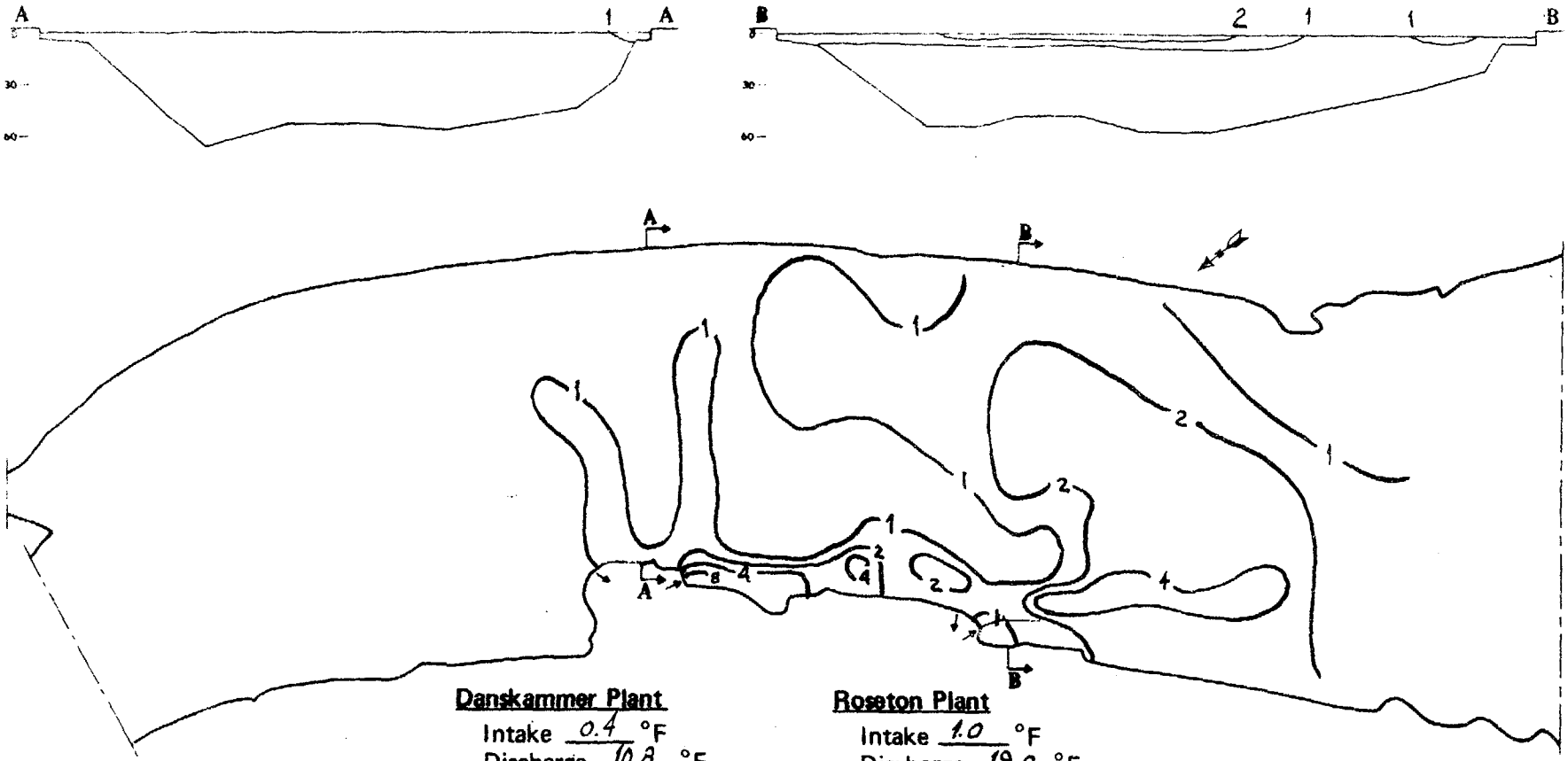
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.4 °F
Discharge 10.8 °F
ΔT 10.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.0 °F
Discharge 19.0 °F
ΔT 18.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

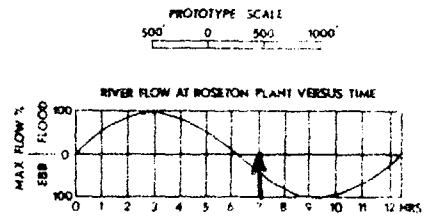
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6° F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

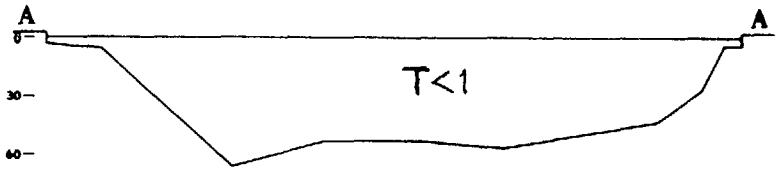


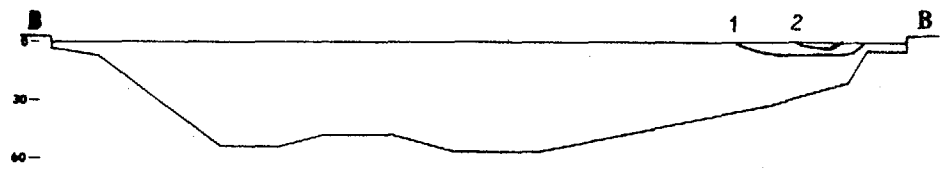
TEMPERATURE RISE ABOVE RIVER AMBIENT

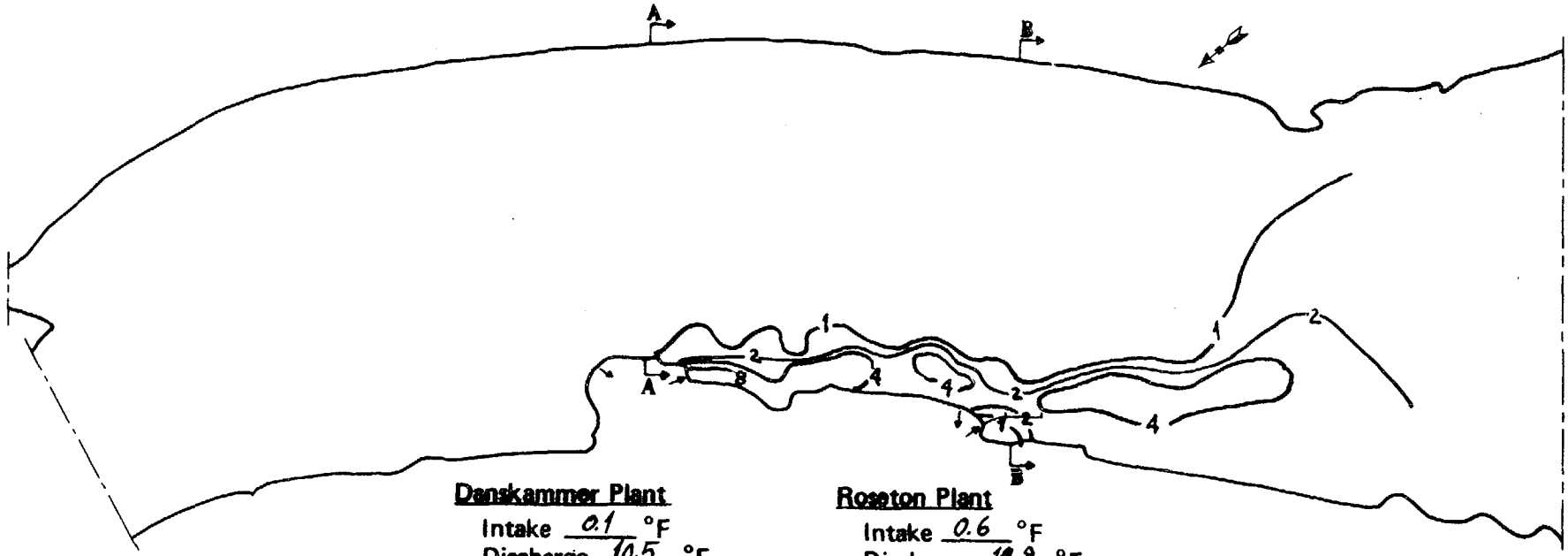
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 55







Danskammer Plant

Intake 0.1 °F
Discharge 10.5 °F
ΔT 10.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 18.9 °F
ΔT 18.3 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

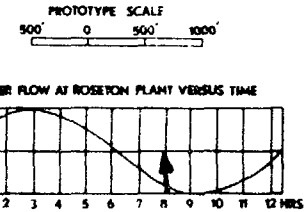
Room Atmosphere

Relative Humidity 98 %
Dry Bulb Temperature 74.8 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 JUNE 72

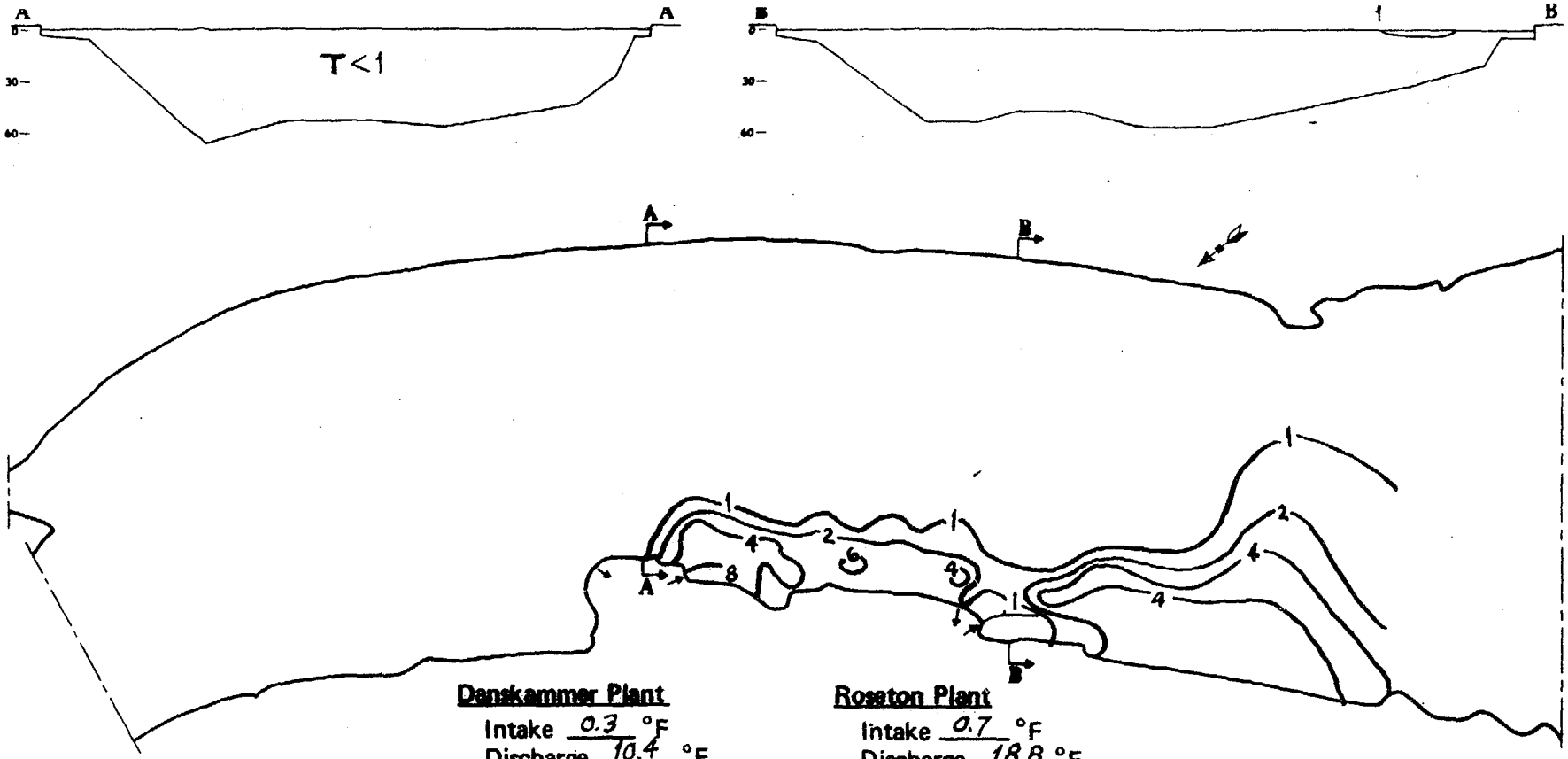


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 56



Danskammer Plant

Intake 0.3 °F
Discharge 10.4 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.7 °F
Discharge 18.8 °F
ΔT 18.1 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 74.9 °F
Thermal Equilibrium Box Temperature 0.0 °F

River

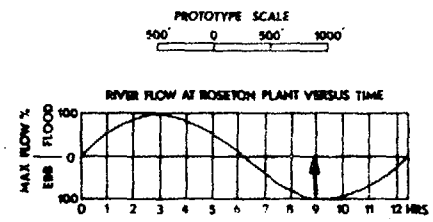
Fresh Water Flow 6000 cfs
Ambient Temperature 75.7 °F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 57

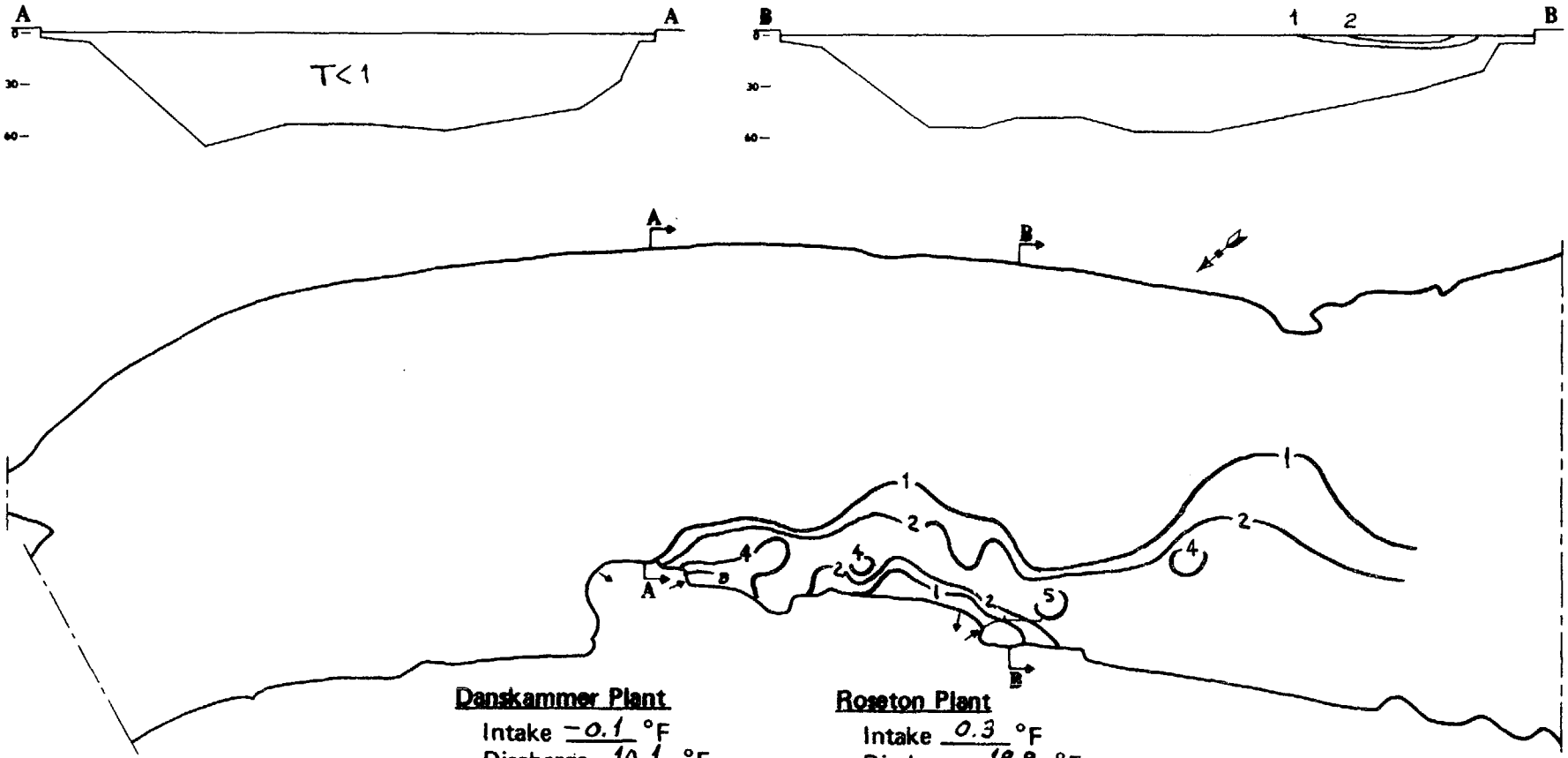


FIGURE A 58

Danskammer Plant

Intake -0.1 °F
Discharge 10.1 °F
ΔT 10.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 18.8 °F
ΔT 18.5 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 74.8 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

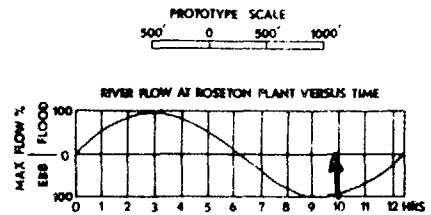
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

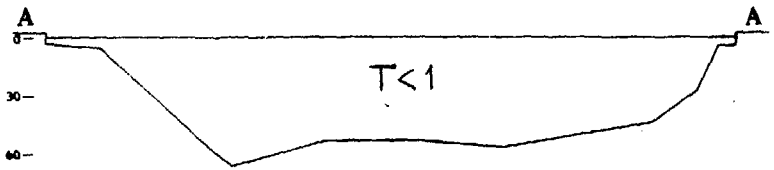
A. With Barge
B. Without Barge

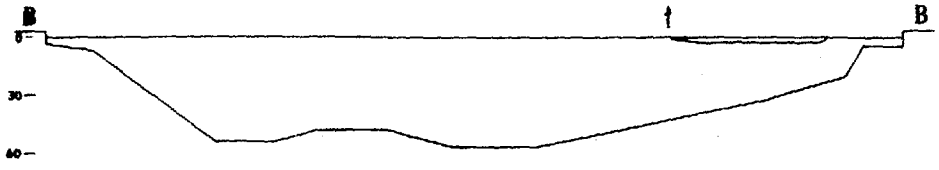


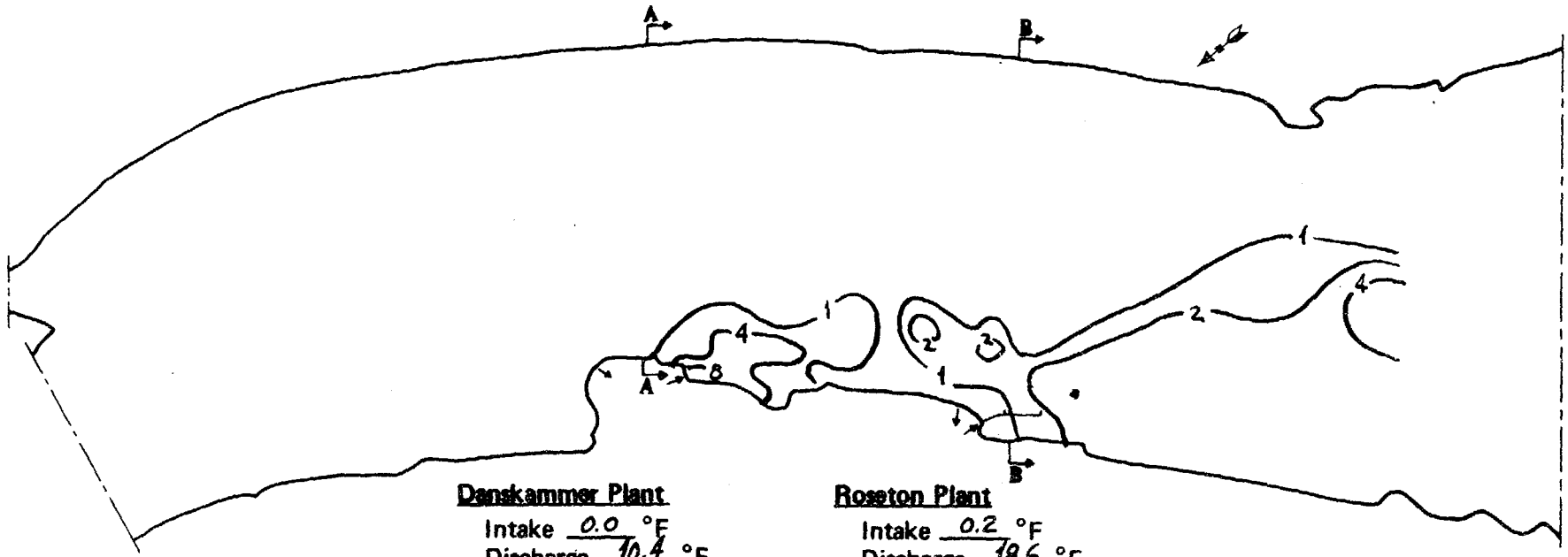
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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Danskammer Plant

Intake 0.0 °F
Discharge 10.4 °F
ΔT 10.4 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.2 °F
Discharge 18.6 °F
ΔT 18.4 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 74.2 °F
Thermal Equilibrium Box Temperature −0.2 °F

River

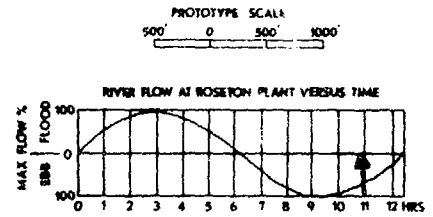
Fresh Water Flow 6000 cfs
Ambient Temperature 75.6 °F

Date 13 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

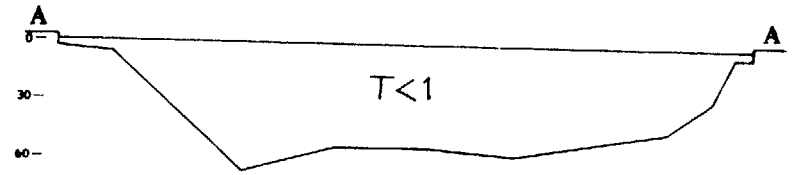


TEMPERATURE RISE ABOVE RIVER AMBIENT

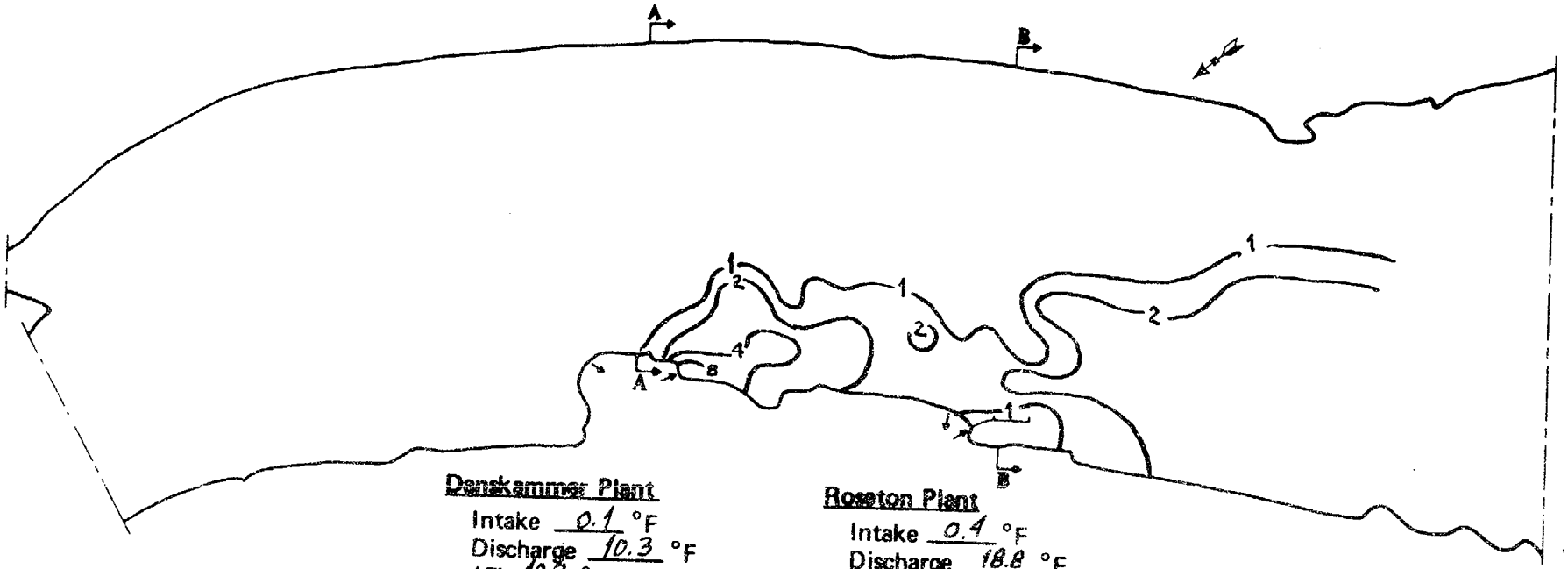
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 59







Danskammer Plant

Intake 0.1 °F
Discharge 10.3 °F
ΔT 10.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.4 °F
Discharge 18.8 °F
ΔT 18.4 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

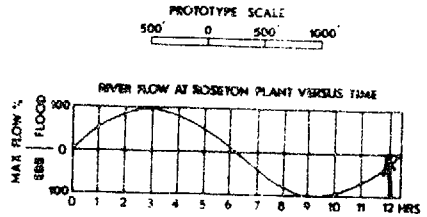
Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 75.0 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 75.7 °F

Date 13 June 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 60

DANSKAMMER

LOAD	60%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	9.5 F

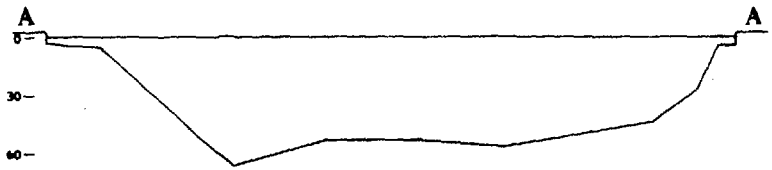
ROSETON

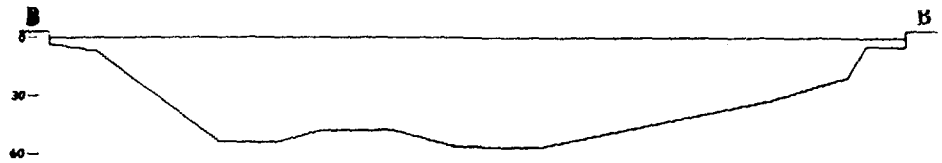
LOAD	85%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	14.5 F
OIL BARGE	NOT INCLUDED

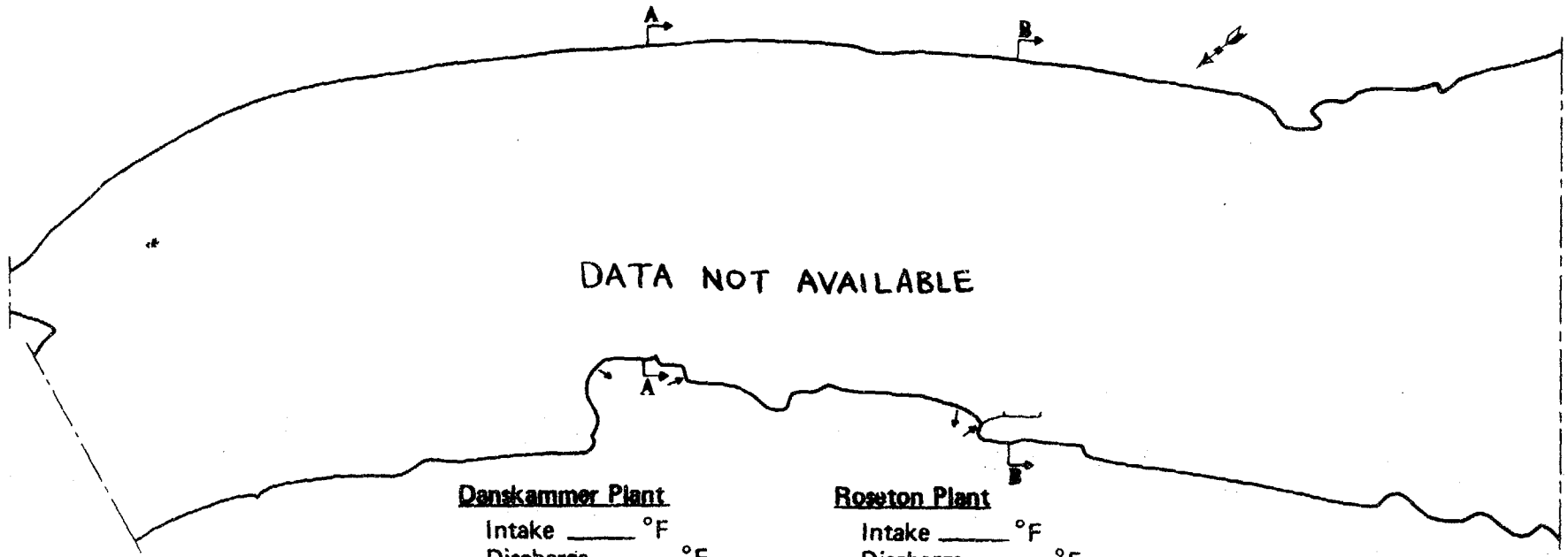
RIVER CONDITIONS

AMBIENT TEMPERATURE	80.6 F
FRESH WATER FLOW	6000 CFS

TEST DATE 15 JUNE 1972







Danskammer Plant

Intake ____ °F
Discharge ____ °F
ΔT ____ °F
Flow ____ cfs
* Outfall Configuration ____

Roseton Plant

Intake ____ °F
Discharge ____ °F
ΔT ____ °F
Flow ____ cfs
** Outfall Configuration ____

Room Atmosphere

Relative Humidity ____ %
Dry Bulb Temperature ____ °F
Thermal Equilibrium Box Temperature ____ °F

River

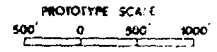
Fresh Water Flow ____ cfs
Ambient Temperature ____ °F

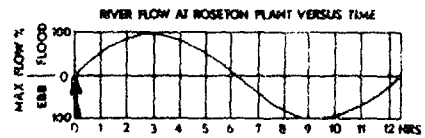
Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



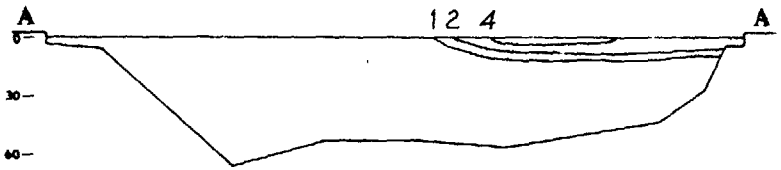


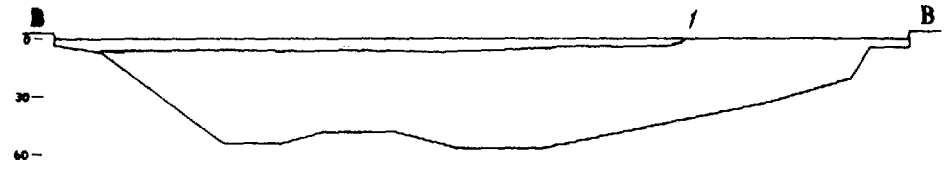
TEMPERATURE RISE ABOVE RIVER AMBIENT

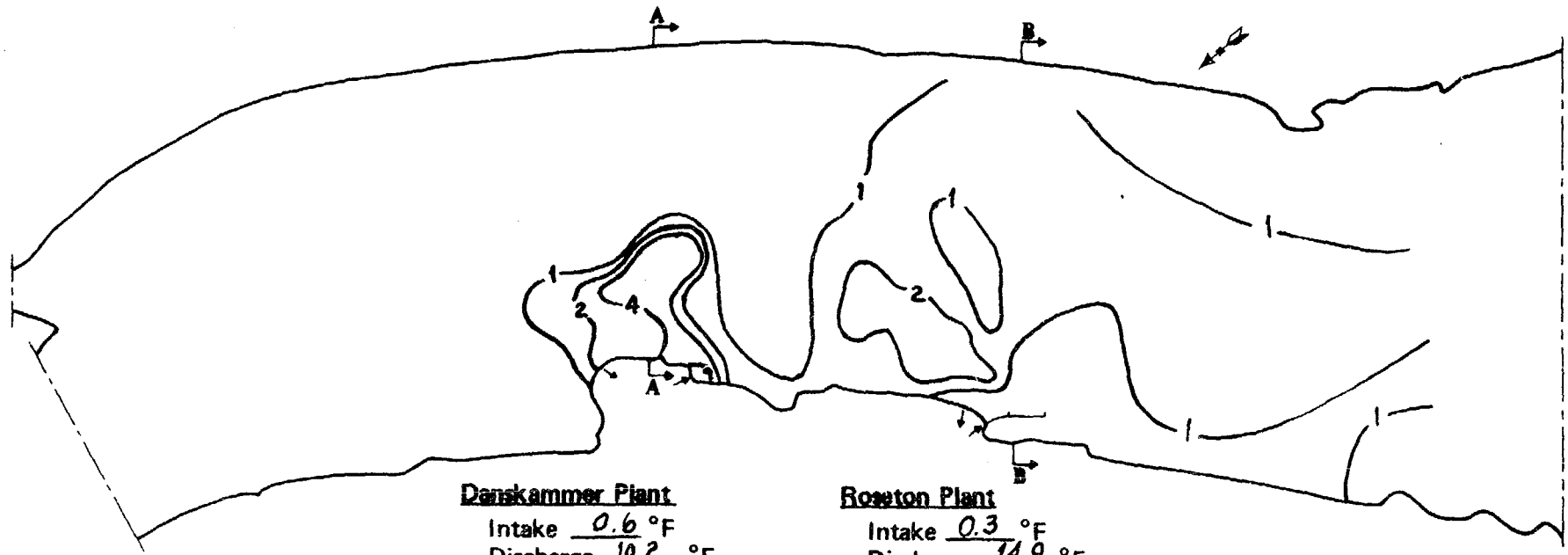
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 61







Danskammer Plant

Intake 0.6 °F
Discharge 10.2 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.9 °F
ΔT 14.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 19.5 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

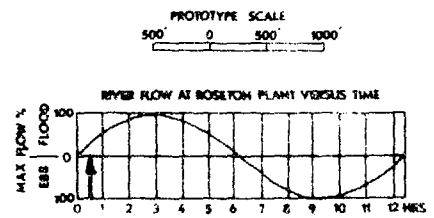
Fresh Water Flow 6000 cfs
Ambient Temperature 80.5 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

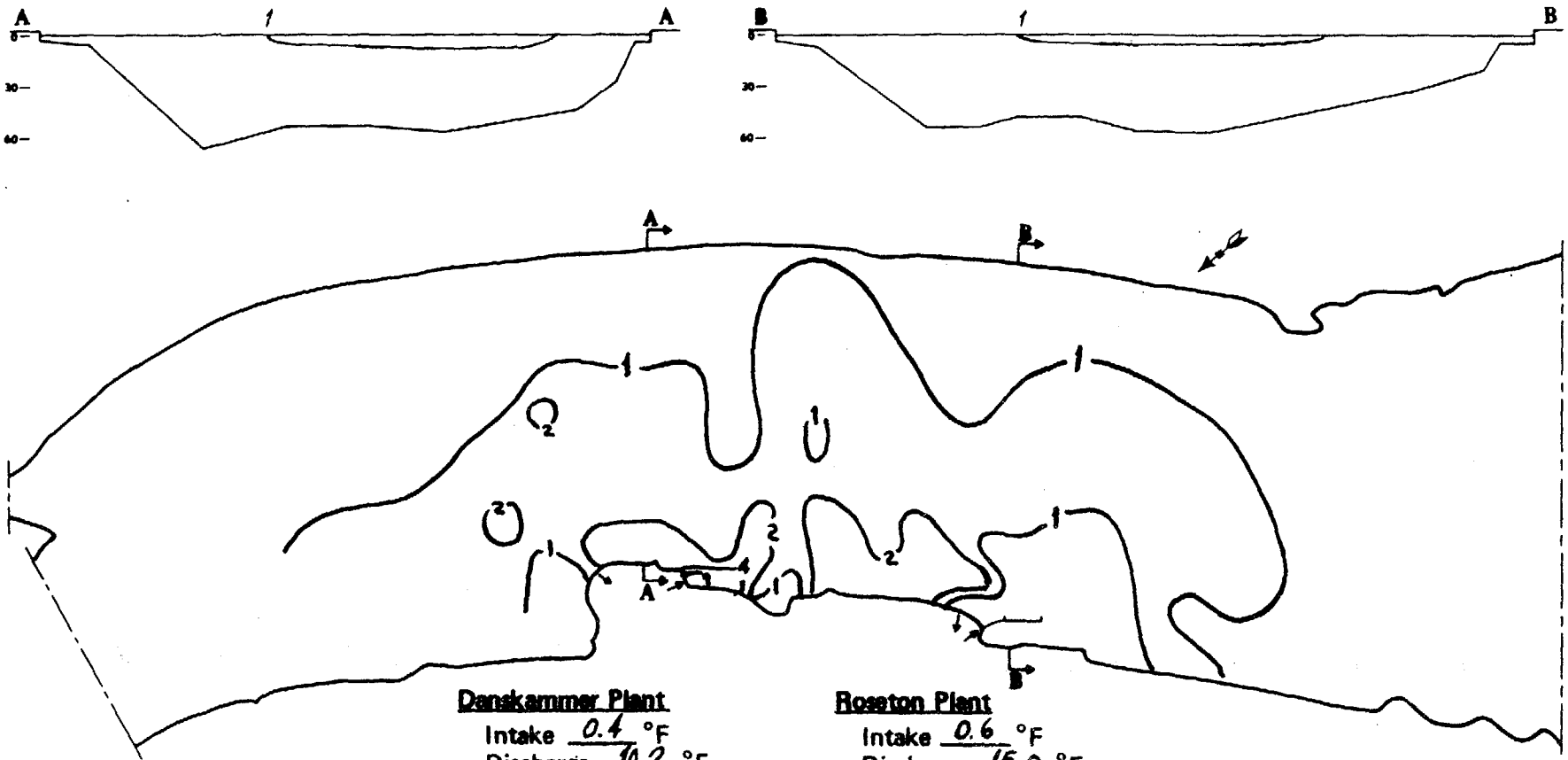


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 62



Danskammer Plant

Intake 0.4 °F
Discharge 10.2 °F
ΔT 9.8 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 15.0 °F
ΔT 14.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

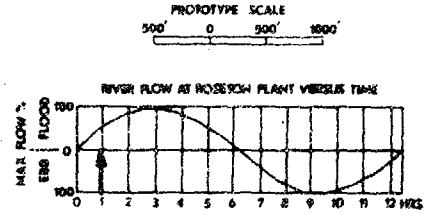
Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.7 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 80.5 °F

Date 15 JUNE 72

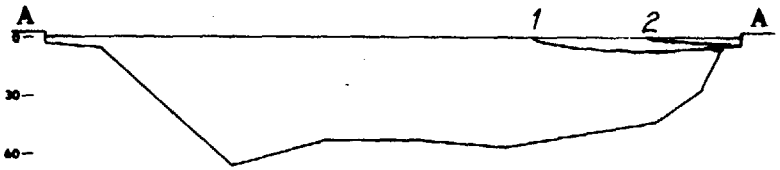


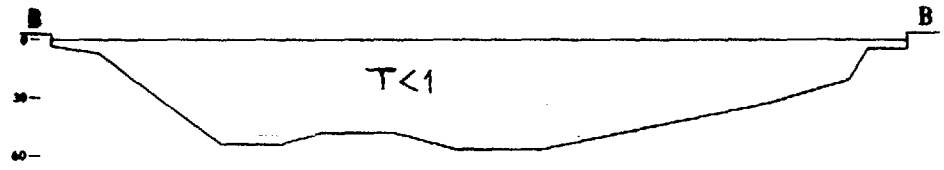
TEMPERATURE RISE ABOVE RIVER AMBIENT

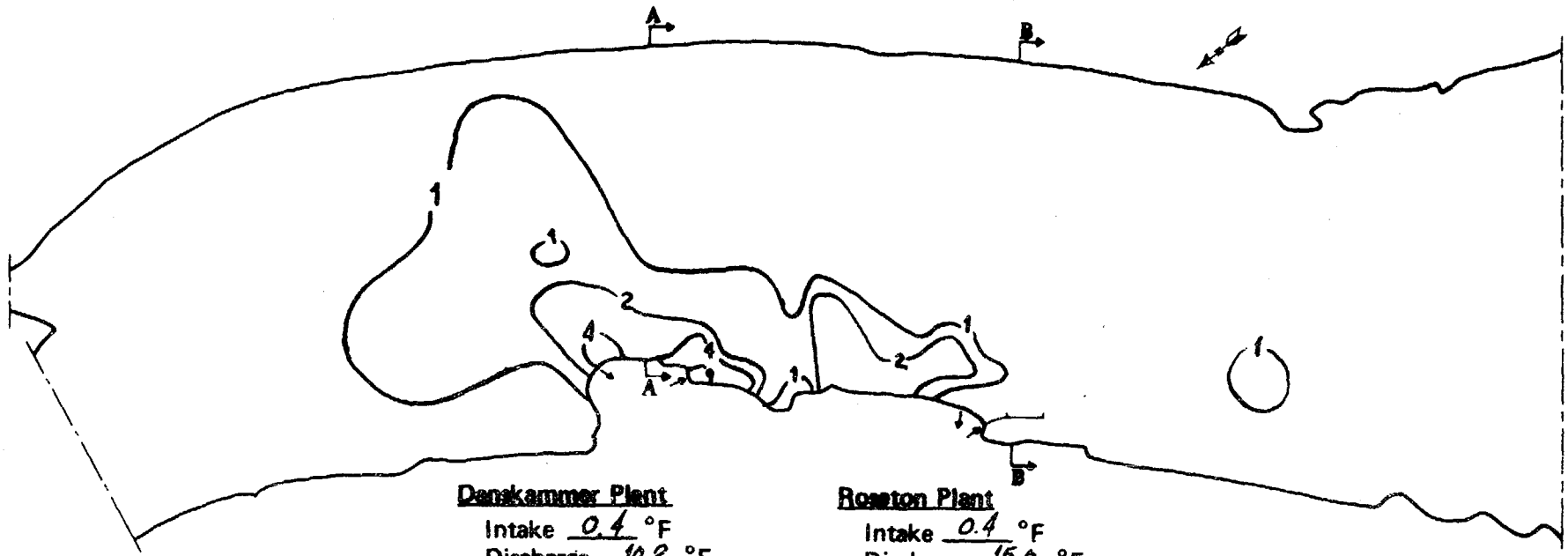
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 63







Danskammer Plant

Intake 0.4 °F
Discharge 10.2 °F
ΔT 9.8 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.4 °F
Discharge 15.0 °F
ΔT 14.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 79.3 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

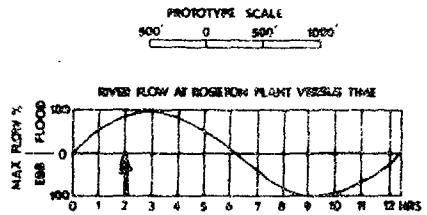
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

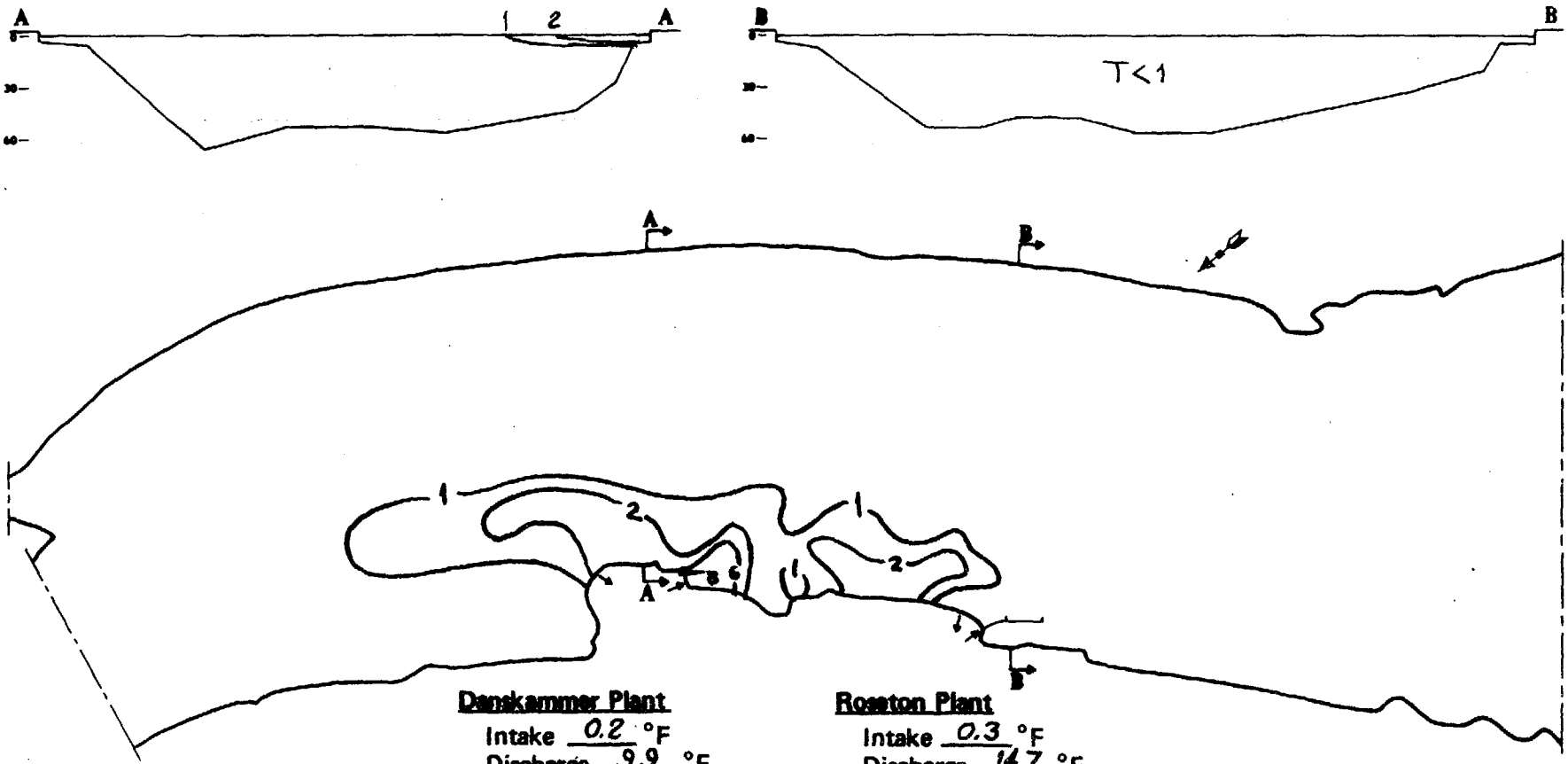


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 64



Danskammer Plant

Intake 0.2 °F
Discharge 9.9 °F
ΔT 9.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.7 °F
ΔT 14.4 °F
Flow 1400 cfs
**Outfall Configuration 18

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.2 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

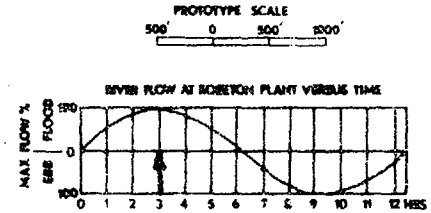
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

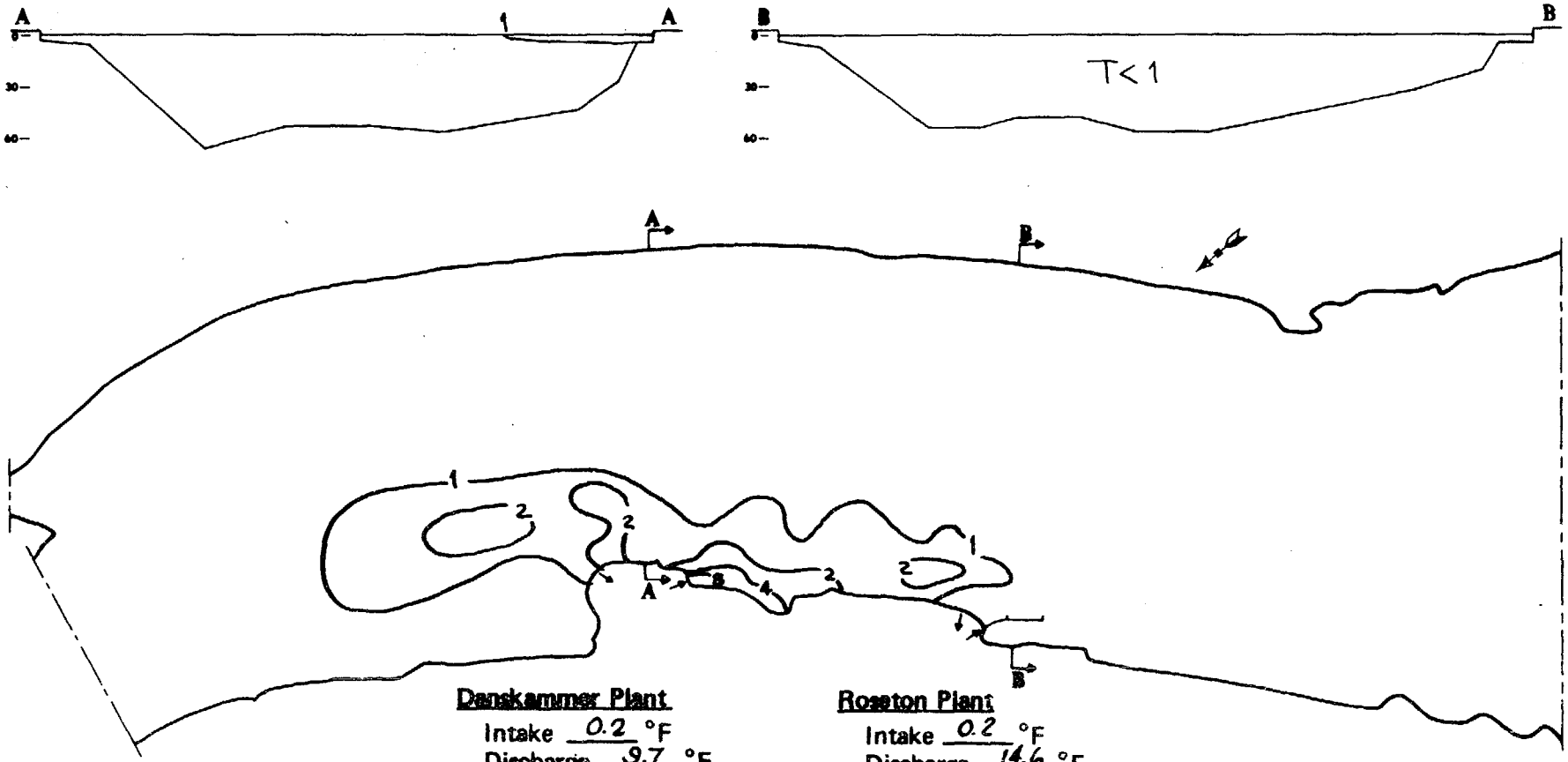


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer--Roseton Power Stations

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FIGURE A 65



Danskammer Plant

Intake 0.2 °F
Discharge 9.7 °F
ΔT 9.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.2 °F
Discharge 14.6 °F
ΔT 14.4 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.0 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

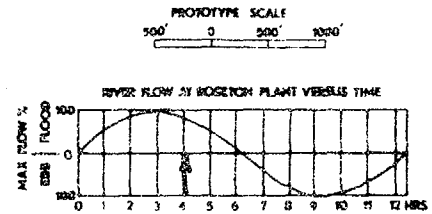
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser – 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

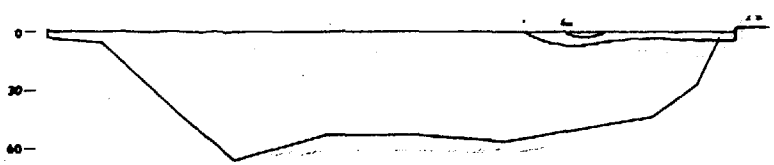


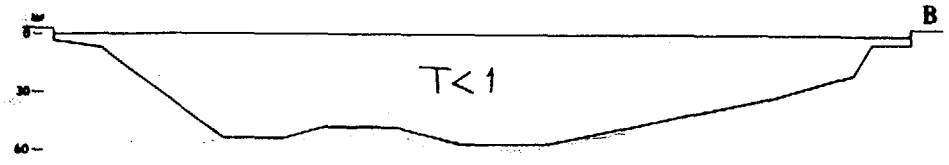
TEMPERATURE RISE ABOVE RIVER AMBIENT

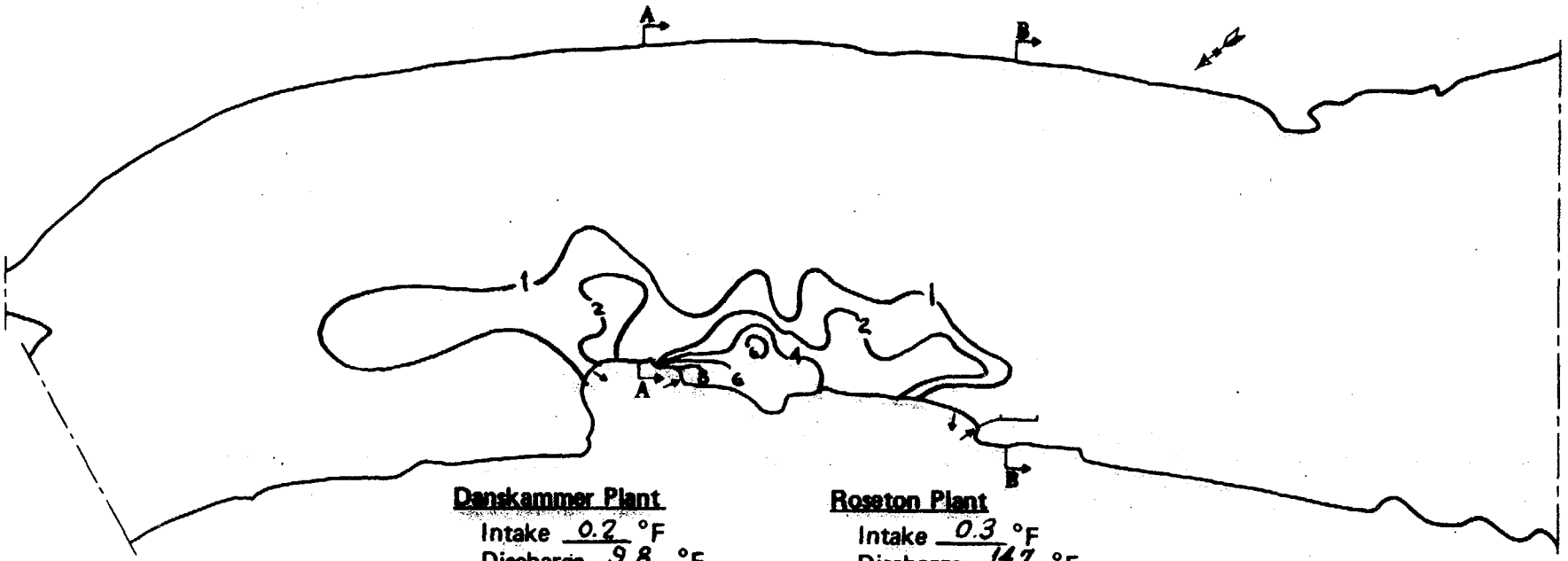
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 66







Danskammer Plant

Intake 0.2 °F
Discharge 9.8 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.7 °F
ΔT 14.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 79.0 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

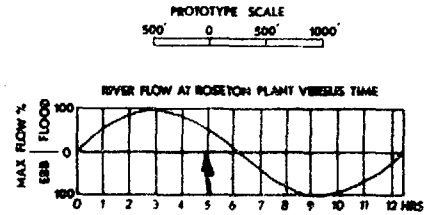
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6° F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 67

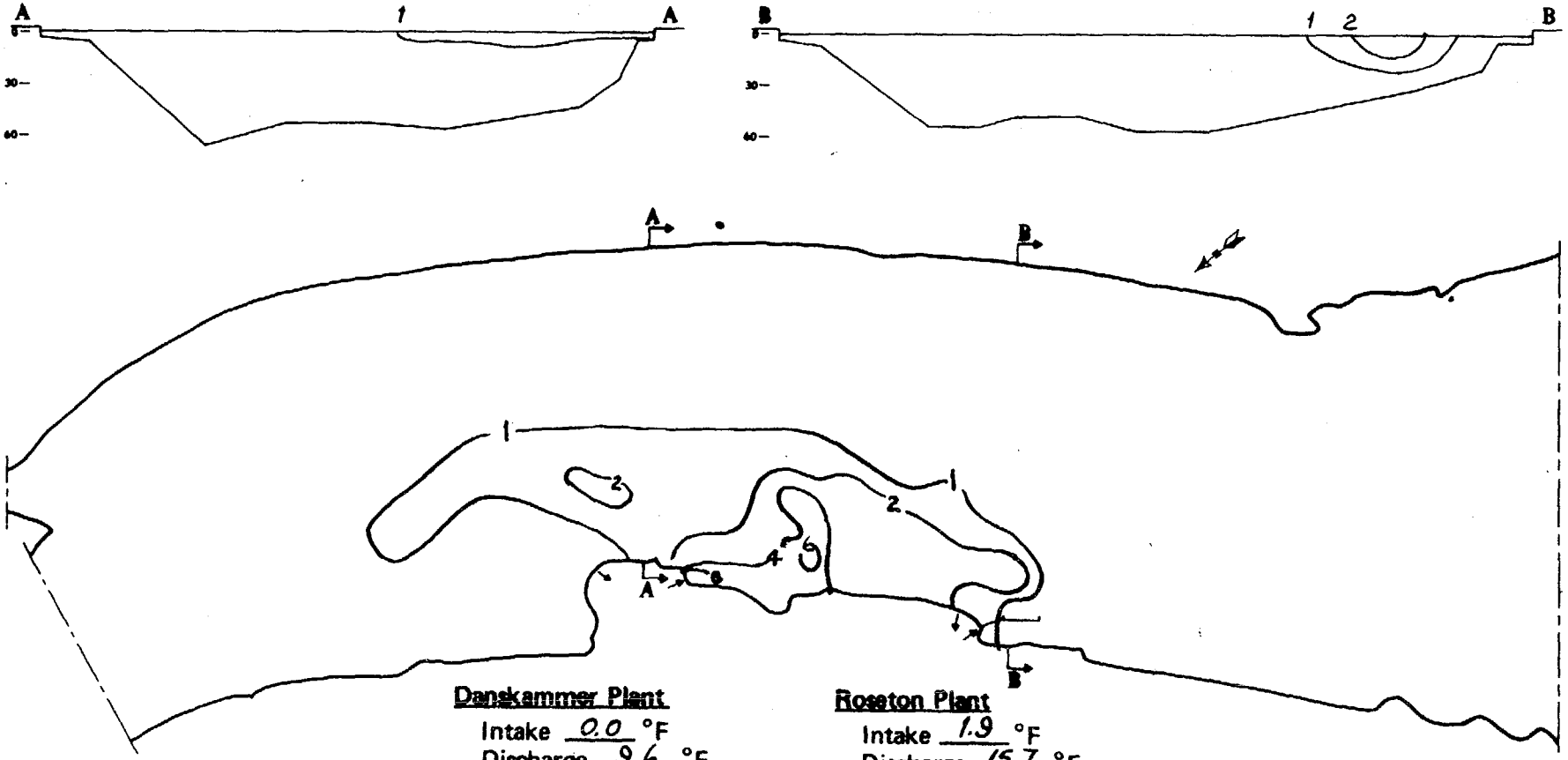


FIGURE A 68

Danskammer Plant

Intake 0.0 °F
Discharge 9.6 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.9 °F
Discharge 15.7 °F
ΔT 13.8 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 97 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

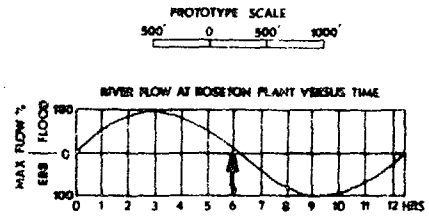
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

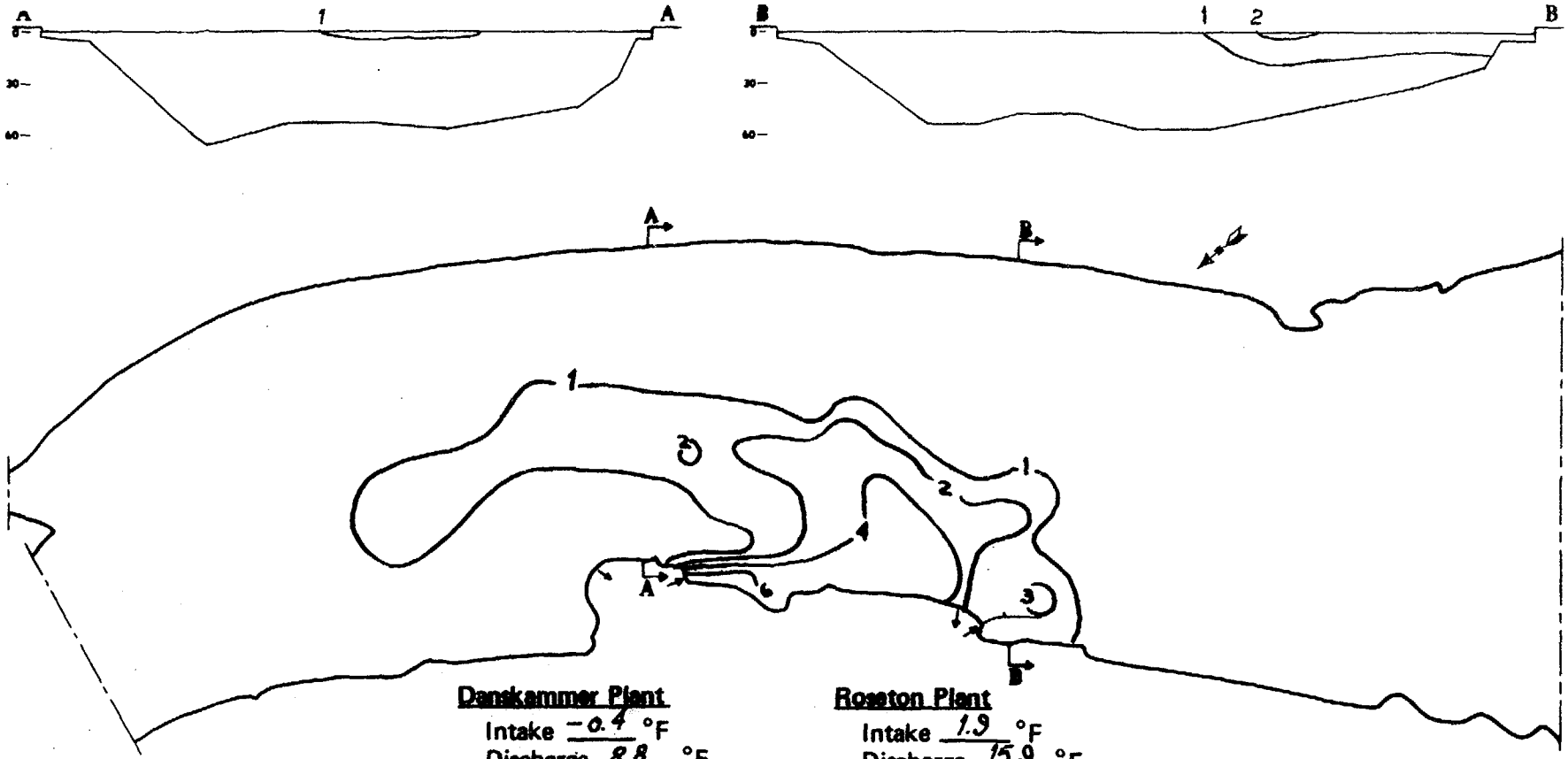
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer--Roseton Power Stations

ARL



Danskammer Plant

Intake −0.4 °F
Discharge 8.8 °F
ΔT 9.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 1.9 °F
Discharge 15.9 °F
ΔT 14.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

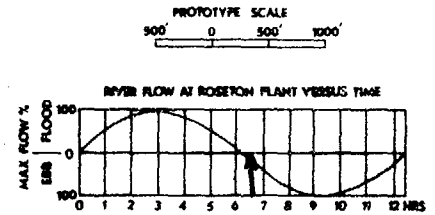
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

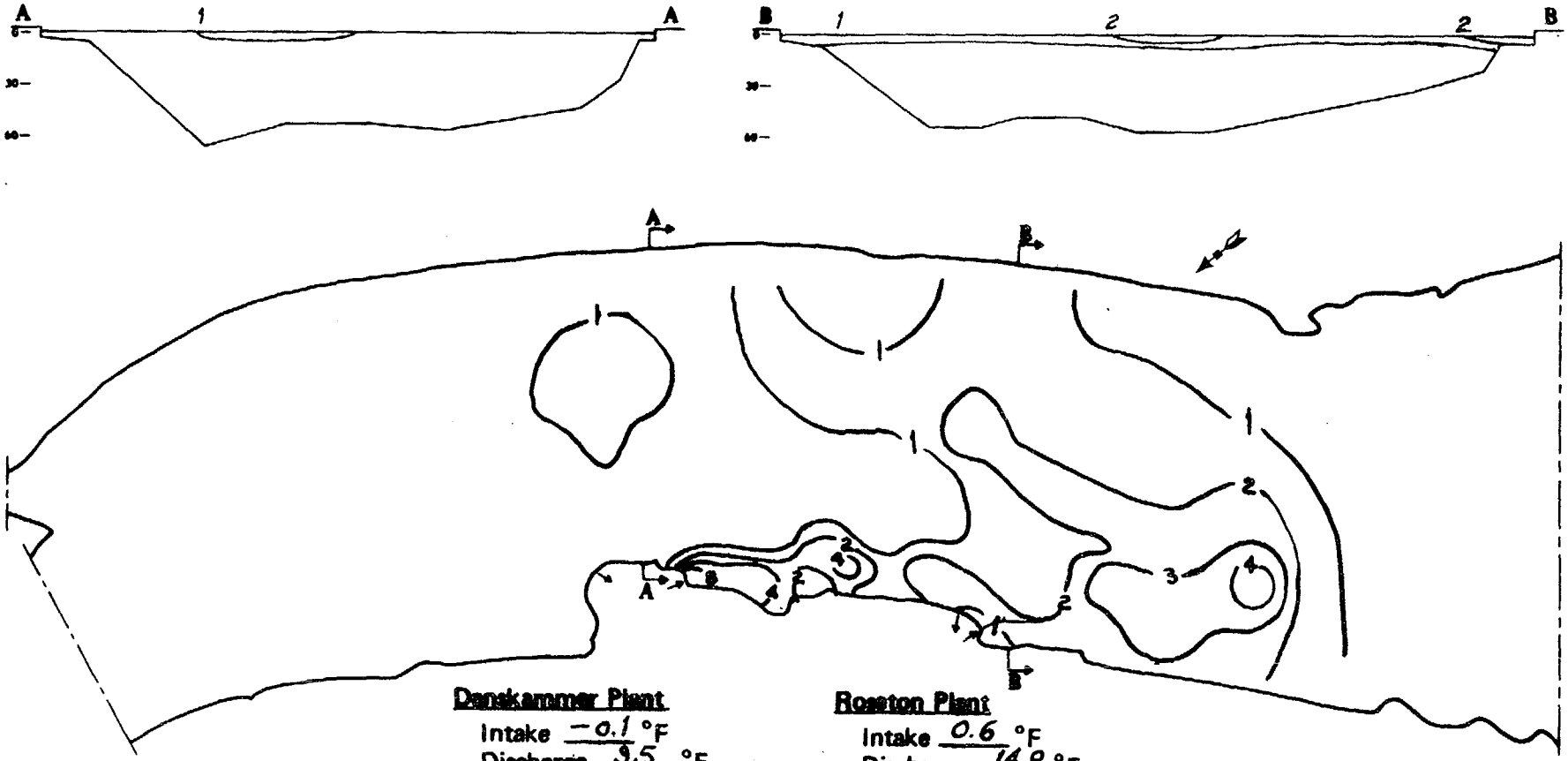


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 69



Danskammer Plant

Intake −0.1 °F
Discharge 9.5 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.6 °F
Discharge 14.8 °F
ΔT 14.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 79.1 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

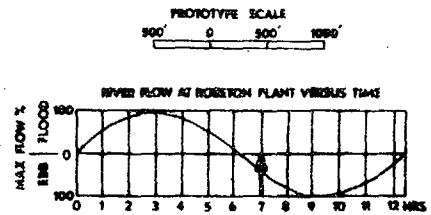
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

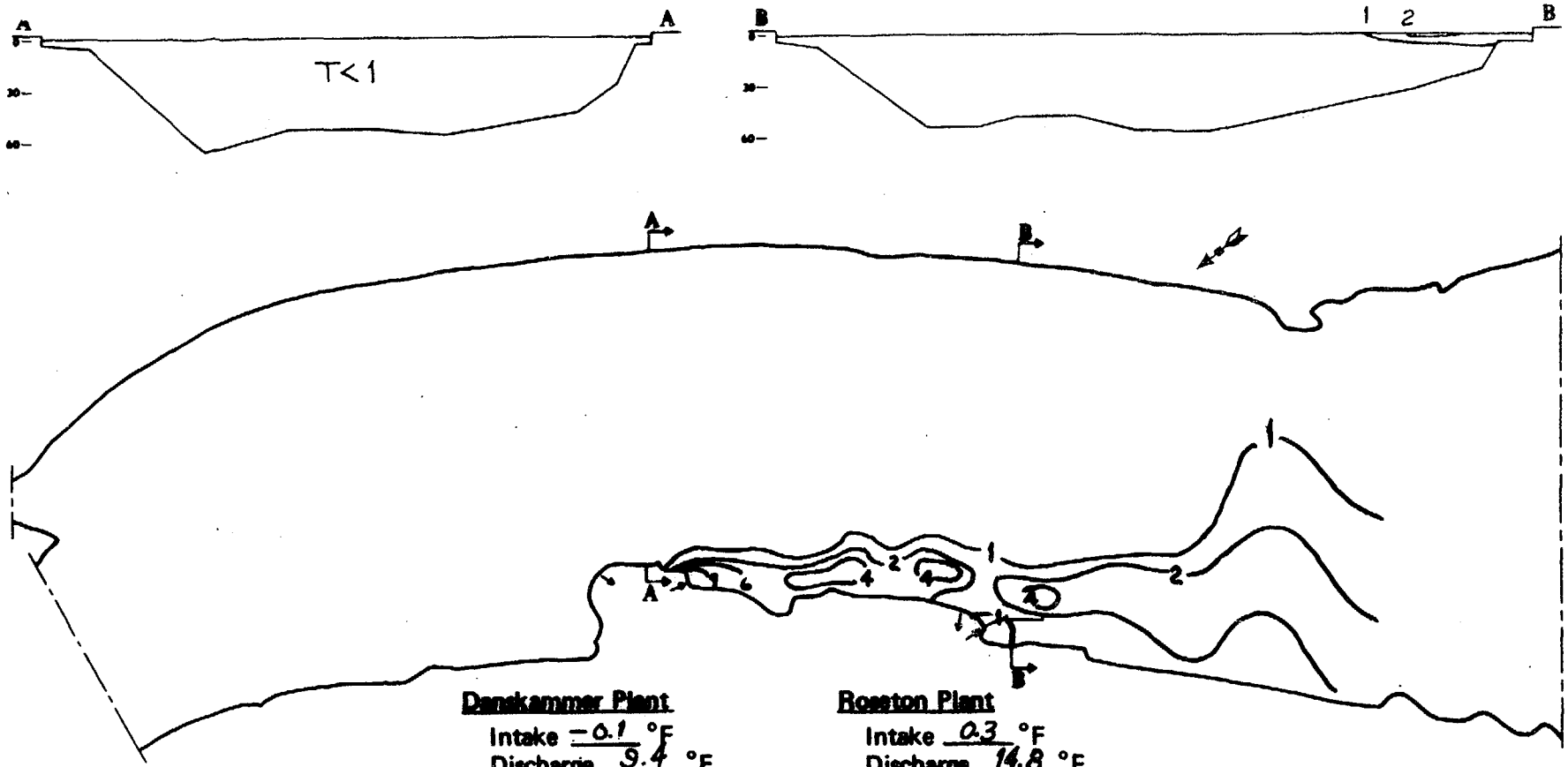


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 70



Danskammer Plant

Intake −0.1 °F
Discharge 9.4 °F
ΔT 9.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 14.8 °F
ΔT 14.5 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 79.7 °F
Thermal Equilibrium Box Temperature −0.5 °F

River

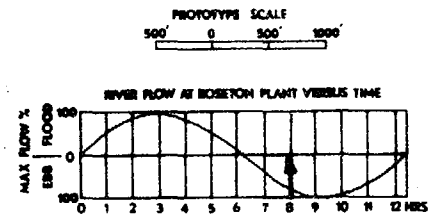
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6° F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



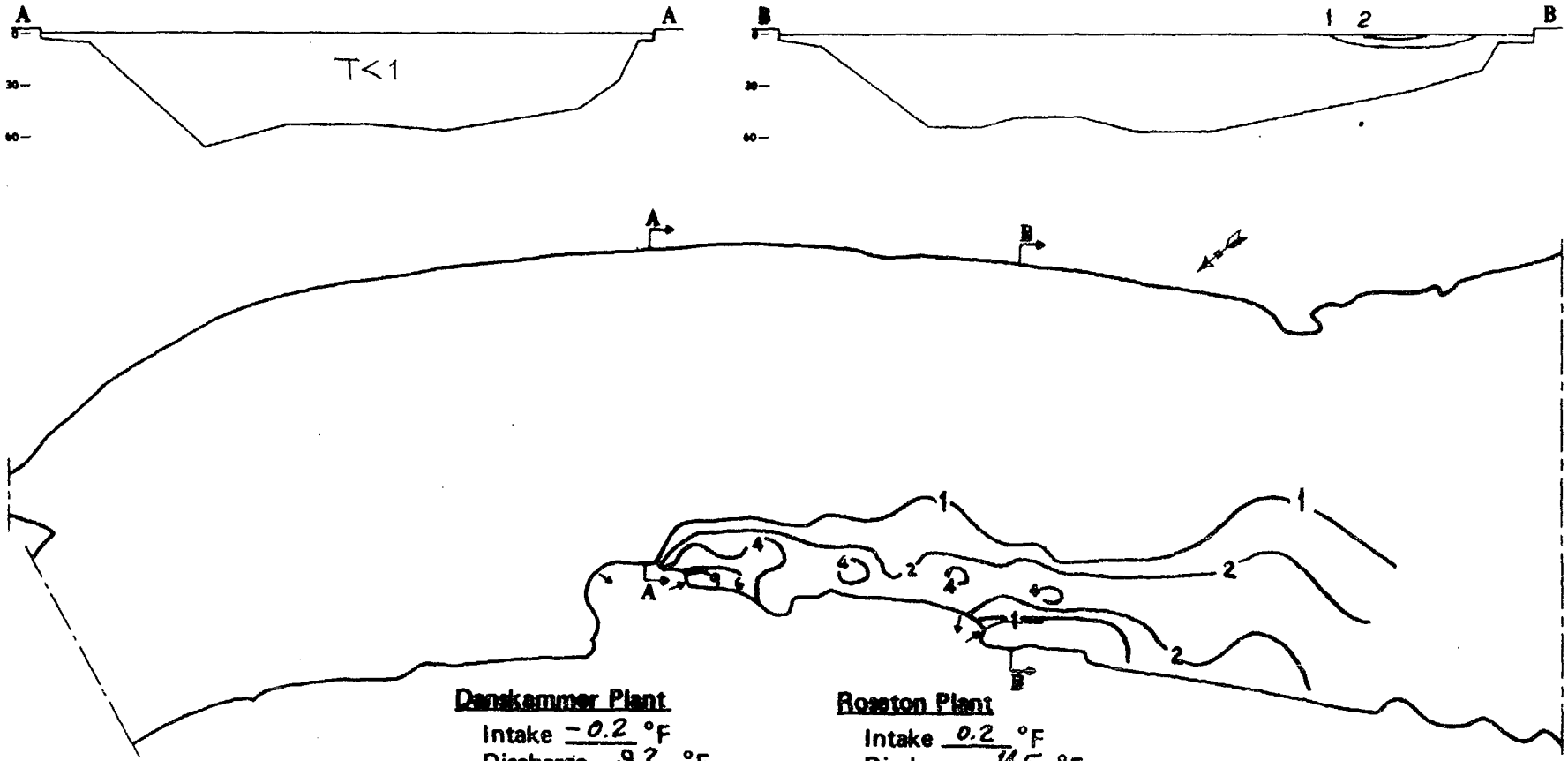
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 71

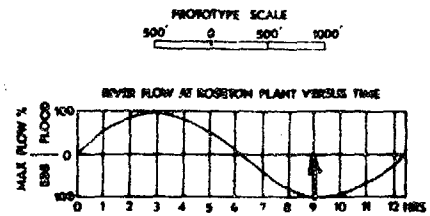
FIGURE A 72



*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

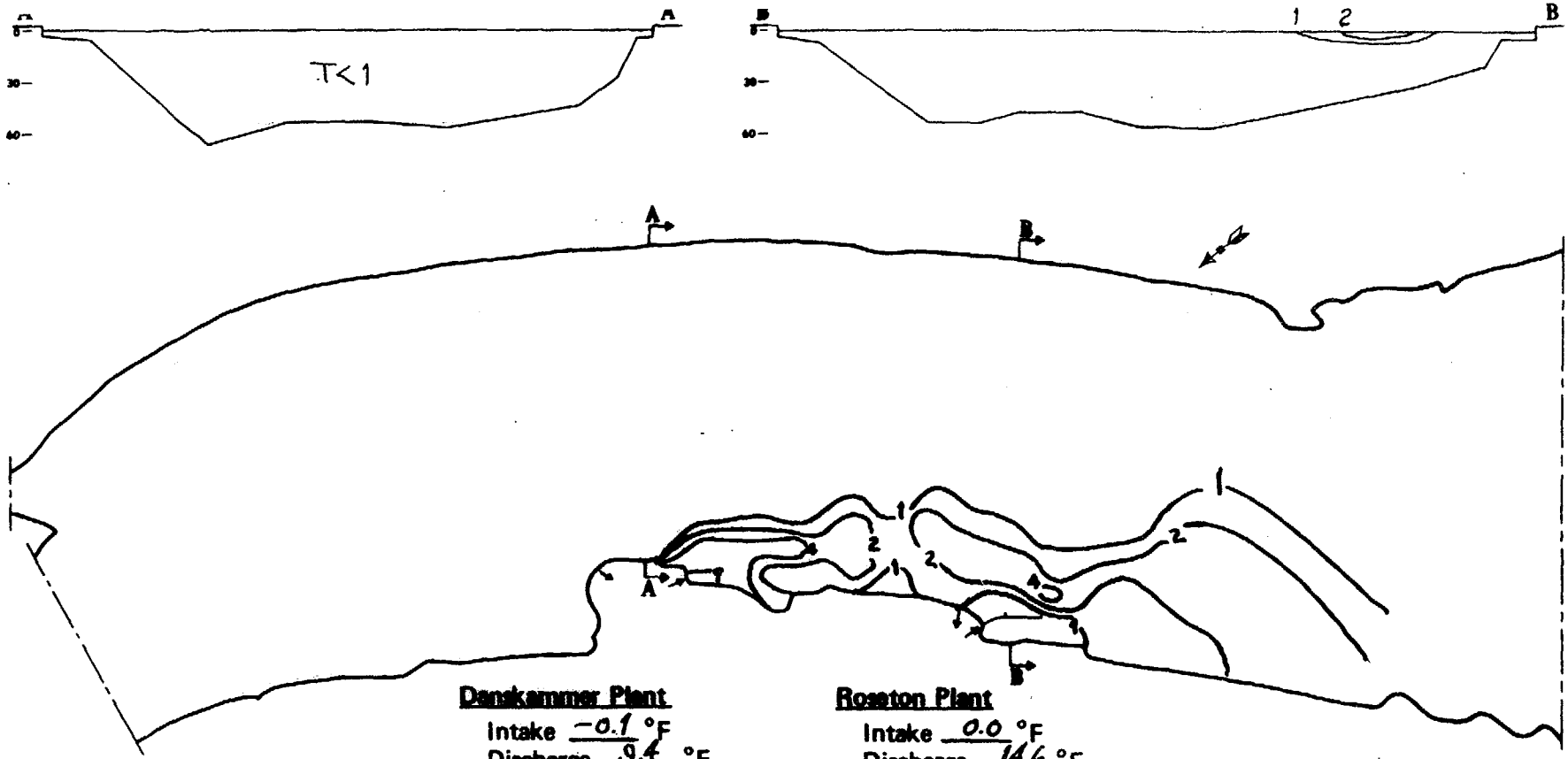


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies

Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake −0.1 °F
Discharge 9.4 °F
ΔT 9.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.0 °F
Discharge 14.6 °F
ΔT 14.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 80.5 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

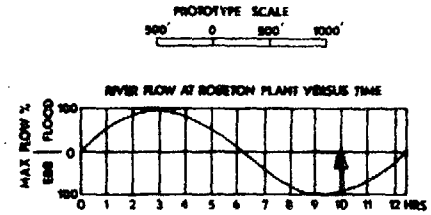
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 73

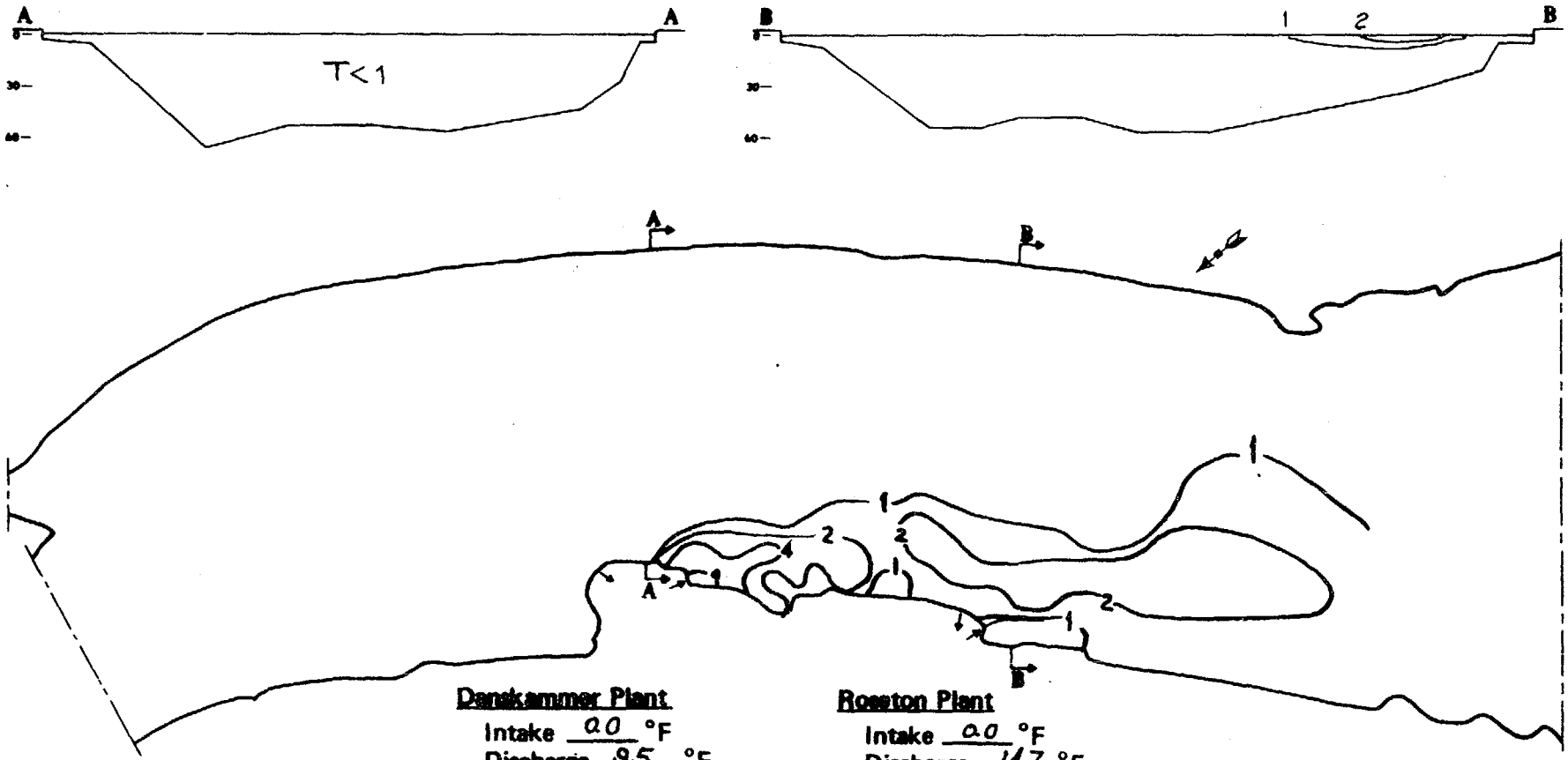


FIGURE A 74

Danskammer Plant

Intake 60 °F
Discharge 9.5 °F
ΔT 9.5 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 60 °F
Discharge 14.7 °F
ΔT 14.7 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 80.2 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

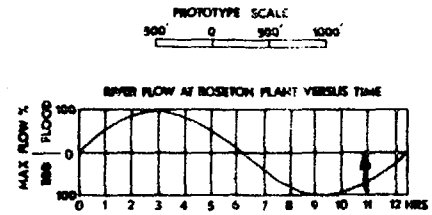
Fresh Water Flow 6000 cfs
Ambient Temperature 80.6 °F

Date 15 June 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

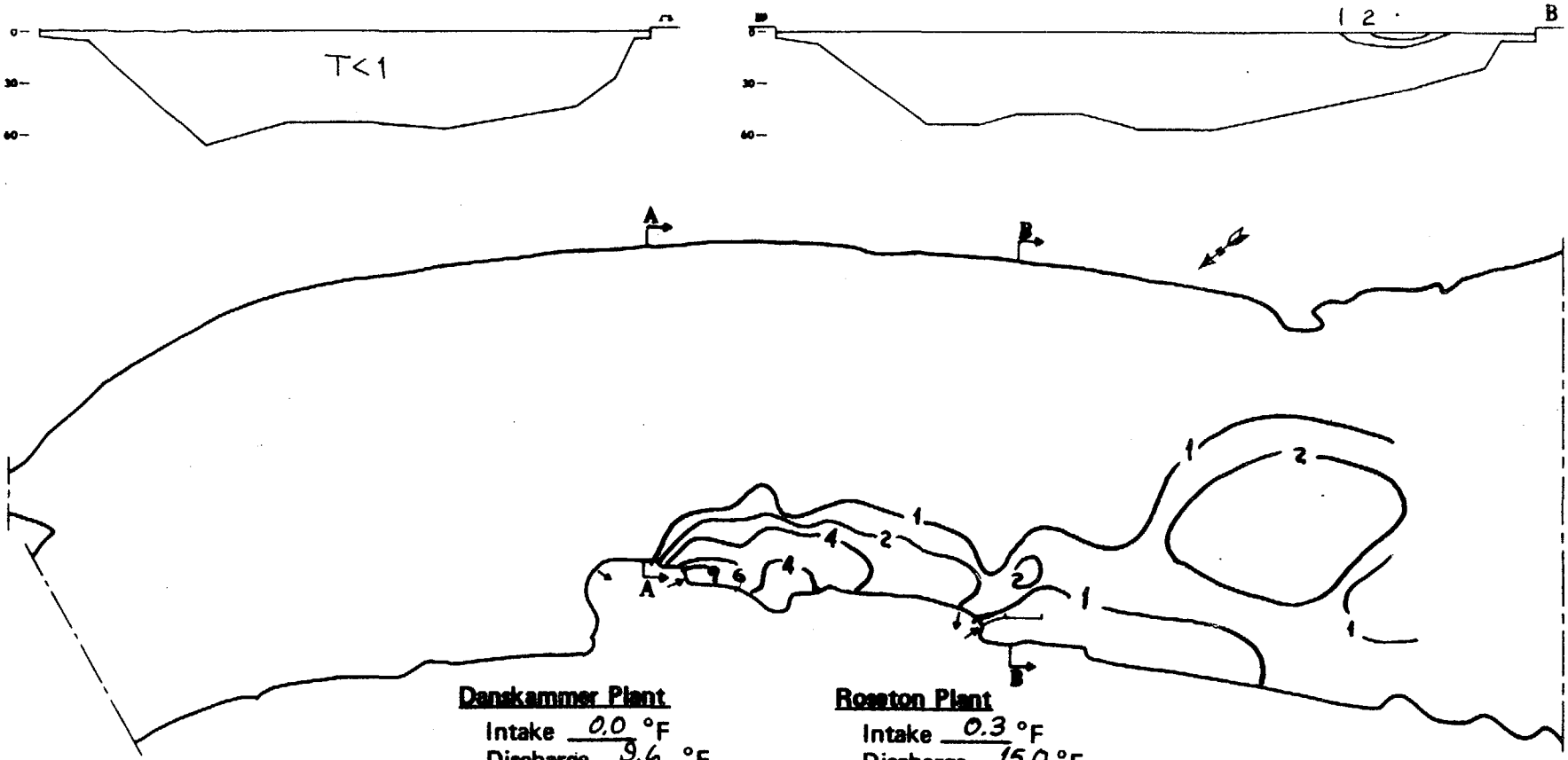
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.0 °F
Discharge 9.6 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake 0.3 °F
Discharge 15.0 °F
ΔT 14.7 °F
Flow 1400 cfs
** Outfall Configuration 18

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 80.1 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

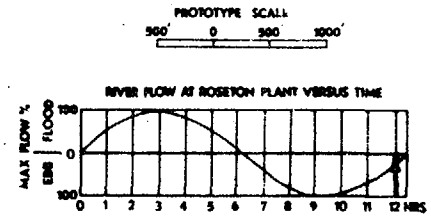
Fresh Water Flow 6000 cfs
Ambient Temperature 80.7 °F

Date 15 JUNE 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 75

DANSKAMMER

LOAD	60%
DISCHARGE DESIGN	PRESENT CONFIGURATION
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	9.9 F

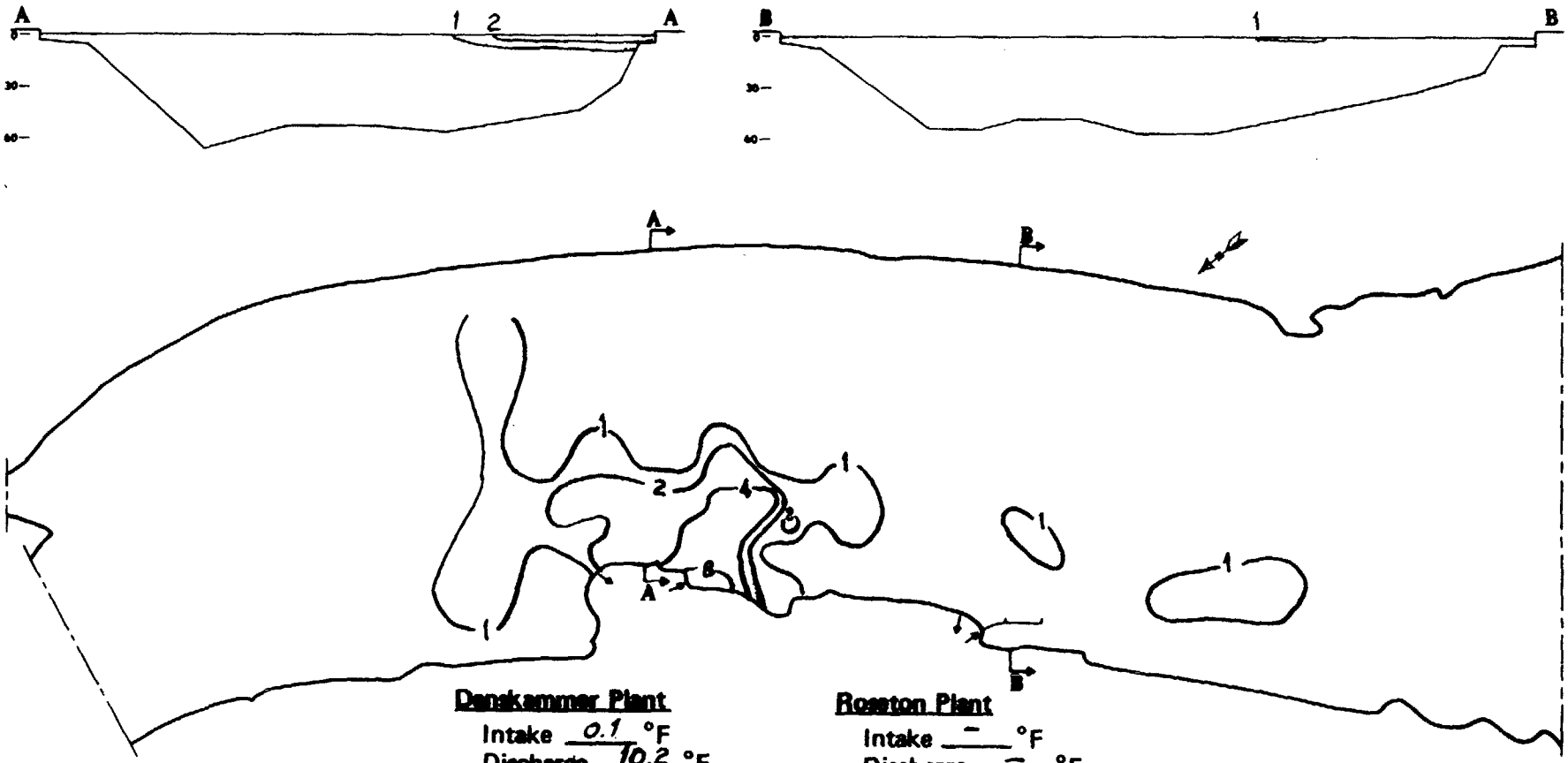
ROSETON NOT OPERATING

LOAD	
DISCHARGE DESIGN	
DISCHARGE FLOW	
TEMPERATURE RISE	
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	81.4 F
FRESH WATER FLOW	6000 CFS

TEST DATE 16 JUNE 1972



Danskammer Plant

Intake 0.1 °F
Discharge 10.2 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 82.0 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

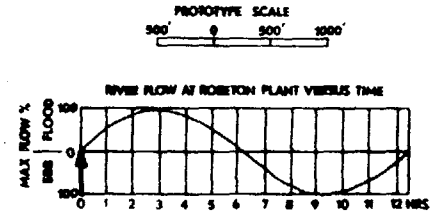
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

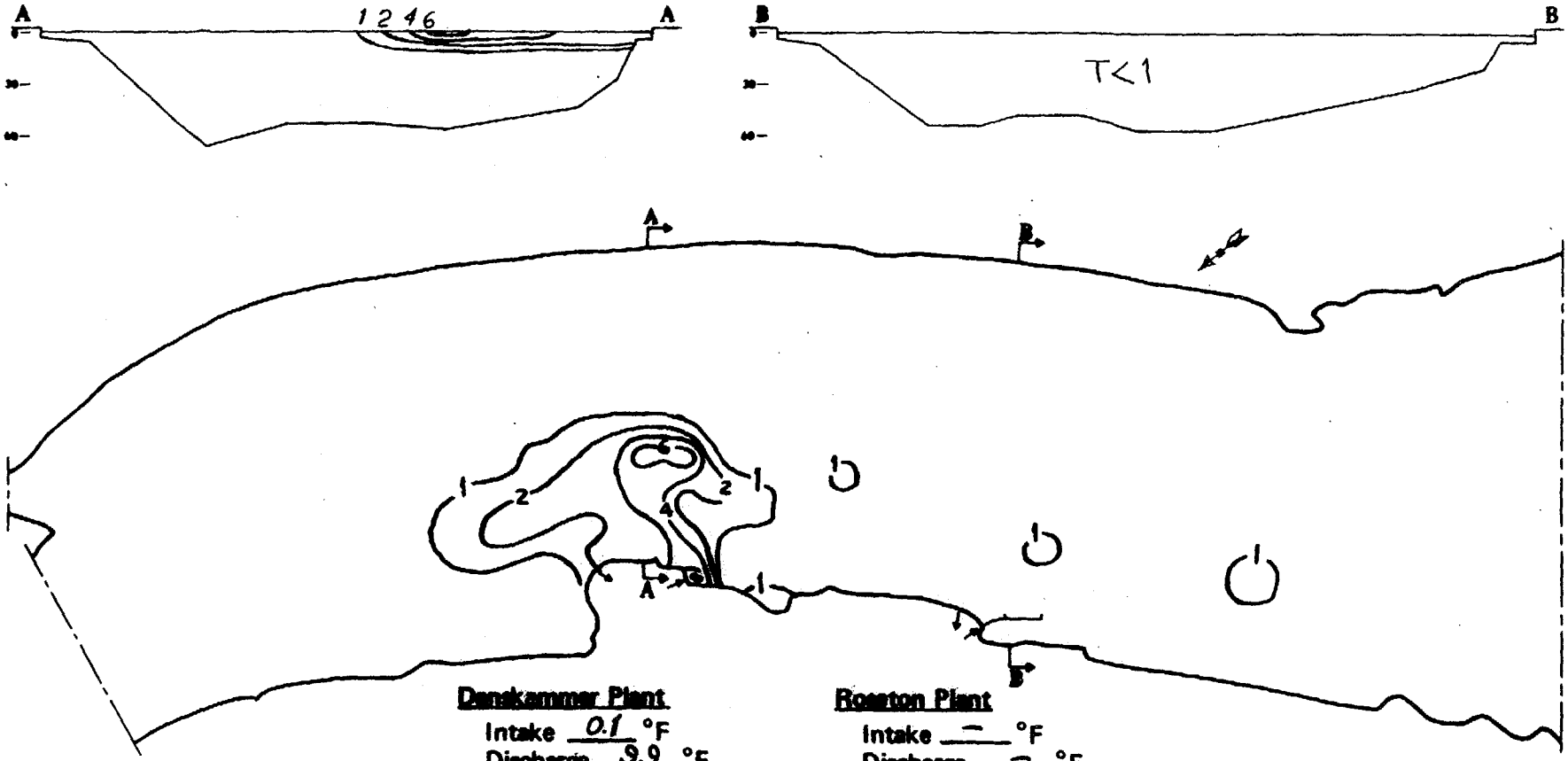


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 76



Danskammer Plant

Intake 0.1 °F
Discharge 9.9 °F
ΔT 9.8 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 82.7 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

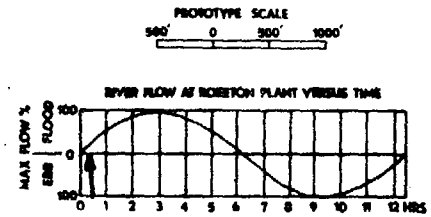
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 77

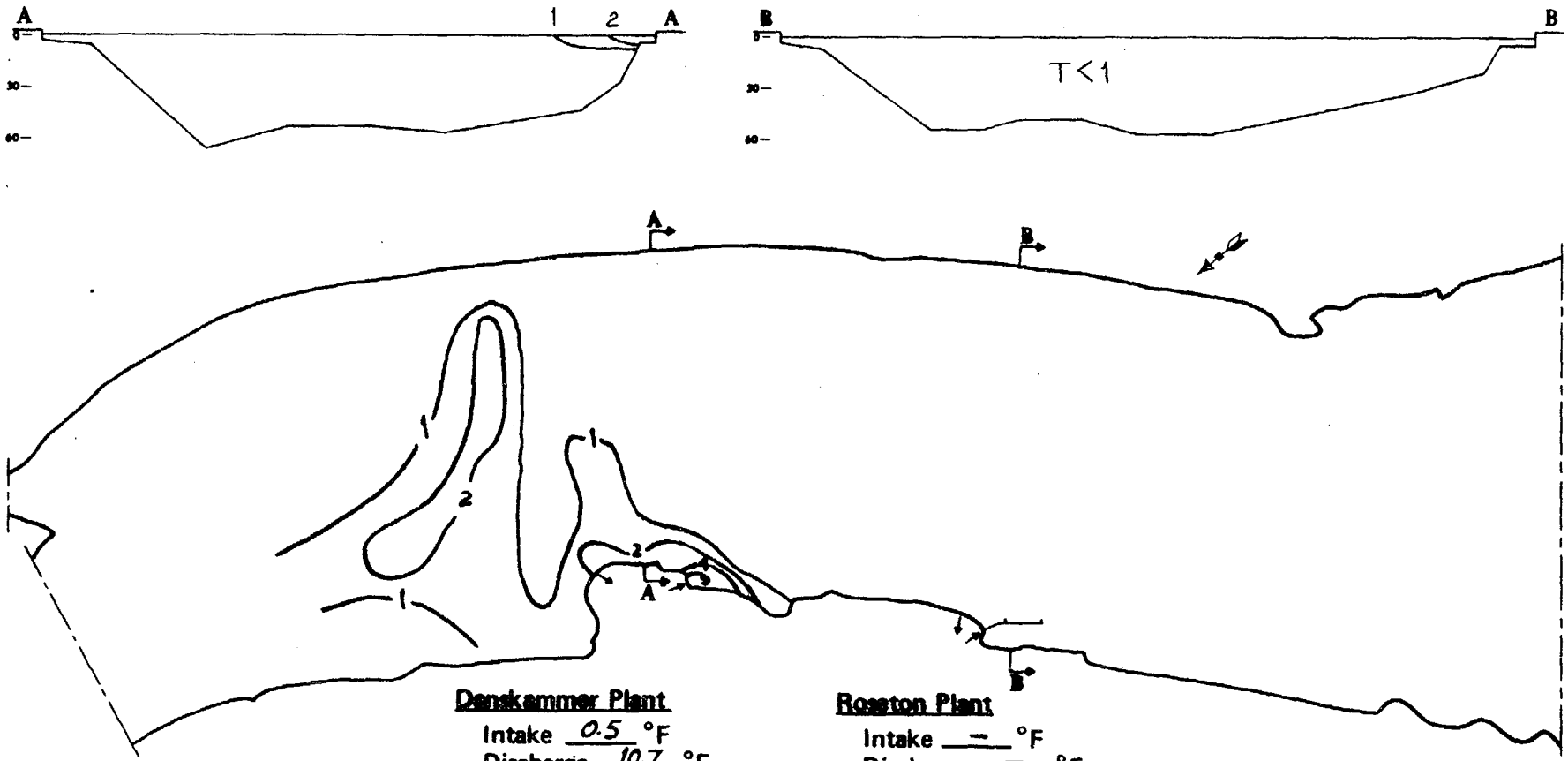


FIGURE A 78

Danskammer Plant

Intake 0.5 °F
Discharge 10.7 °F
ΔT 10.2 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 80.6 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

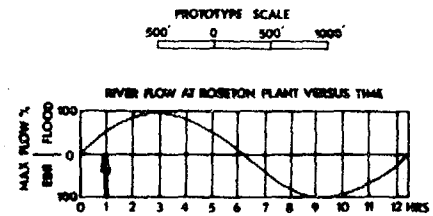
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

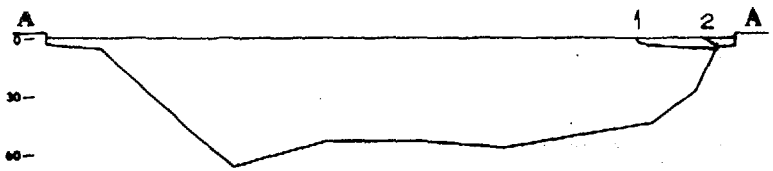
A. With Barge
B. Without Barge

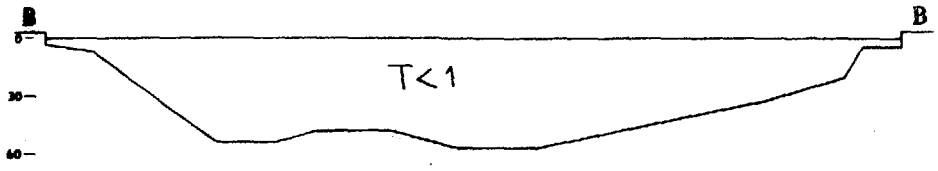


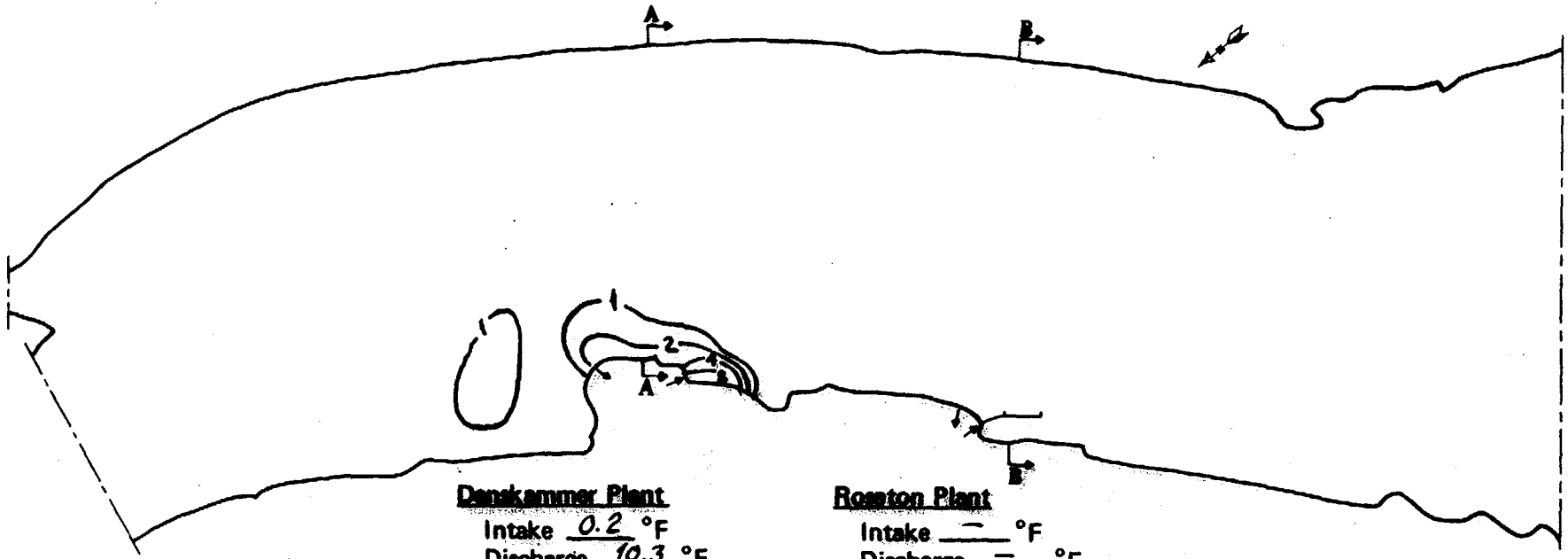
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL







Danskammer Plant

Intake 0.2 °F
Discharge 10.3 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 81.4 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

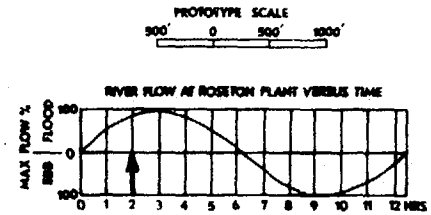
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



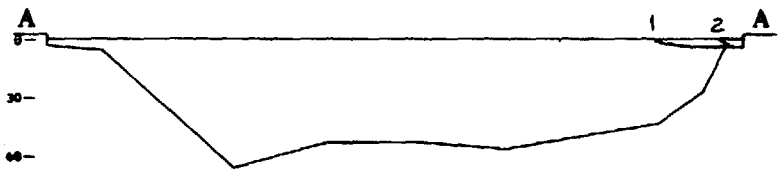
TEMPERATURE RISE ABOVE RIVER AMBIENT

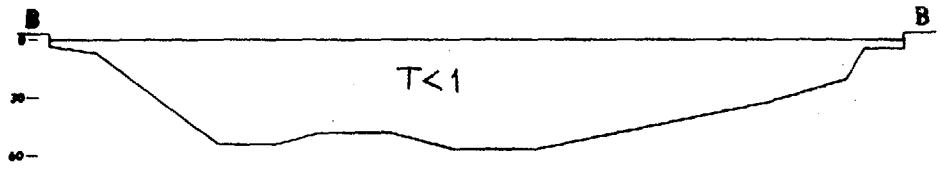
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

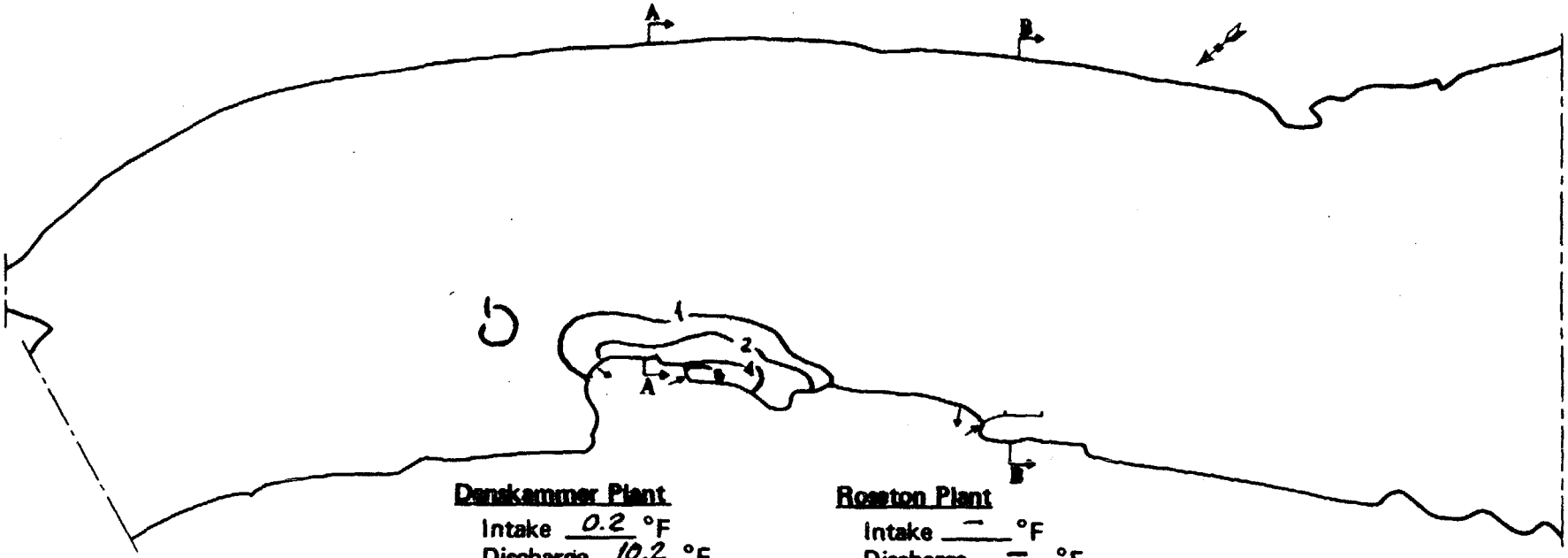
ARL

FIGURE A 79

FIGURE A 80







Danskammer Plant

Intake 0.2 °F
Discharge 10.2 °F
ΔT 10.0 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 81.4 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

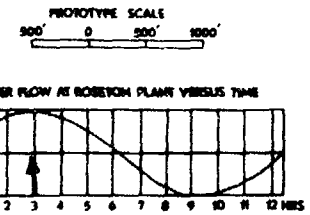
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

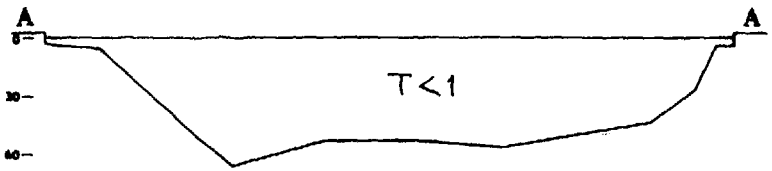
A. With Barge
B. Without Barge

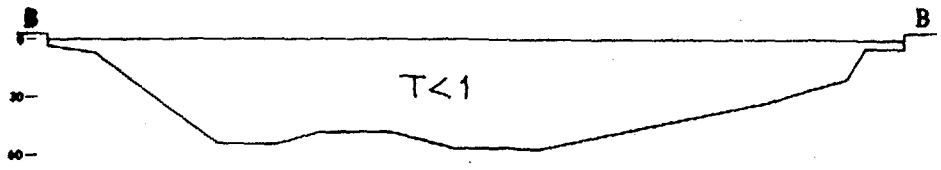


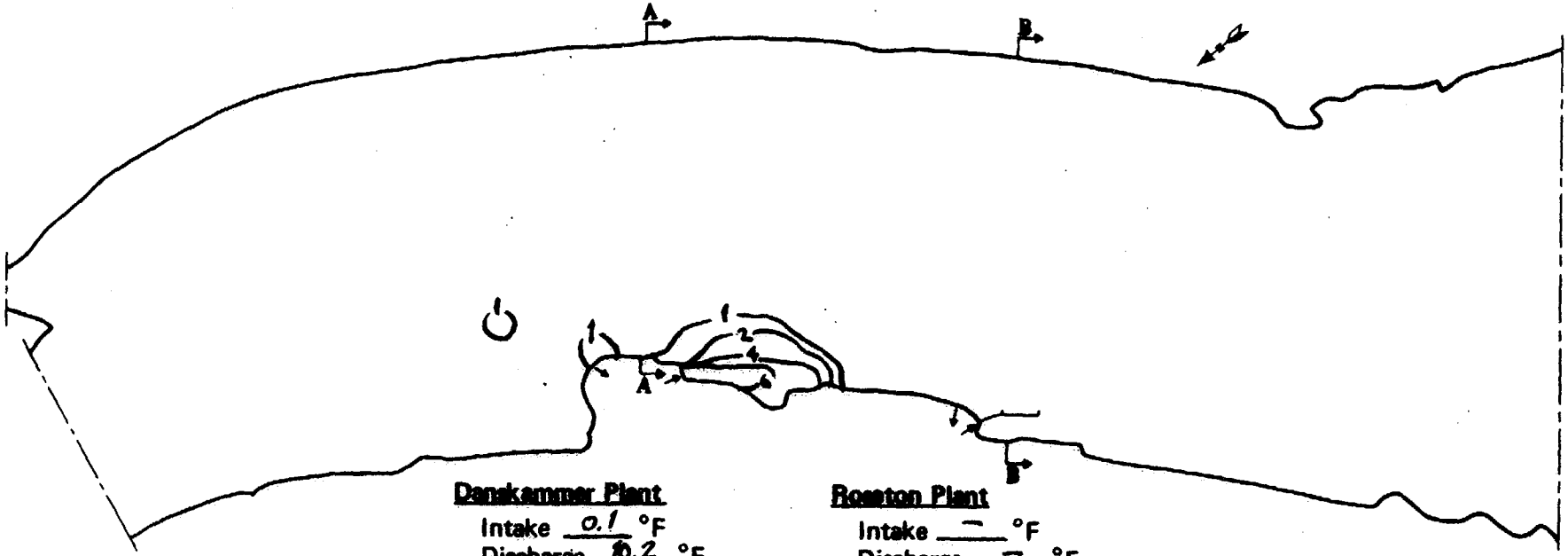
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.1 °F
Discharge 10.2 °F
ΔT 10.1 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

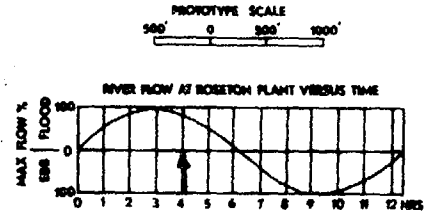
Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 92.0 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.



*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

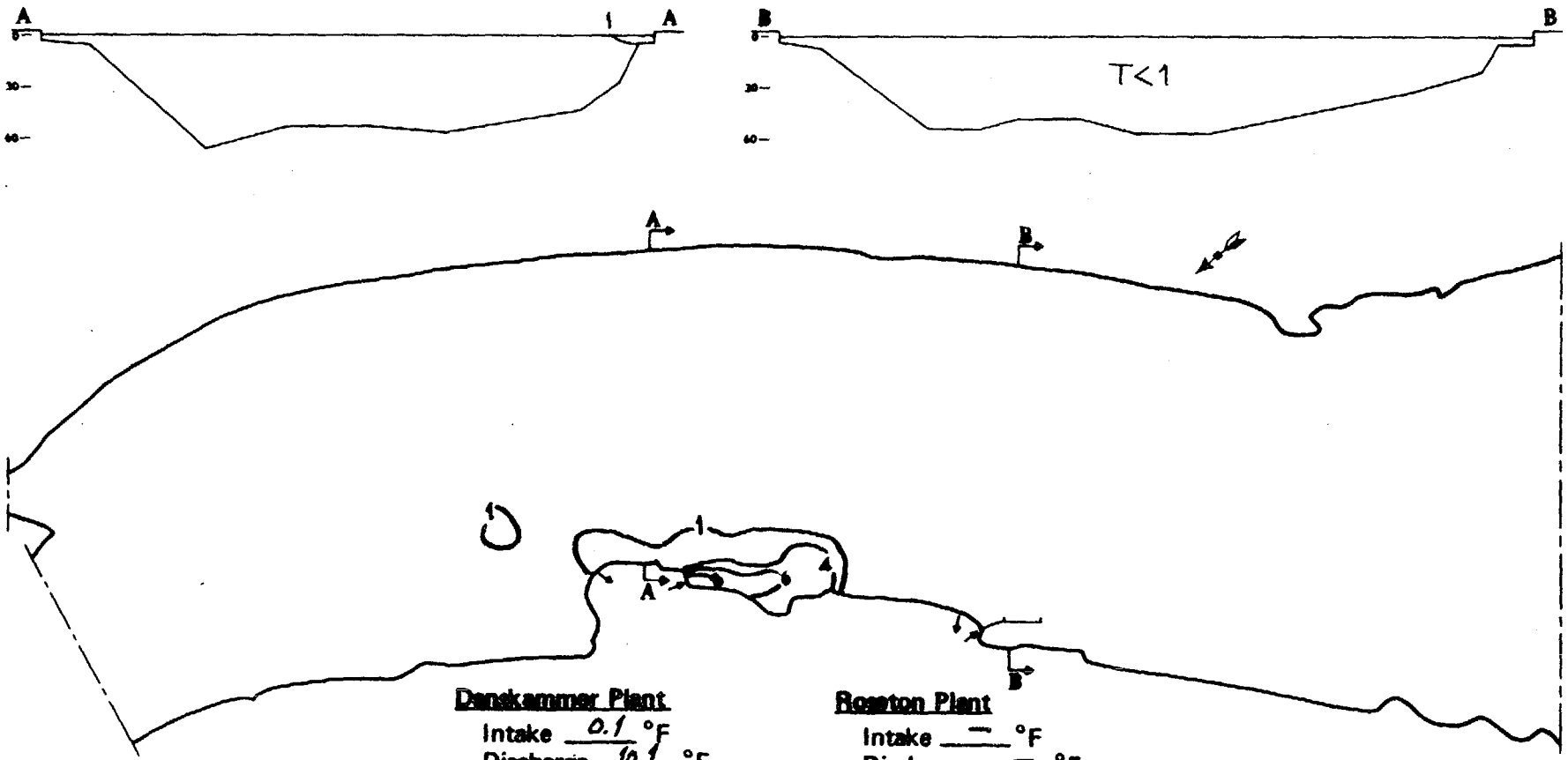
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 81

FIGURE A 82



Danskammer Plant

Intake 0.1 °F
Discharge 10.1 °F
ΔT 10.0 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 81.8 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

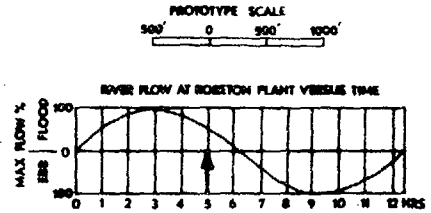
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

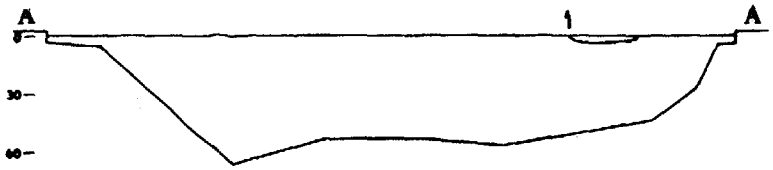
A. With Barge
B. Without Barge

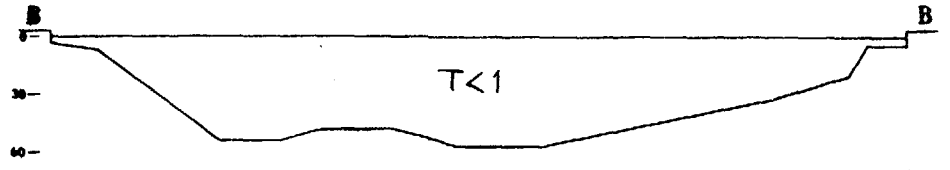


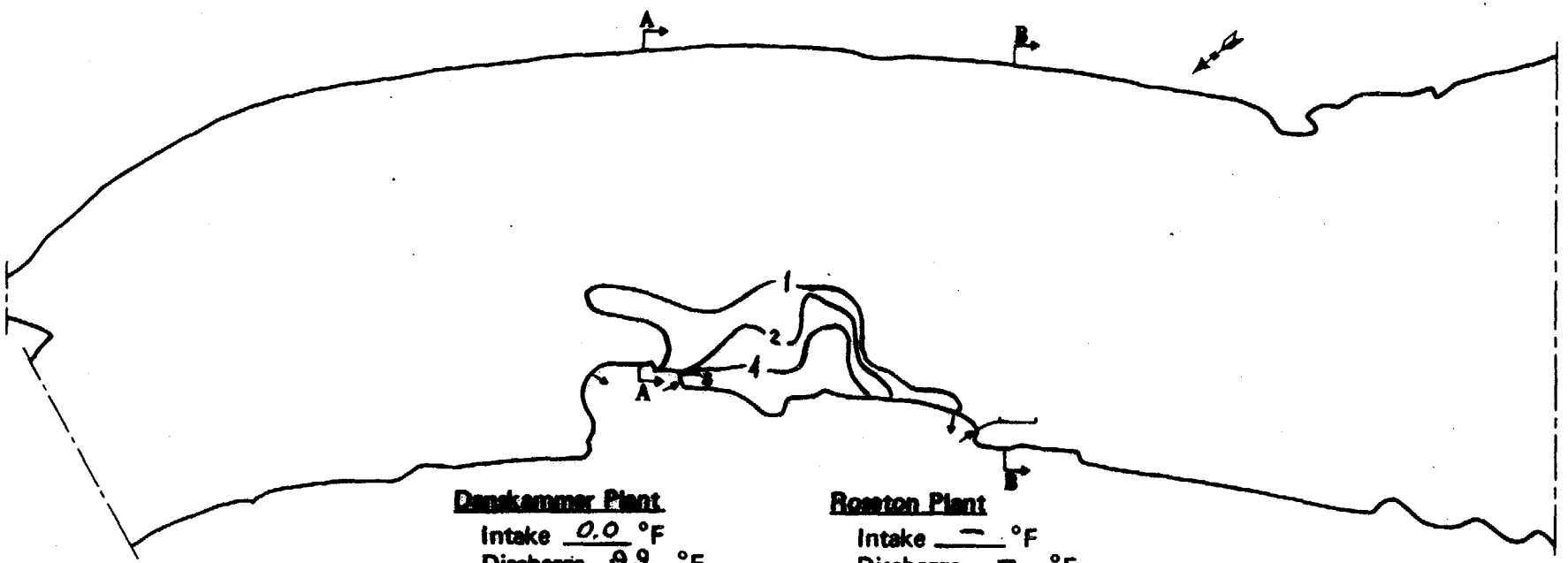
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.0 °F
Discharge 9.9 °F
ΔT 9.9 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 81.8 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

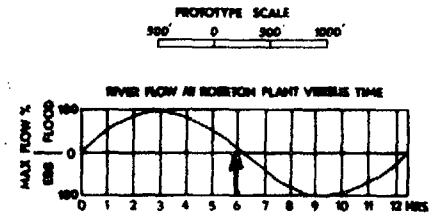
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



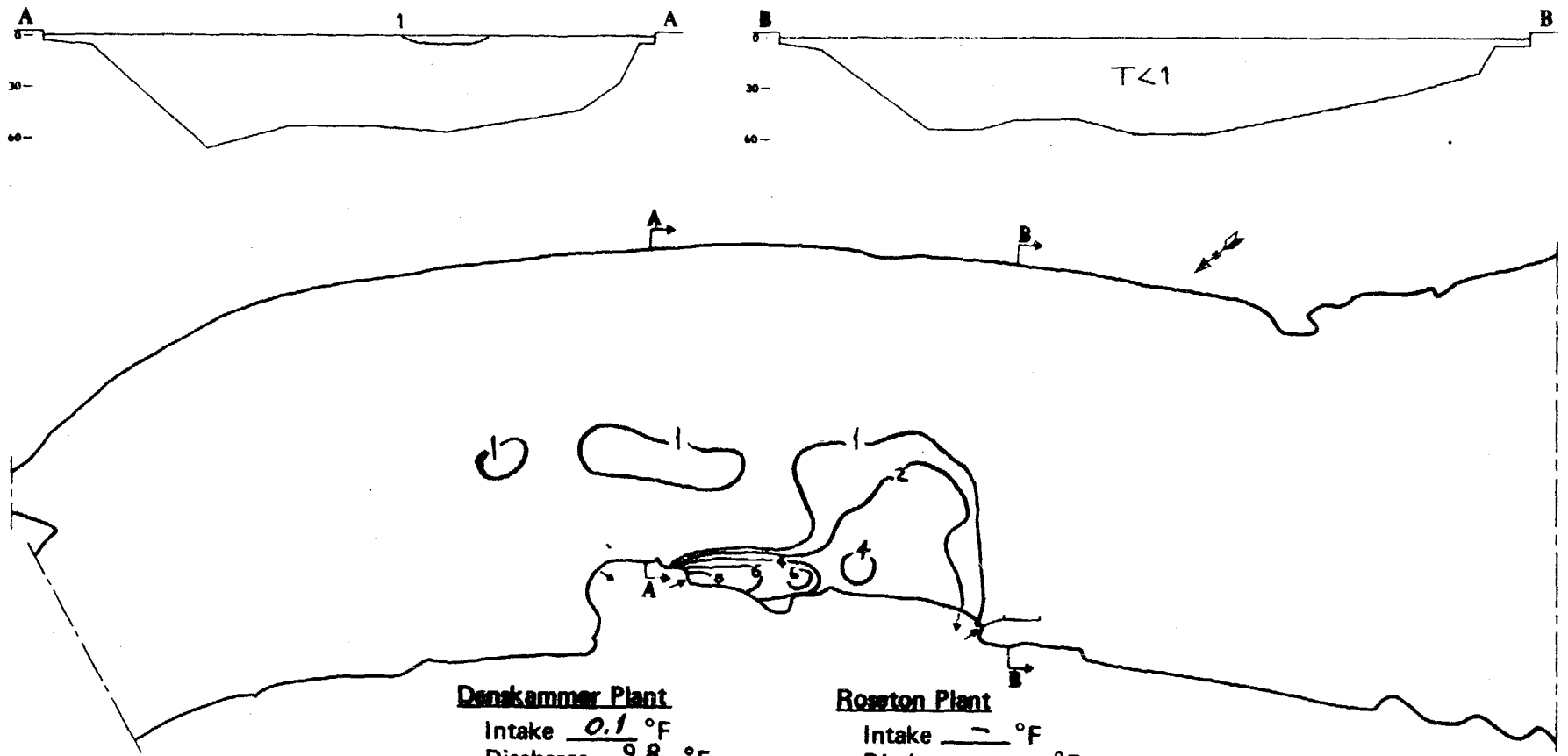
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 83

FIGURE A 84



Danskammer Plant

Intake 0.1 °F
Discharge 9.8 °F
ΔT 9.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 96 %
Dry Bulb Temperature 80.9 °F
Thermal Equilibrium Box Temperature -0.3 °F

River

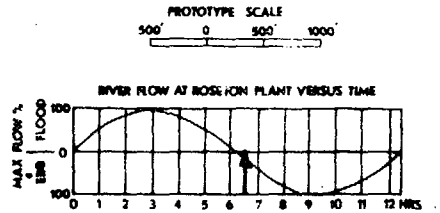
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

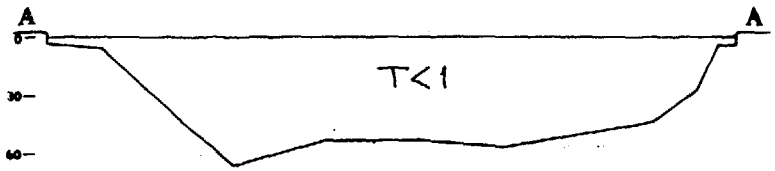
A. With Barge
B. Without Barge

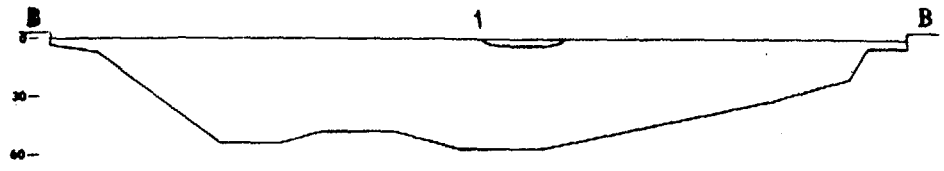


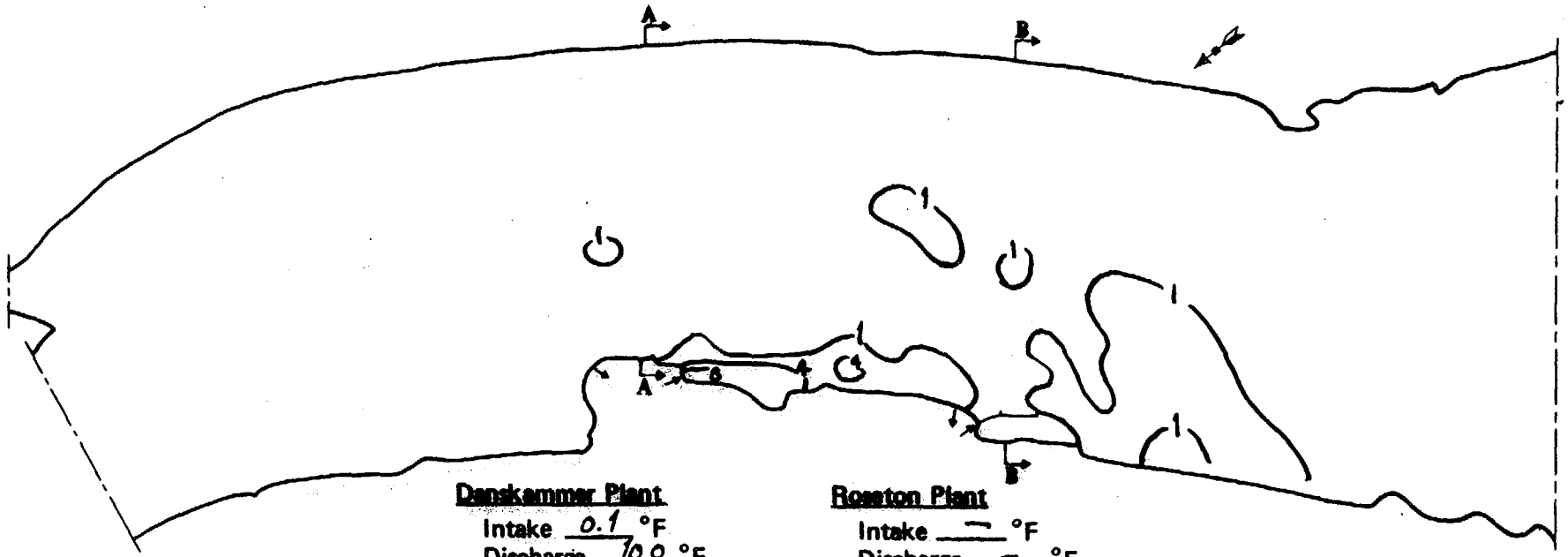
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.1 °F
Discharge 10.0 °F
ΔT 9.9 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 95 %
Dry Bulb Temperature 81.4 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

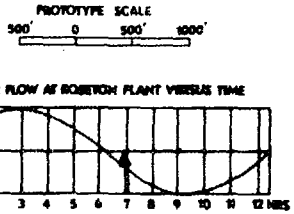
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A.85

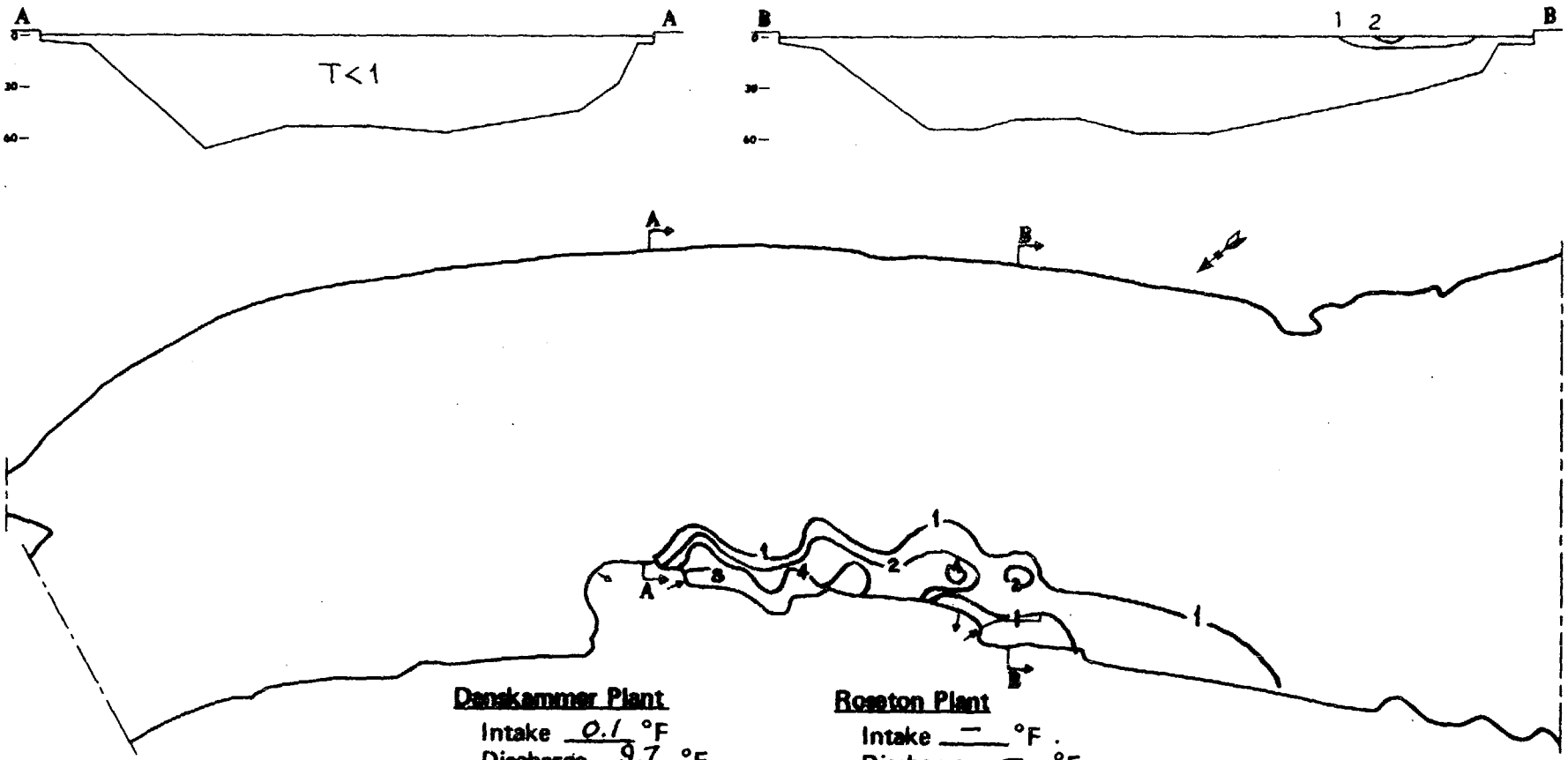


FIGURE A 86

Danskammer Plant

Intake 0.1 °F
Discharge 9.7 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 81.2 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

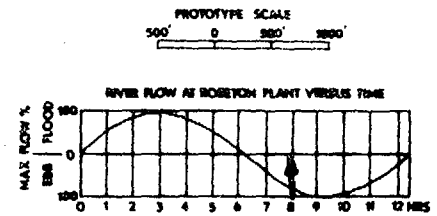
Fresh Water Flow 6000 cfs
Ambient Temperature 81.4 °F

Date 16 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

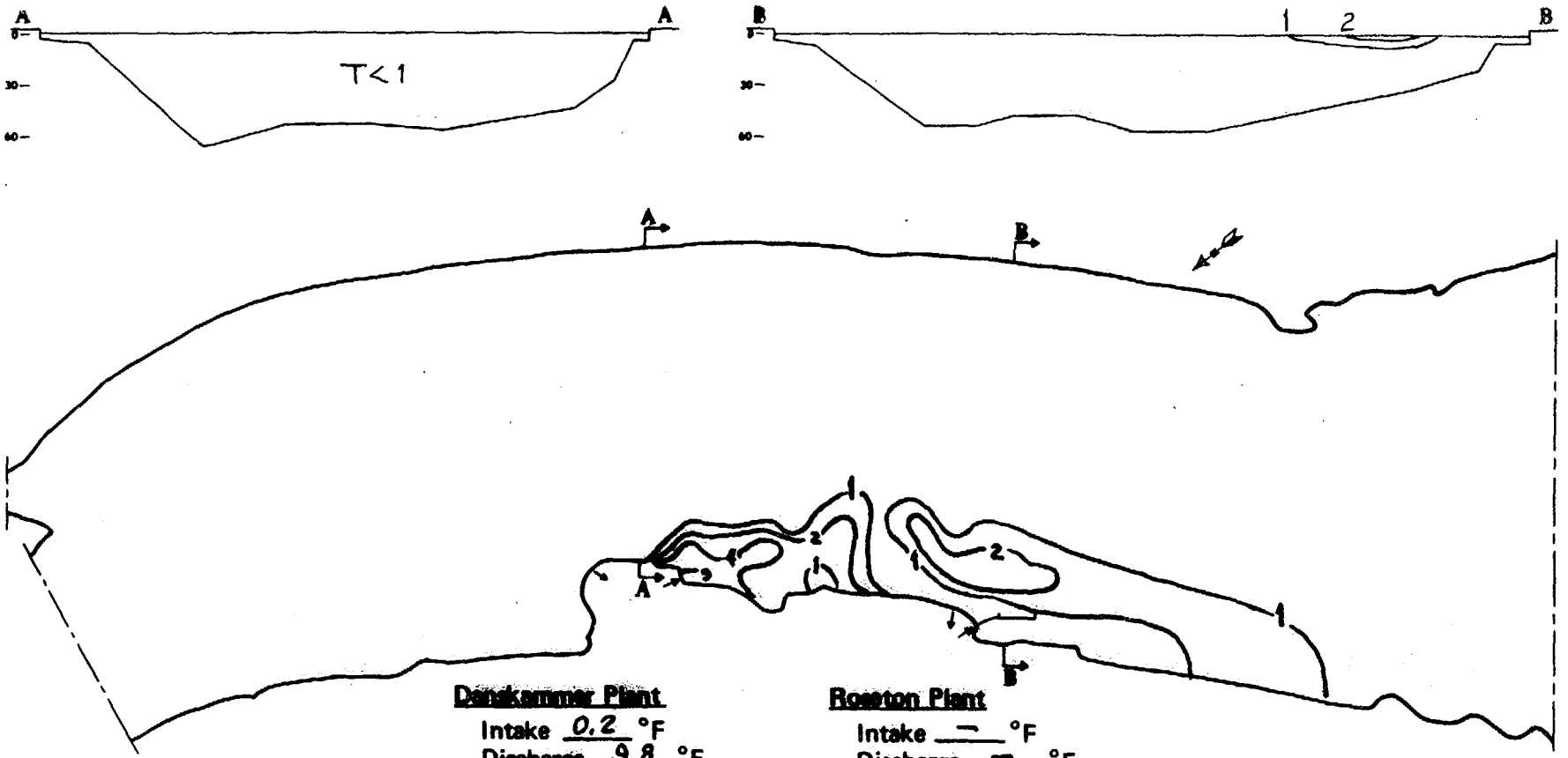
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.2 °F
Discharge 9.8 °F
ΔT 9.6 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 81.3 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

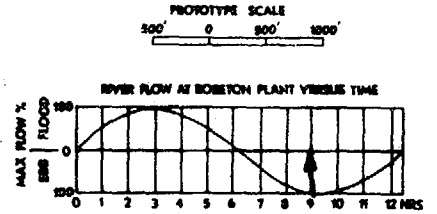
Fresh Water Flow 6000 cfs
Ambient Temperature 84.5 °F

Date 16 JUNE 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 87

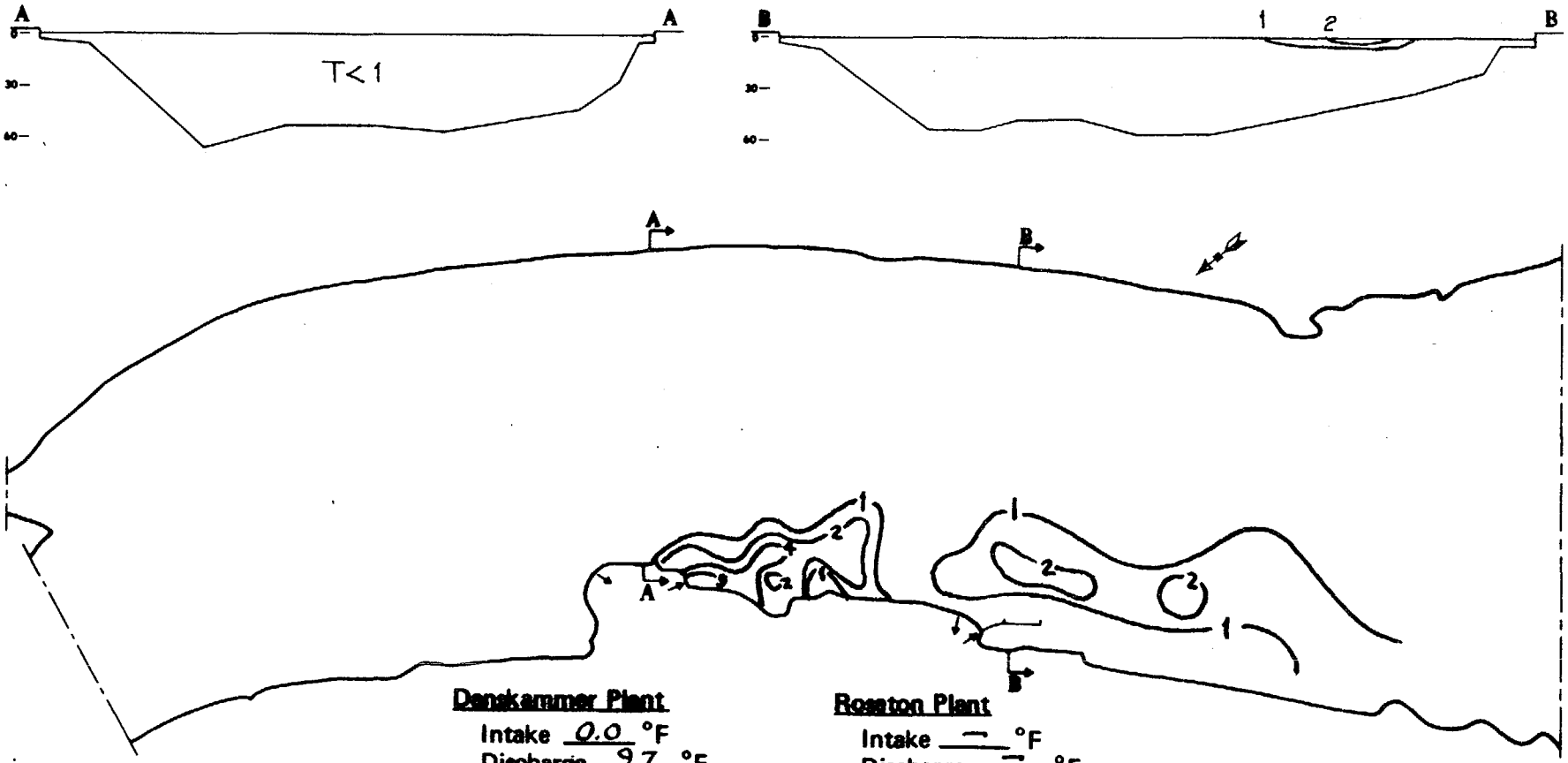


FIGURE A 88

Danskammer Plant

Intake 0.0 °F
Discharge 9.7 °F
ΔT 9.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 94 %
Dry Bulb Temperature 84.4 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

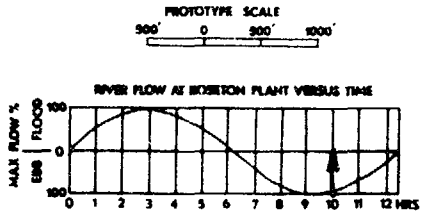
Fresh Water Flow 6000 cfs
Ambient Temperature 84.5 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

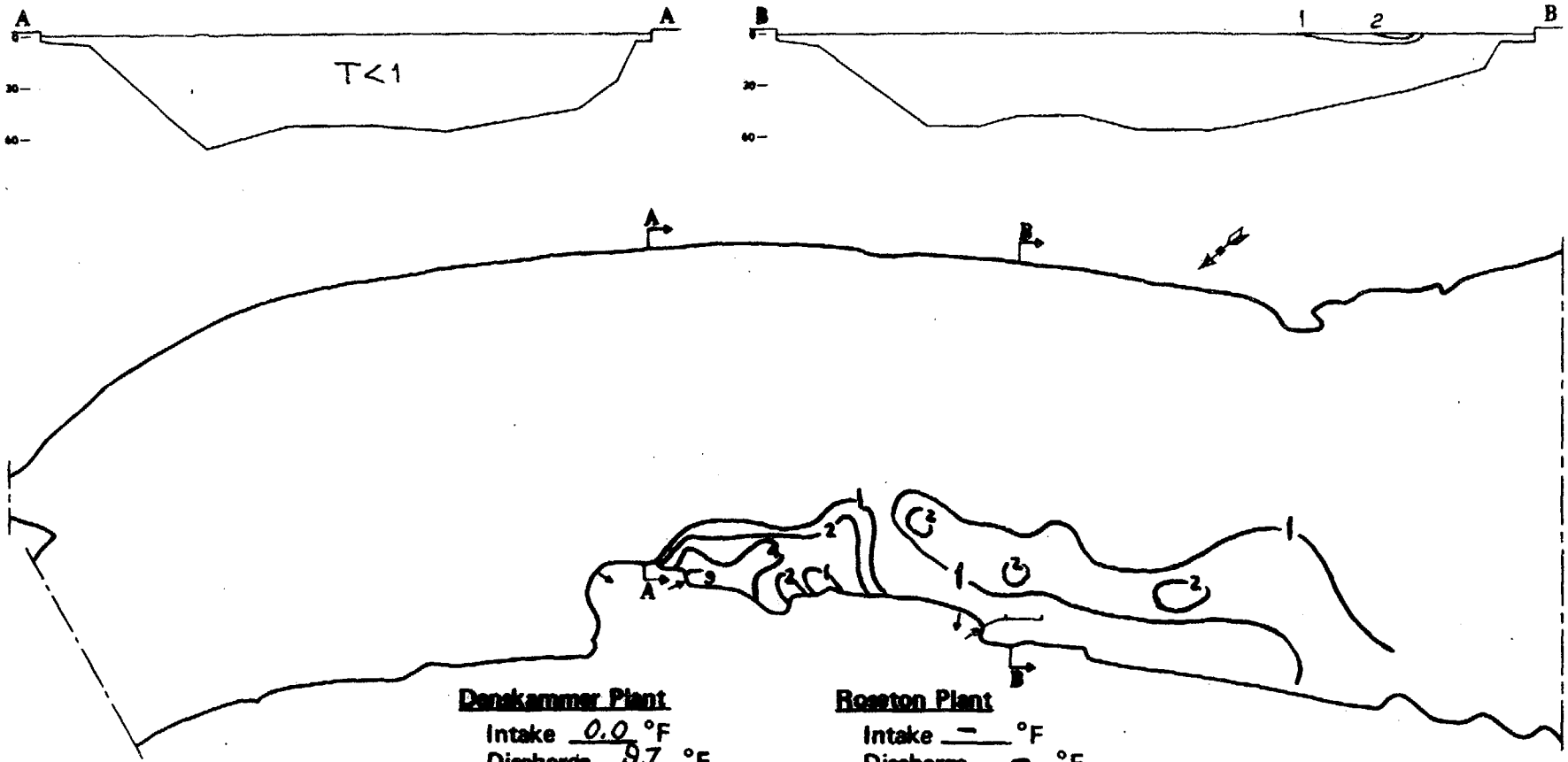
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.0 °F
Discharge 9.7 °F
ΔT 9.7 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

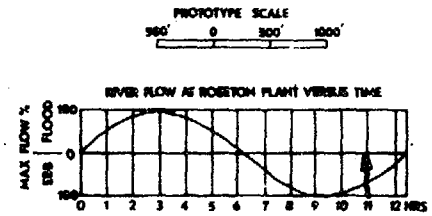
Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 81.3 °F
Thermal Equilibrium Box Temperature -0.1 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 81.5 °F

Date 16 June 72 p.m.

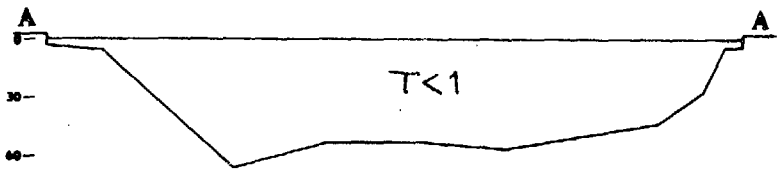


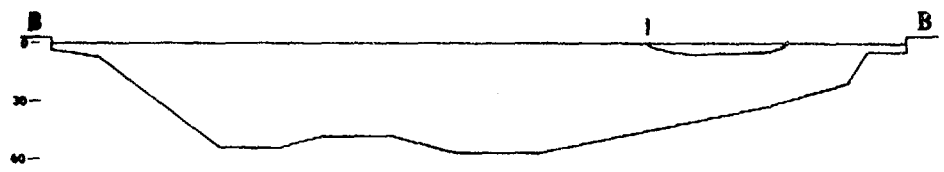
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 89





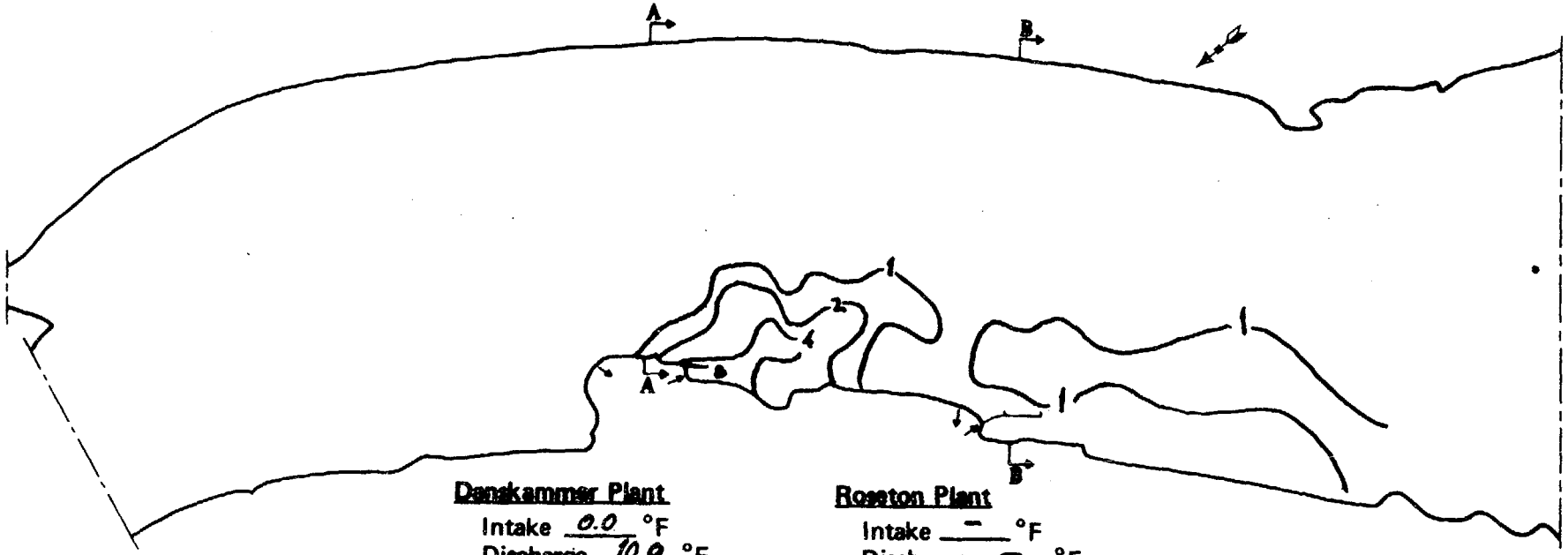


FIGURE A 90

Danskammer Plant

Intake 0.0 °F
Discharge 10.0 °F
ΔT 10.0 °F
Flow 700 cfs
* Outfall Configuration 1

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 81.5 °F
Thermal Equilibrium Box Temperature 0.0 °F

River

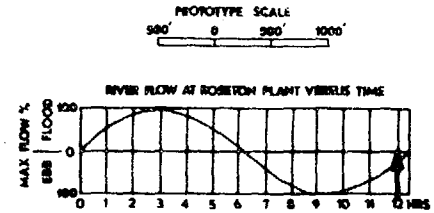
Fresh Water Flow 6000 cfs
Ambient Temperature 81.5 °F

Date 16 June 72 p.m.

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

DANSKAMMER

LOAD	100%
DISCHARGE DESIGN	BULKHEAD
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	16.0 F

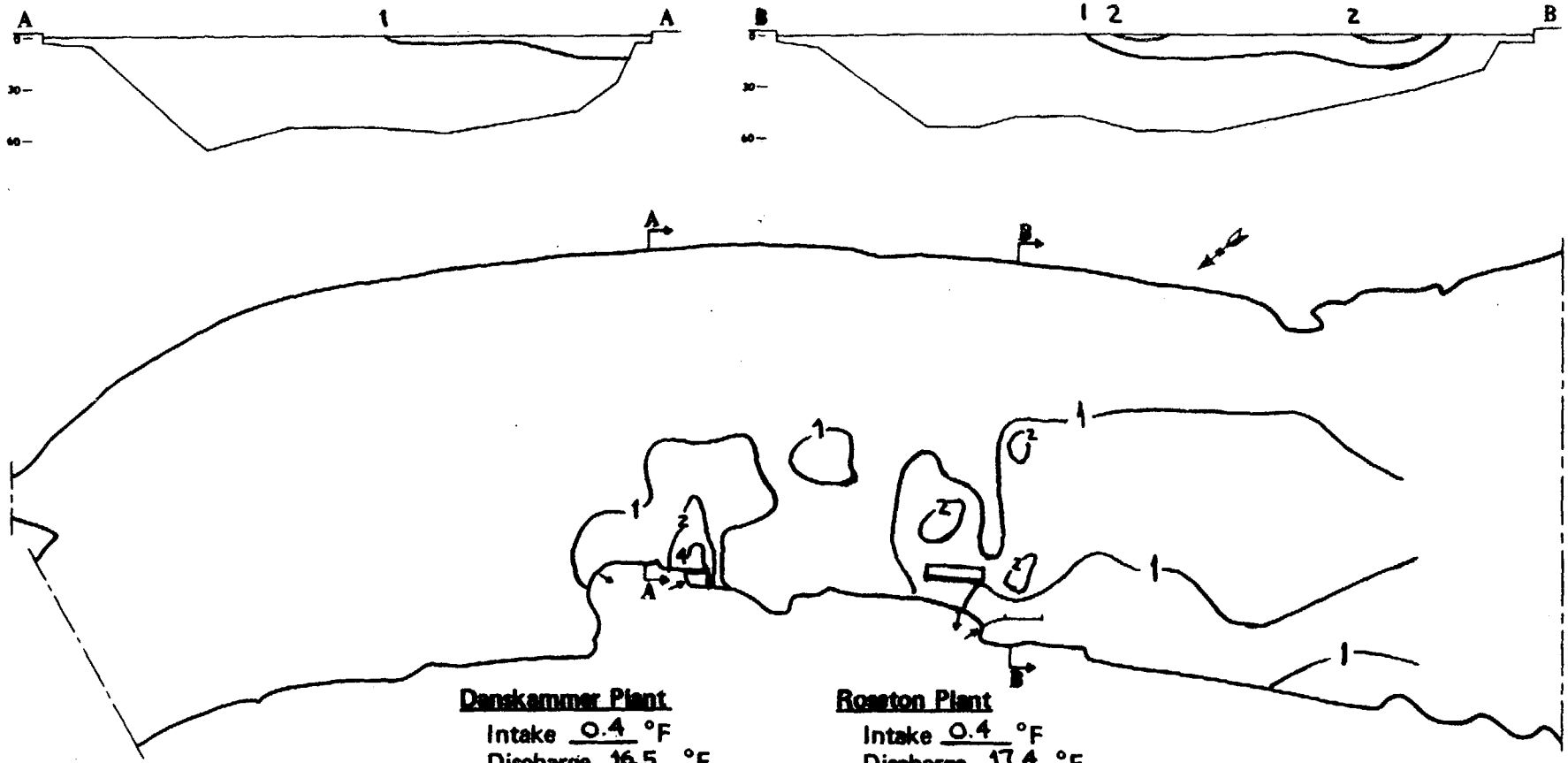
ROSETON

LOAD	100%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	16.7 F
OIL BARGE	INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	78.1 F
FRESH WATER FLOW	6000 CFS

TEST DATE 27 SEPT. 1972



Danskammer Plant

Intake 0.4 °F
Discharge 16.5 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.4 °F
Discharge 17.4 °F
ΔT 17.0 °F
Flow 1400 cfs
**Outfall Configuration 1A

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 79.0 °F
Thermal Equilibrium Box Temperature 0.9 °F

River

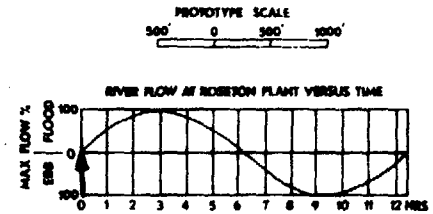
Fresh Water Flow 6000 cfs
Ambient Temperature 78.0° F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 91

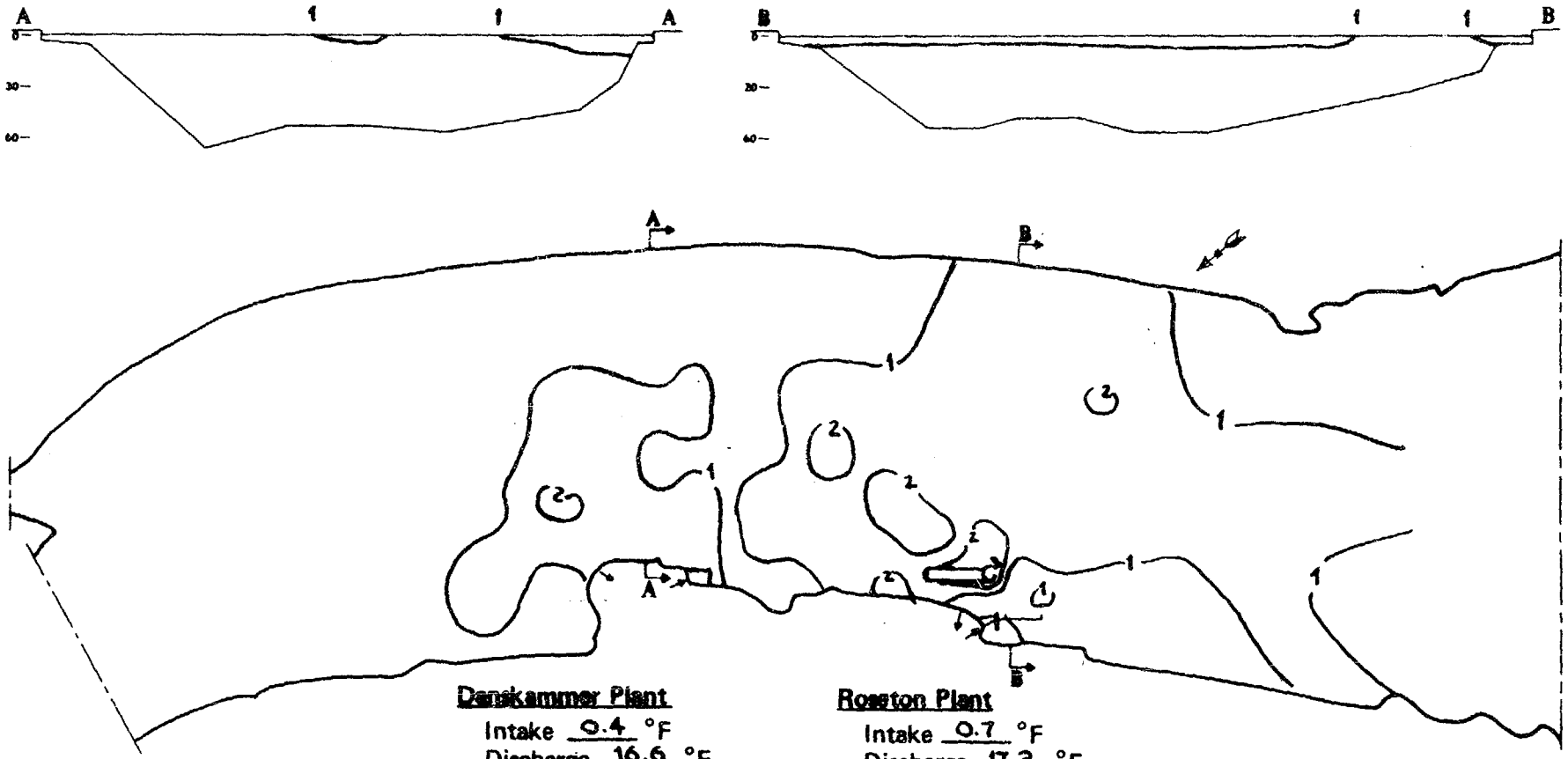


FIGURE A 92

Danskammer Plant

Intake 0.4 °F
Discharge 16.6 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.7 °F
Discharge 17.3 °F
ΔT 16.6 °F
Flow 1400 cfs
**Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature 81 °F

River

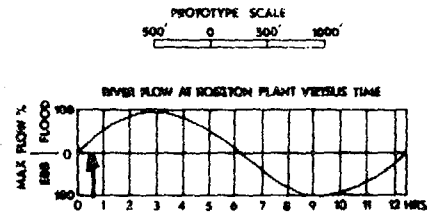
Fresh Water Flow 6000 cfs
Ambient Temperature 78.0°F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

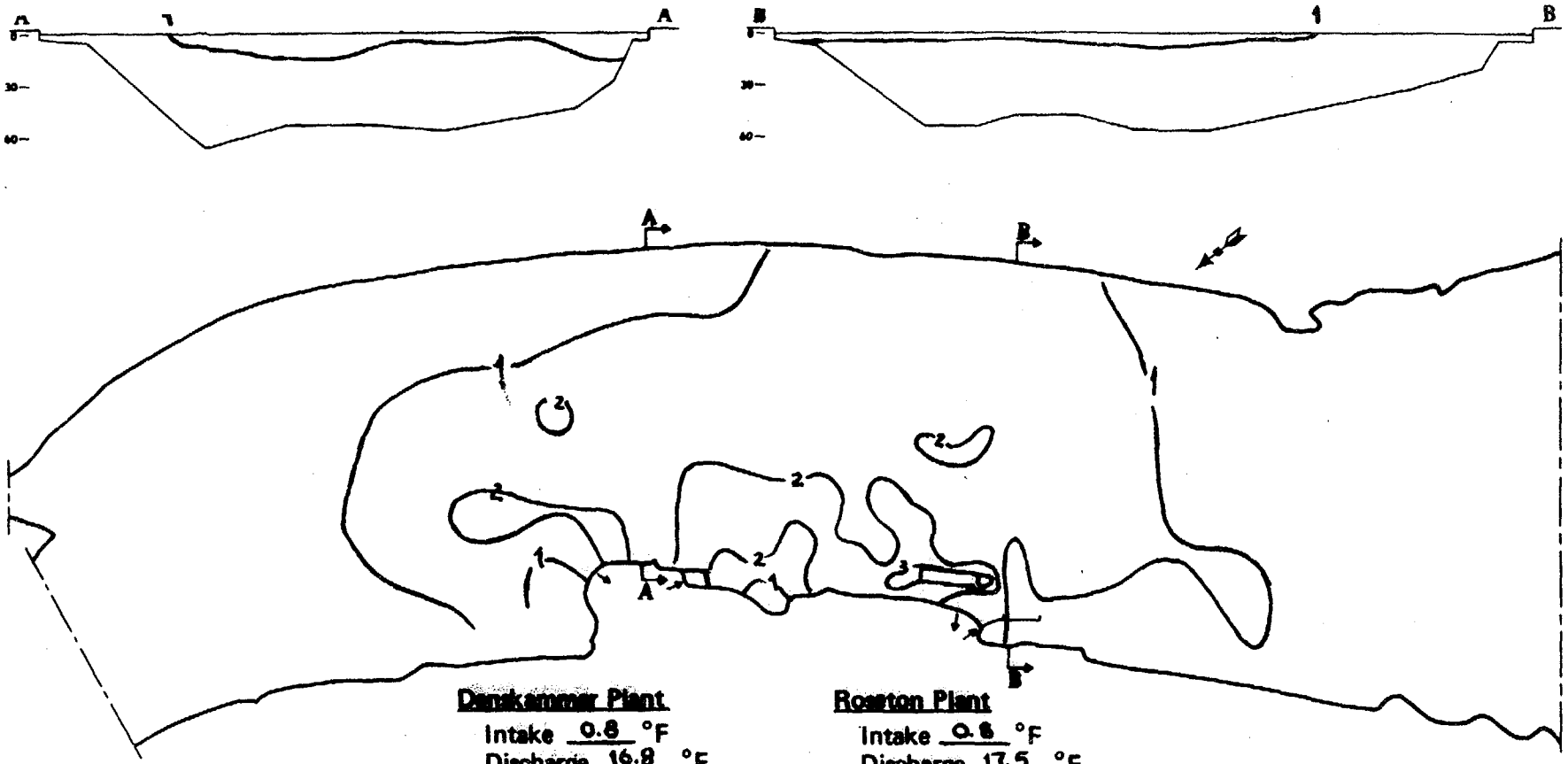
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.8 °F
Discharge 16.8 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.8 °F
Discharge 17.5 °F
ΔT 16.7 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature 0.9 °F

River

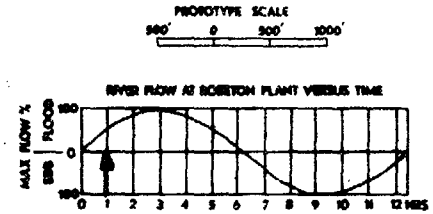
Fresh Water Flow 6000 cfs
Ambient Temperature 78.0° F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

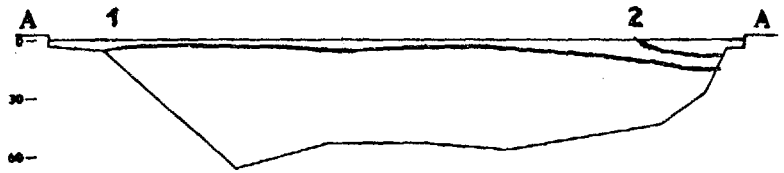


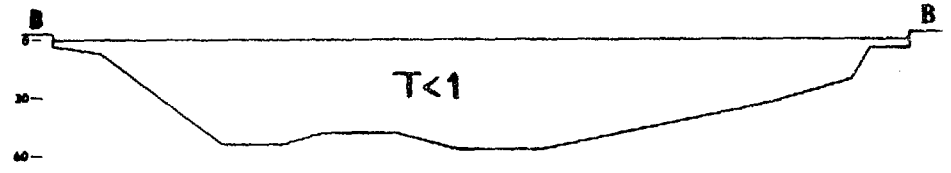
TEMPERATURE RISE ABOVE RIVER AMBIENT

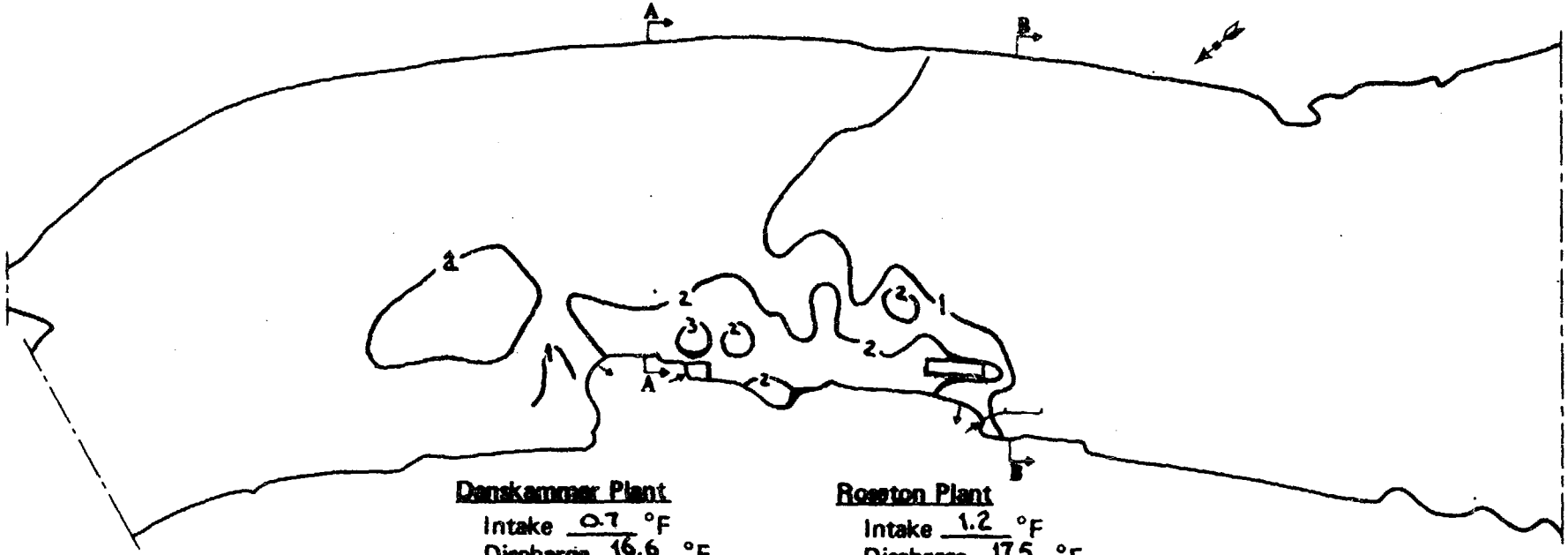
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 93







Danskammer Plant

Intake 0.7 °F
Discharge 16.6 °F
ΔT 15.9 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 1.2 °F
Discharge 17.5 °F
ΔT 16.3 °F
Flow 1400 cfs
**Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.9 °F

River

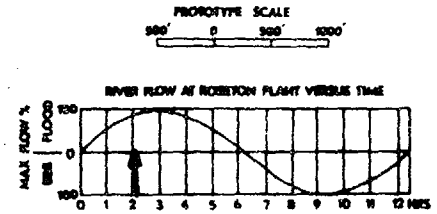
Fresh Water Flow 6000 cfs
Ambient Temperature 78.0°F

Date 27 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

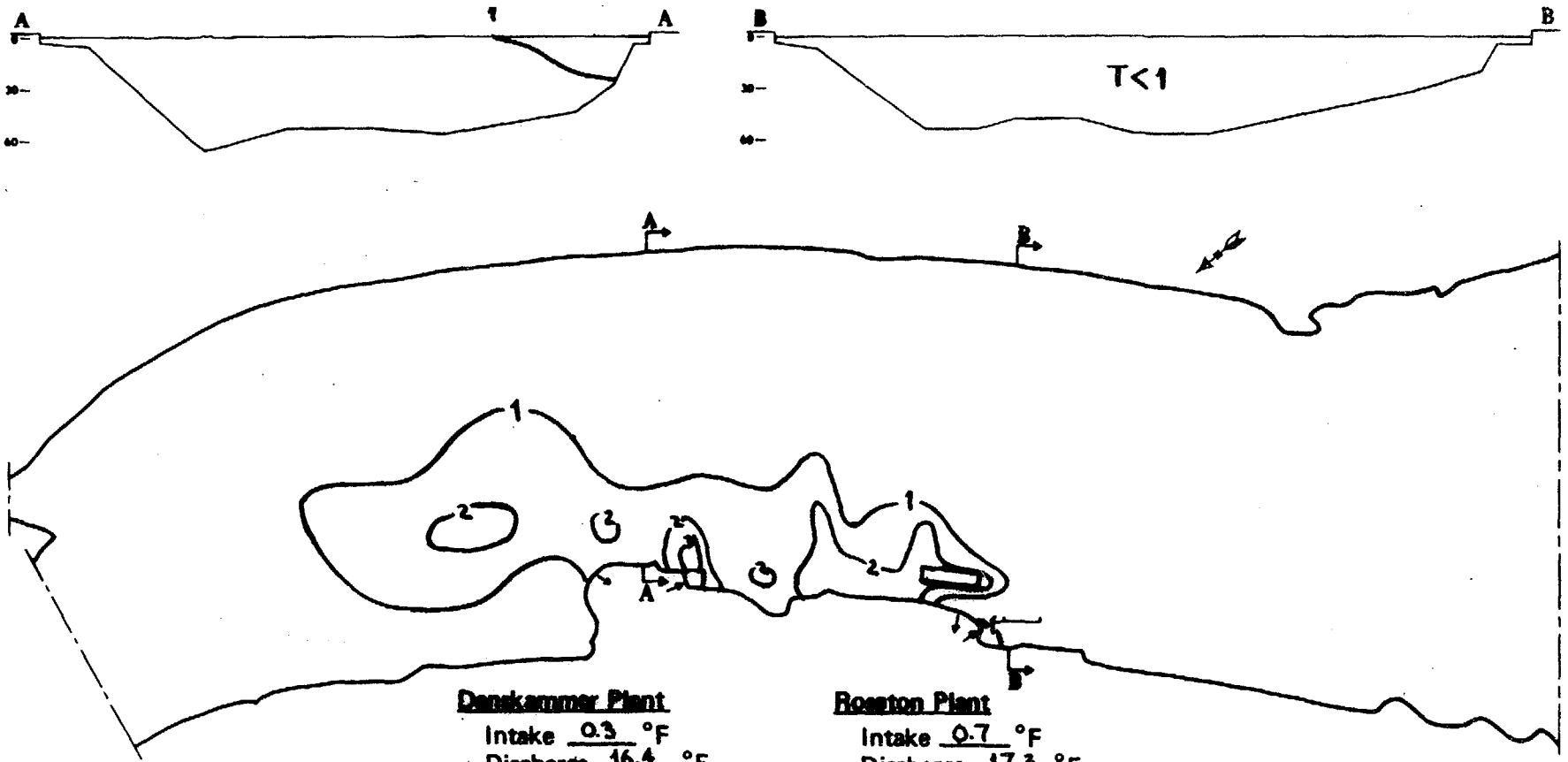


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 94



Danskammer Plant

Intake 0.3 °F
Discharge 16.4 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.7 °F
Discharge 17.3 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

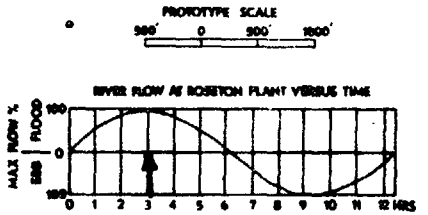
Fresh Water Flow 6000 cfs
Ambient Temperature 78.0 °F

Date 27 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

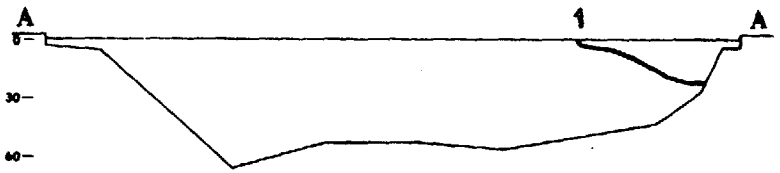


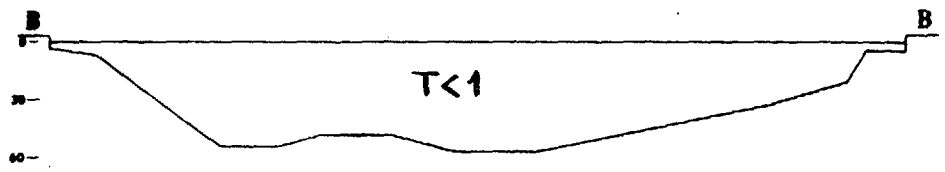
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 95





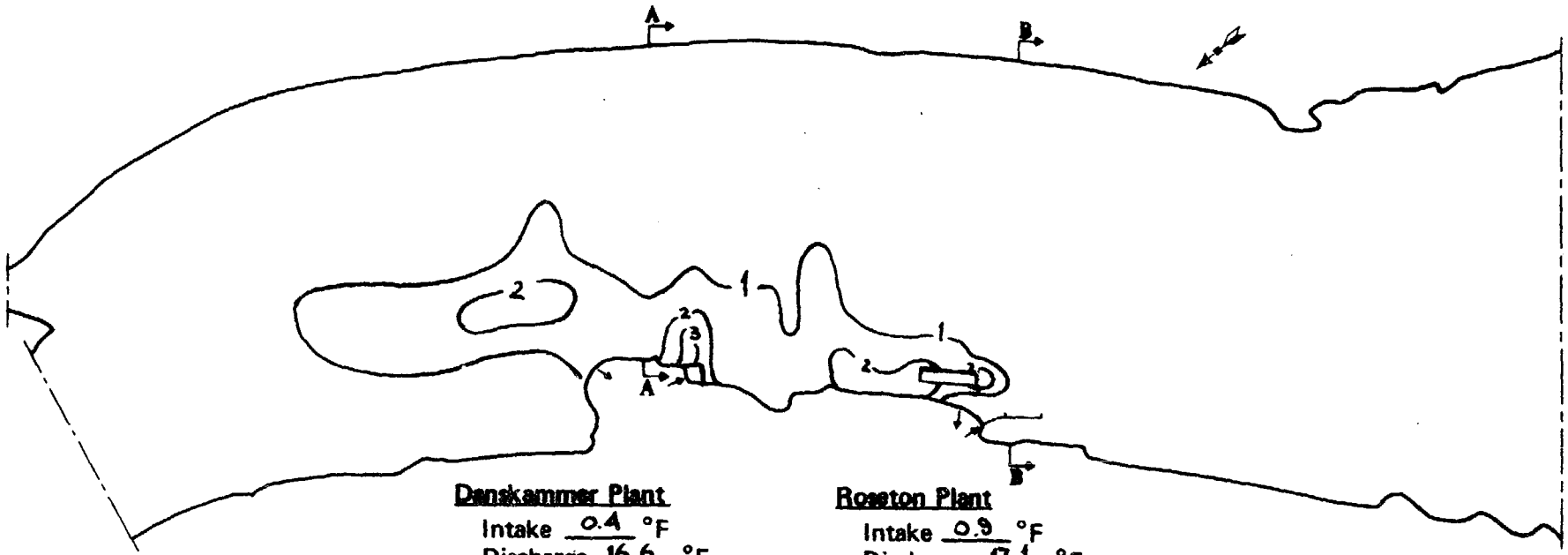


FIGURE A 96

Danskammer Plant

Intake 0.4 °F
Discharge 16.6 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.9 °F
Discharge 17.1 °F
ΔT 16.2 °F
Flow 1400 cfs
** Outfall Configuration 1A

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

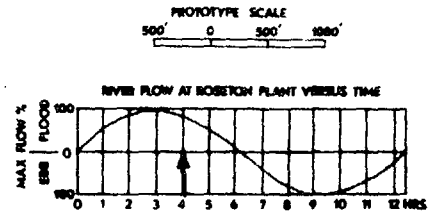
Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.6 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

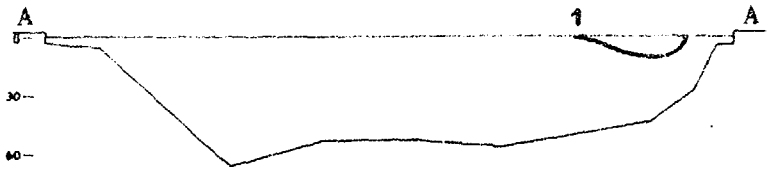
Date 27 SEPT. 72

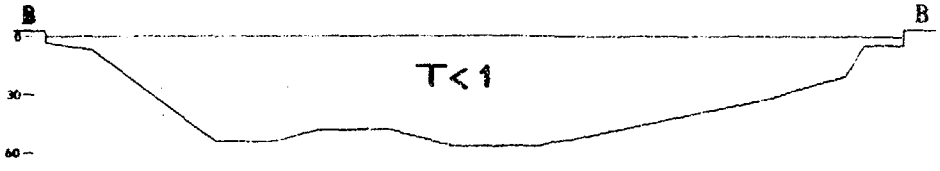


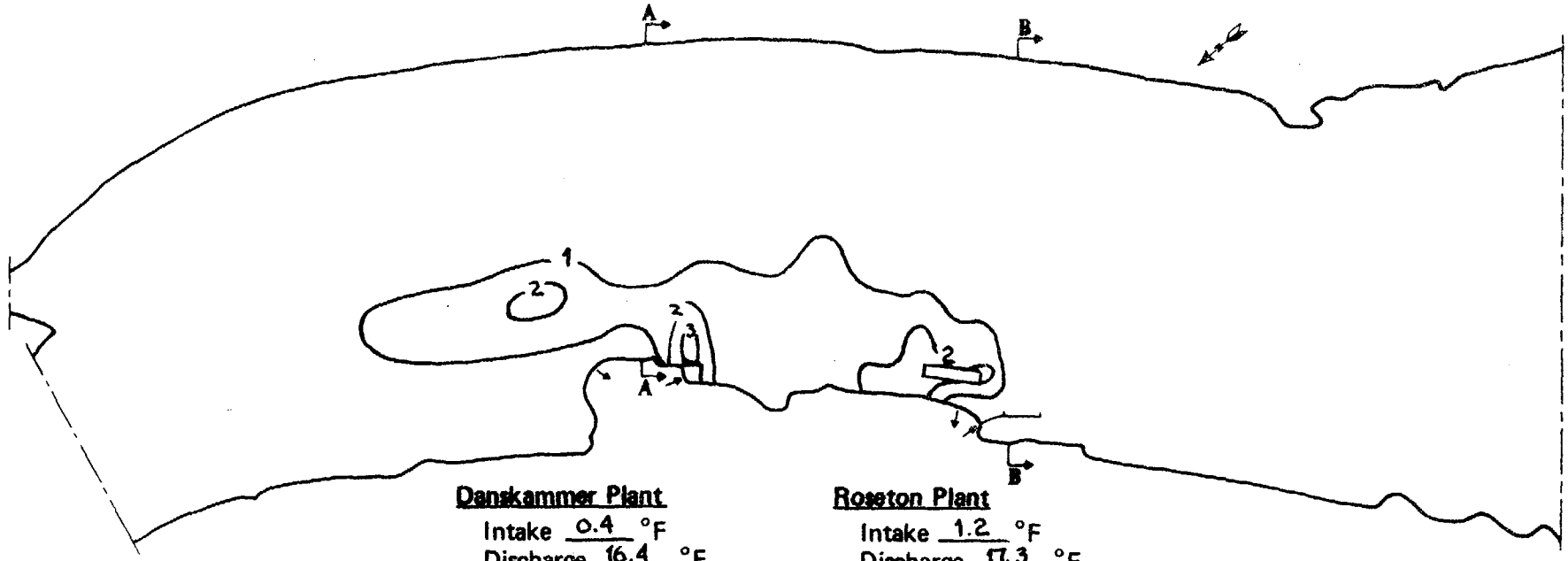
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.4 °F
Discharge 16.4 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 1.2 °F
Discharge 17.3 °F
ΔT 16.1 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

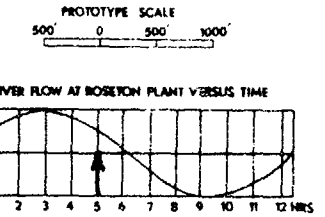
Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

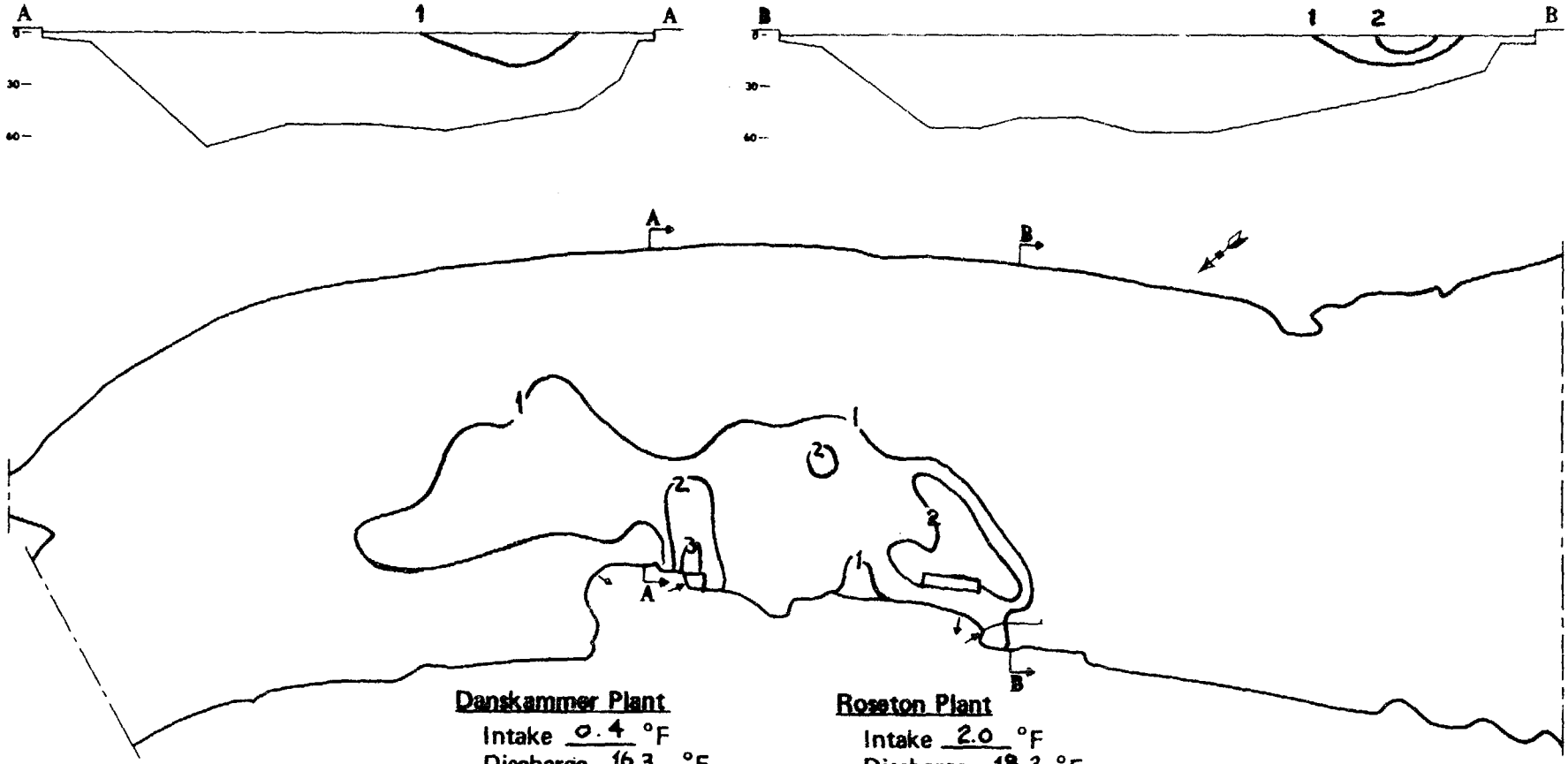


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 97



Danskammer Plant

Intake 0.4 °F
Discharge 16.3 °F
ΔT 15.9 °F
Flow 760 cfs
* Outfall Configuration 2

Roseton Plant

Intake 2.0 °F
Discharge 18.2 °F
ΔT 16.2 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

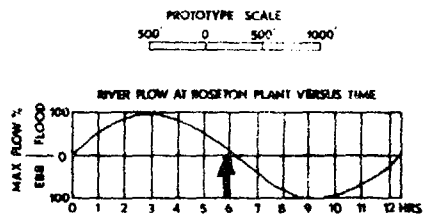
Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

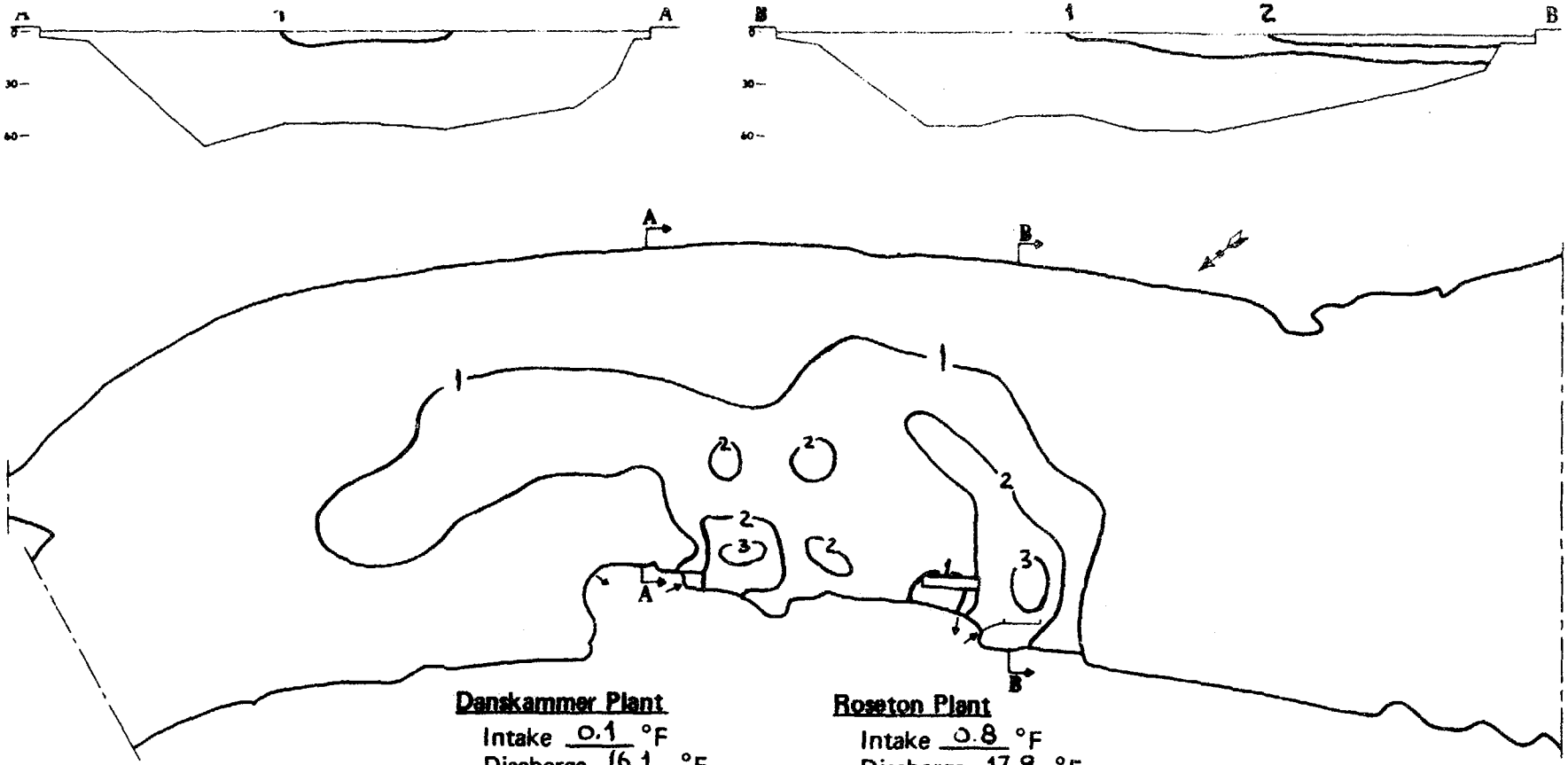


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 98



Danskammer Plant

Intake 0.1 °F
Discharge 16.1 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.8 °F
Discharge 17.8 °F
ΔT 17.0 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.8 °F

River

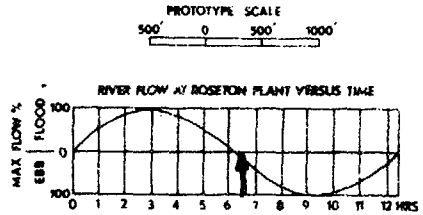
Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



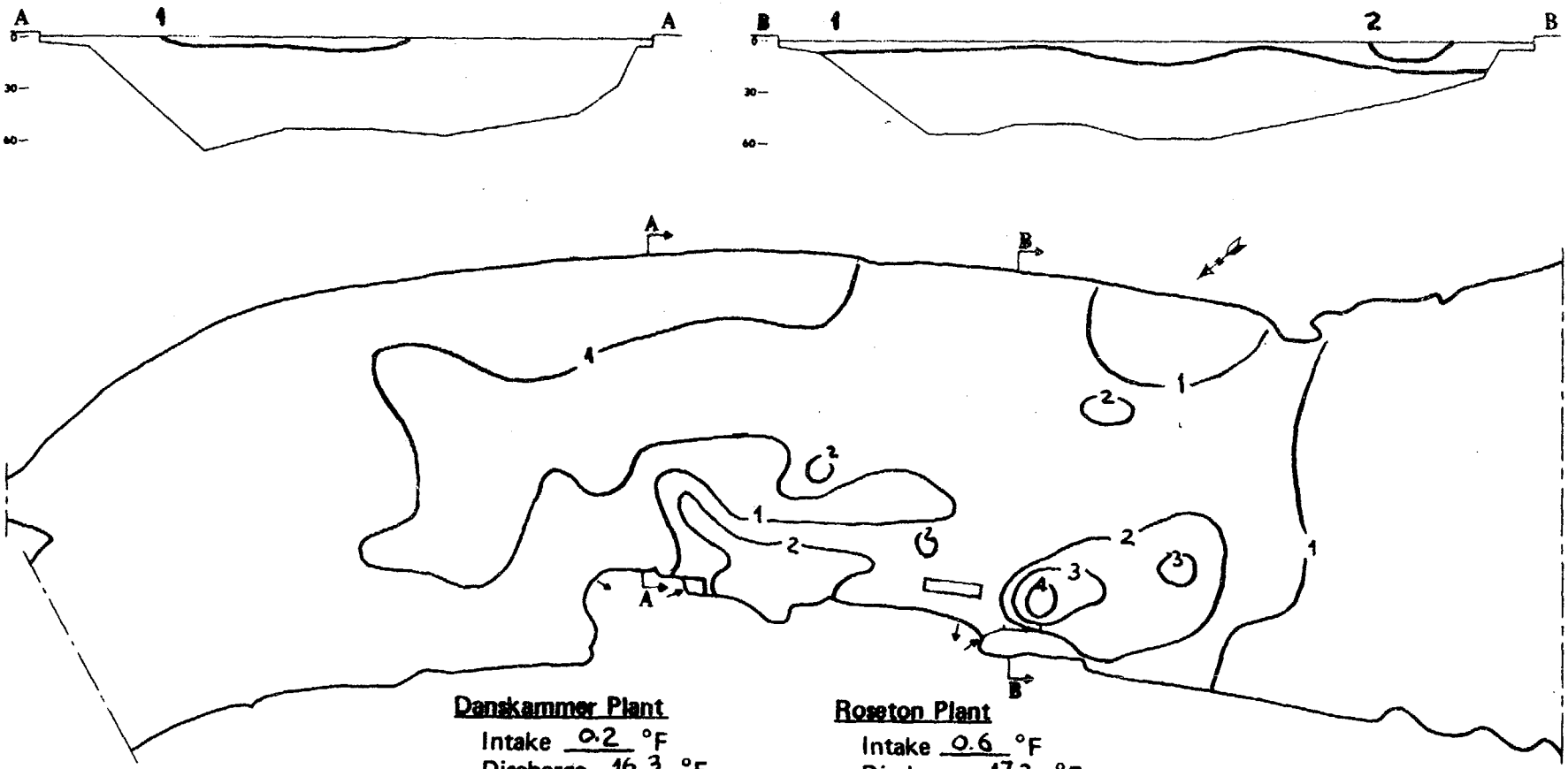
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 99

FIGURE A 100



Danskammer Plant

Intake 0.2 °F
Discharge 16.3 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.6 °F
Discharge 17.2 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1A

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.7 °F

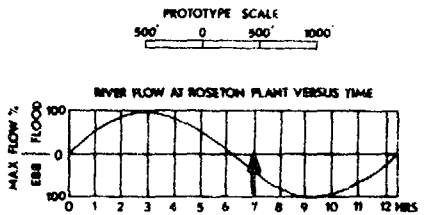
River

Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

**1. All 14 Ports

A. With Barge
B. Without Barge

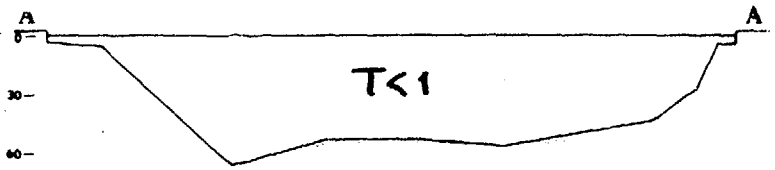
Date 27 SEPT. 72



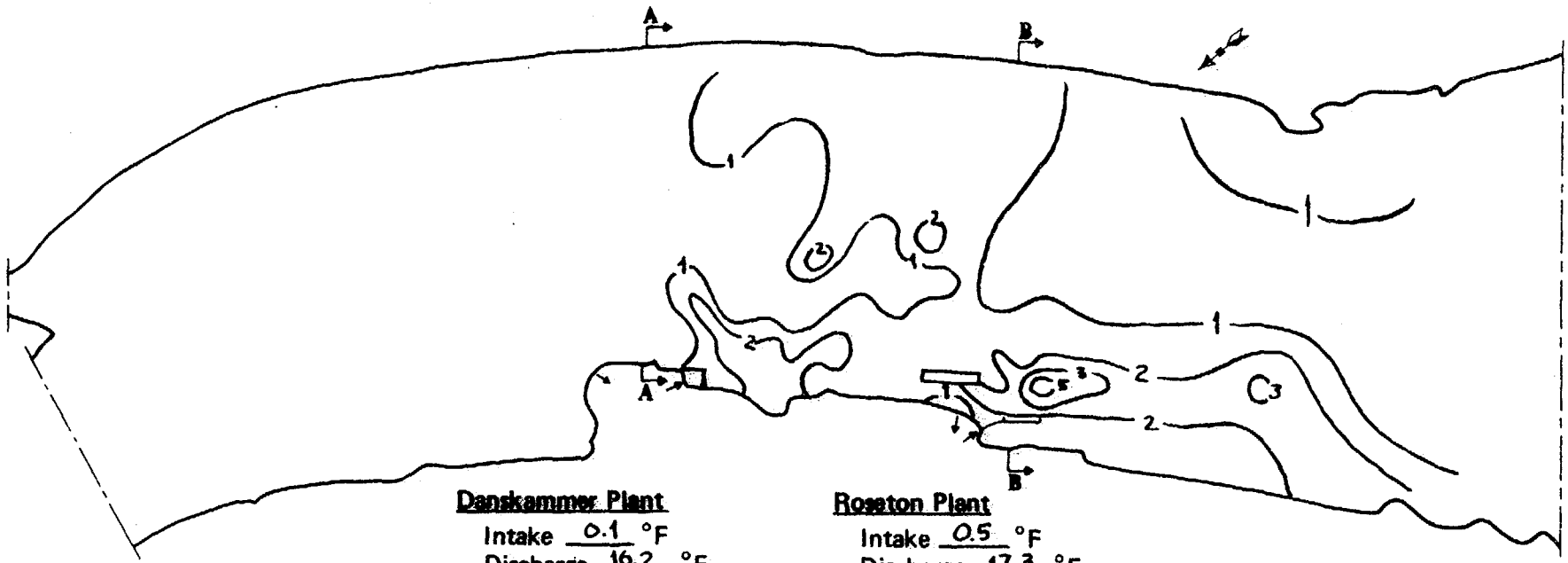
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.1 °F
Discharge 16.2 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.5 °F
Discharge 17.3 °F
ΔT 16.8 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.6 °F

River

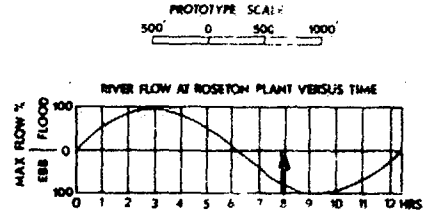
Fresh Water Flow 6000 cfs
Ambient Temperature 78.1 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 101

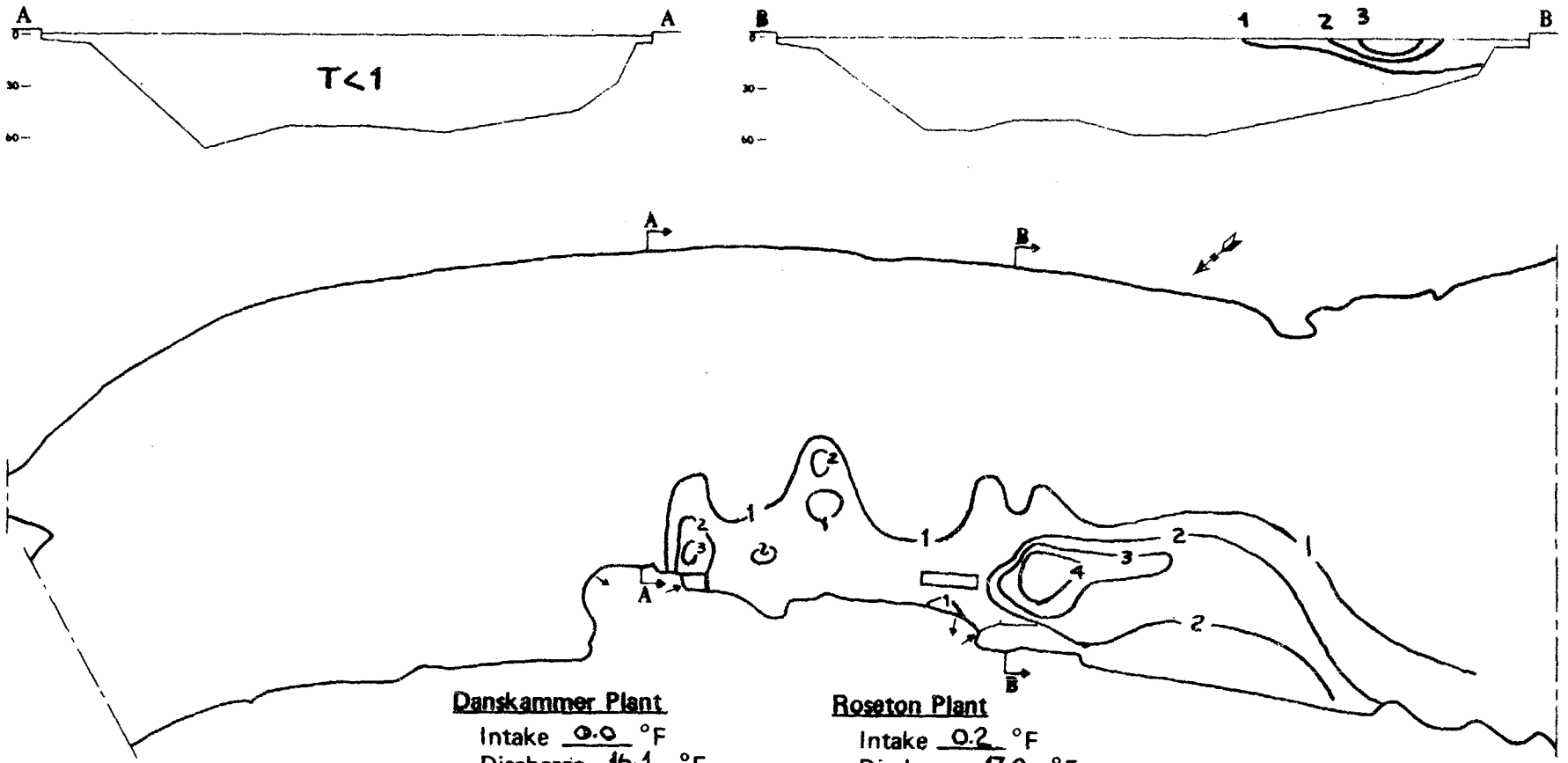


FIGURE A 102

Danskammer Plant

Intake 0.0 °F
Discharge 16.1 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 17.0 °F
ΔT 16.8 °F
Flow 1400 cfs
**Outfall Configuration 1A

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.6 °F

River

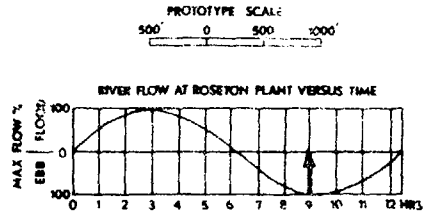
Fresh Water Flow 6000 cfs
Ambient Temperature 78.2 °F

Date 27 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

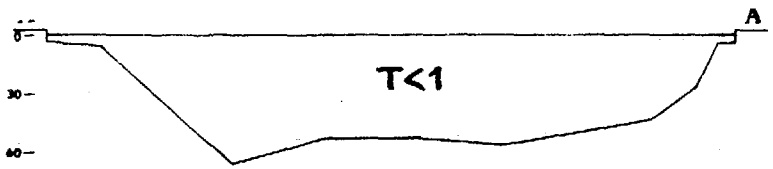
A. With Barge
B. Without Barge

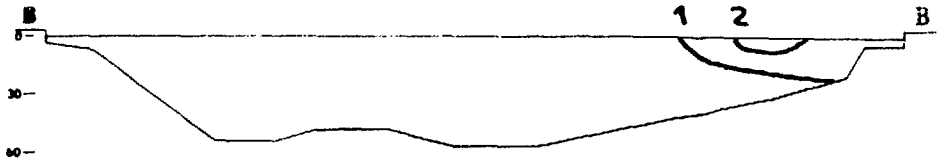


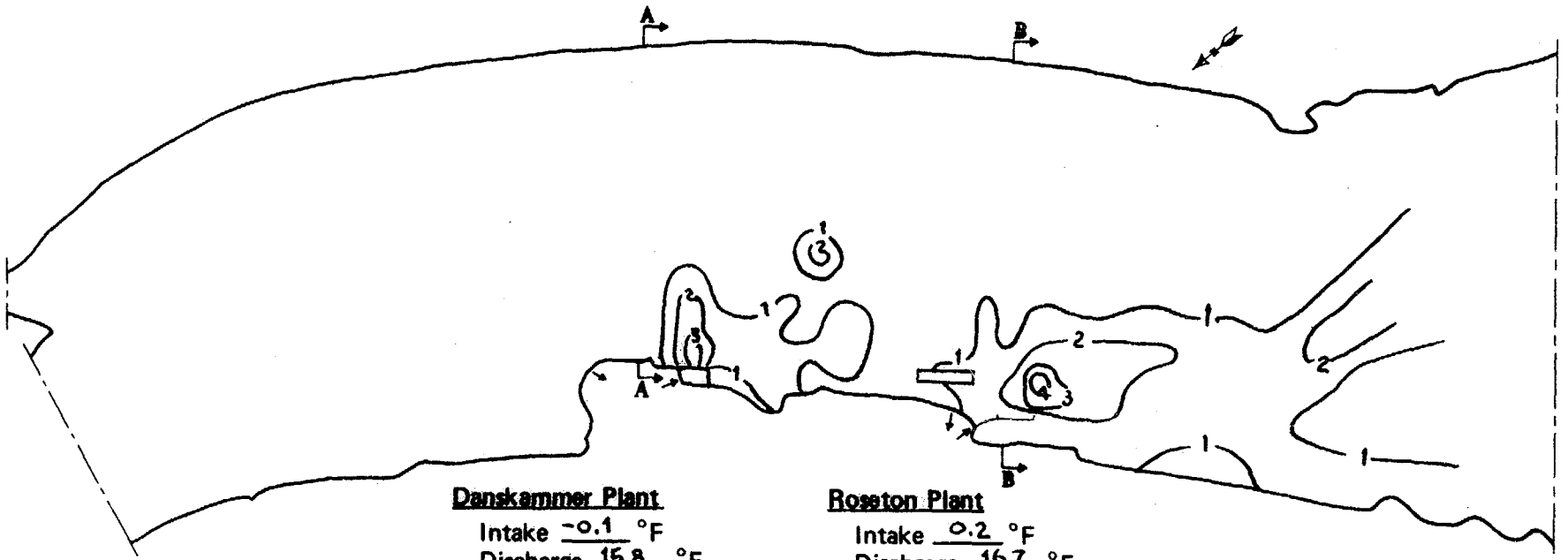
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake -0.1 °F
Discharge 15.8 °F
ΔT 15.9 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 16.7 °F
ΔT 16.5 °F
Flow 1400 cfs
**Outfall Configuration 1A

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature 0.6 °F

River

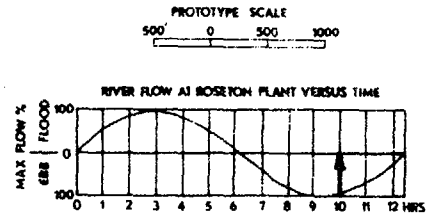
Fresh Water Flow 6000 cfs
Ambient Temperature 78.2 °F

Date 27 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 103

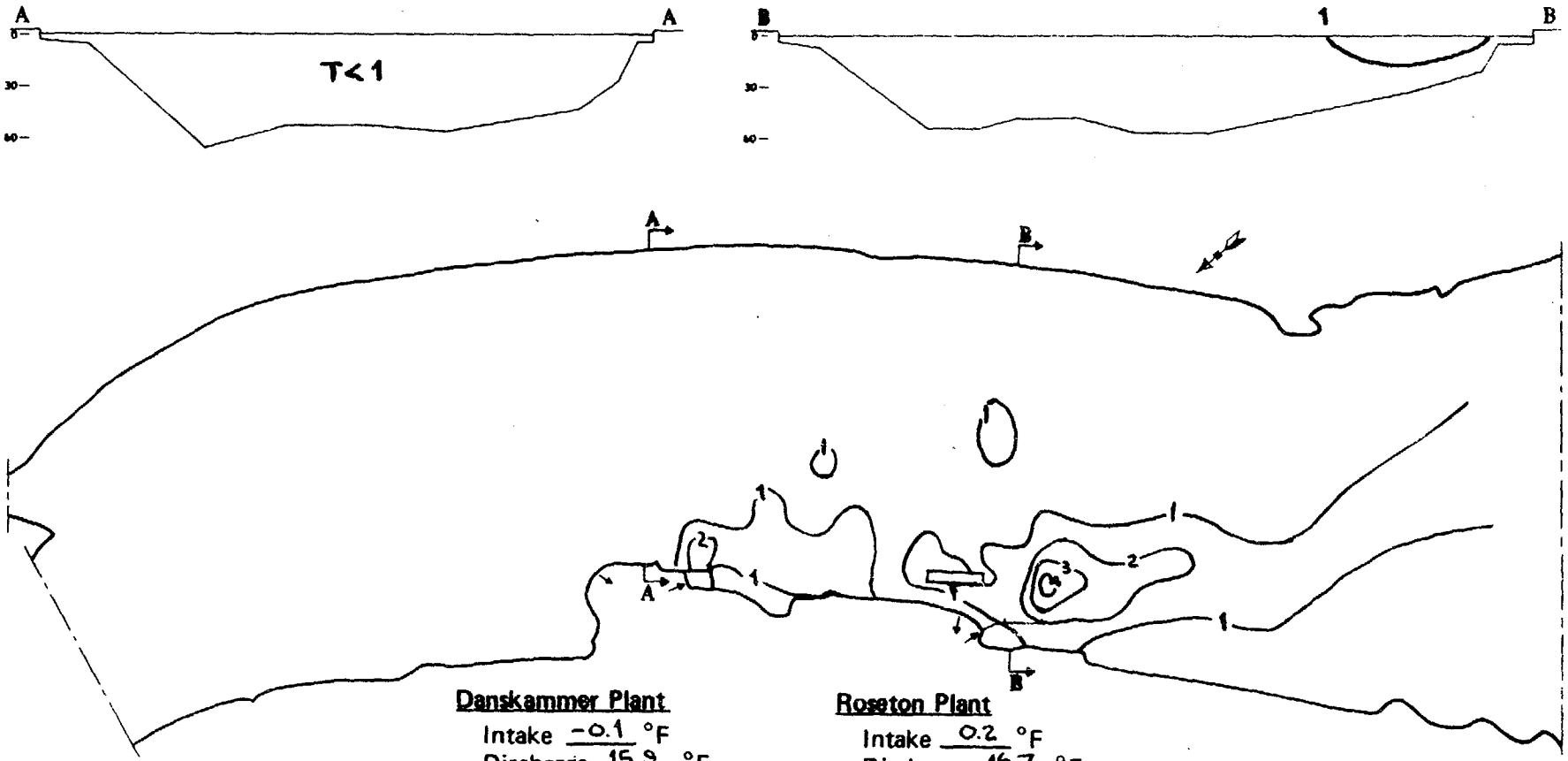


FIGURE A 104

Danskammer Plant

Intake -0.1 °F
Discharge 15.9 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 16.7 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 78.8 °F
Thermal Equilibrium Box Temperature 0.6 °F

River

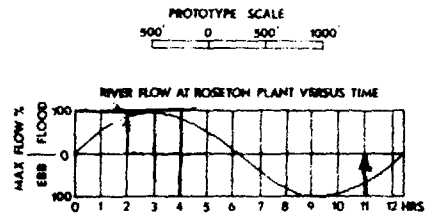
Fresh Water Flow 6000 cfs
Ambient Temperature 78.2 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

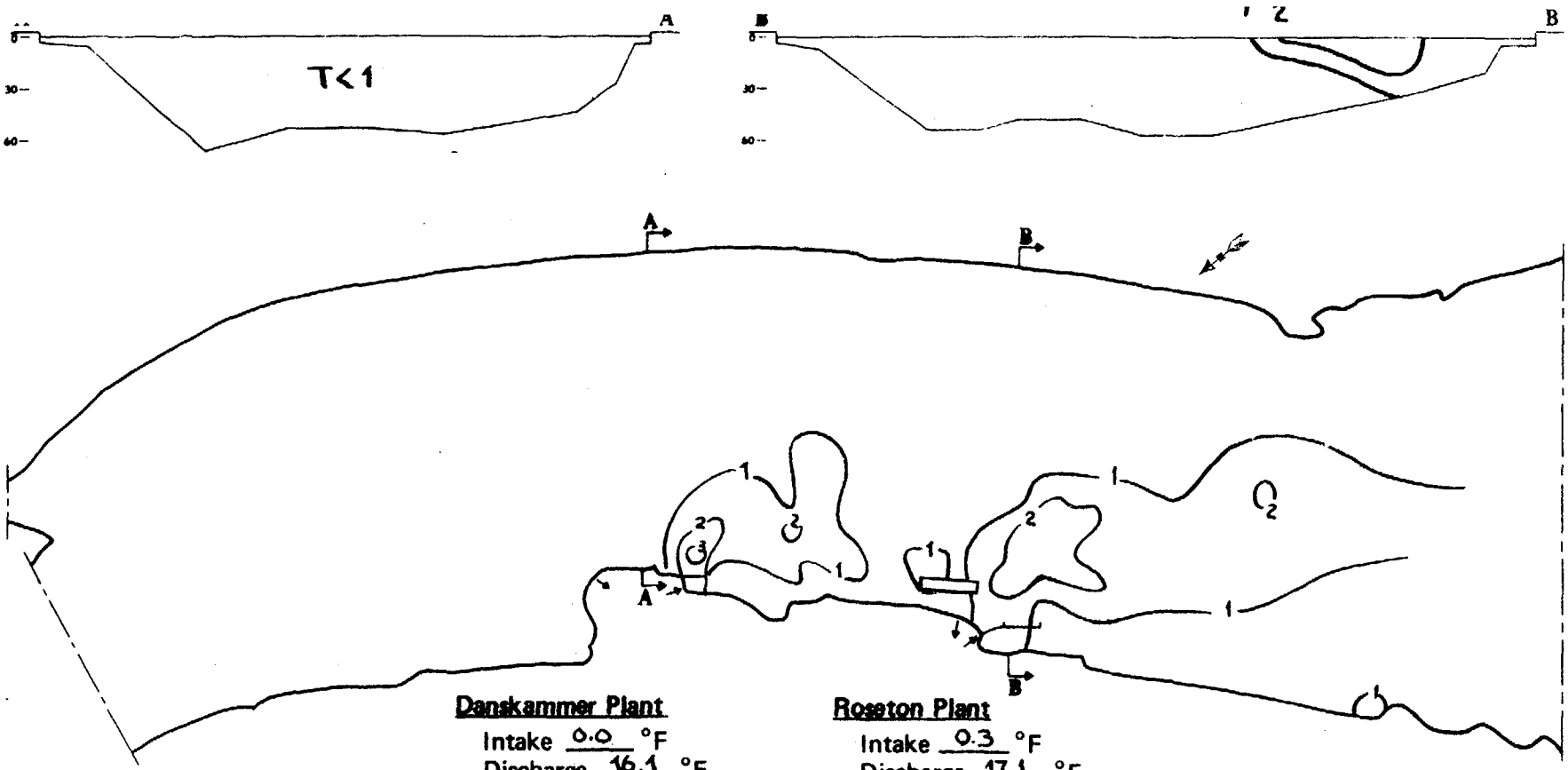
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.0 °F
Discharge 16.1 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.3 °F
Discharge 17.1 °F
ΔT 16.8 °F
Flow 1400 cfs
** Outfall Configuration 1A

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 78.7 °F
Thermal Equilibrium Box Temperature 0.5 °F

River

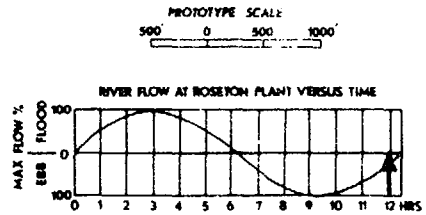
Fresh Water Flow 9000 cfs
Ambient Temperature 78.2 °F

Date 27 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 105

DANSKAMMER

LOAD	100%
DISCHARGE DESIGN	BULKHEAD
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	17.1 F

ROSETON

LOAD	100%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	16.7 F
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	76.7 F
FRESH WATER FLOW	6000 CFS

TEST DATE 28 SEPT. 1972

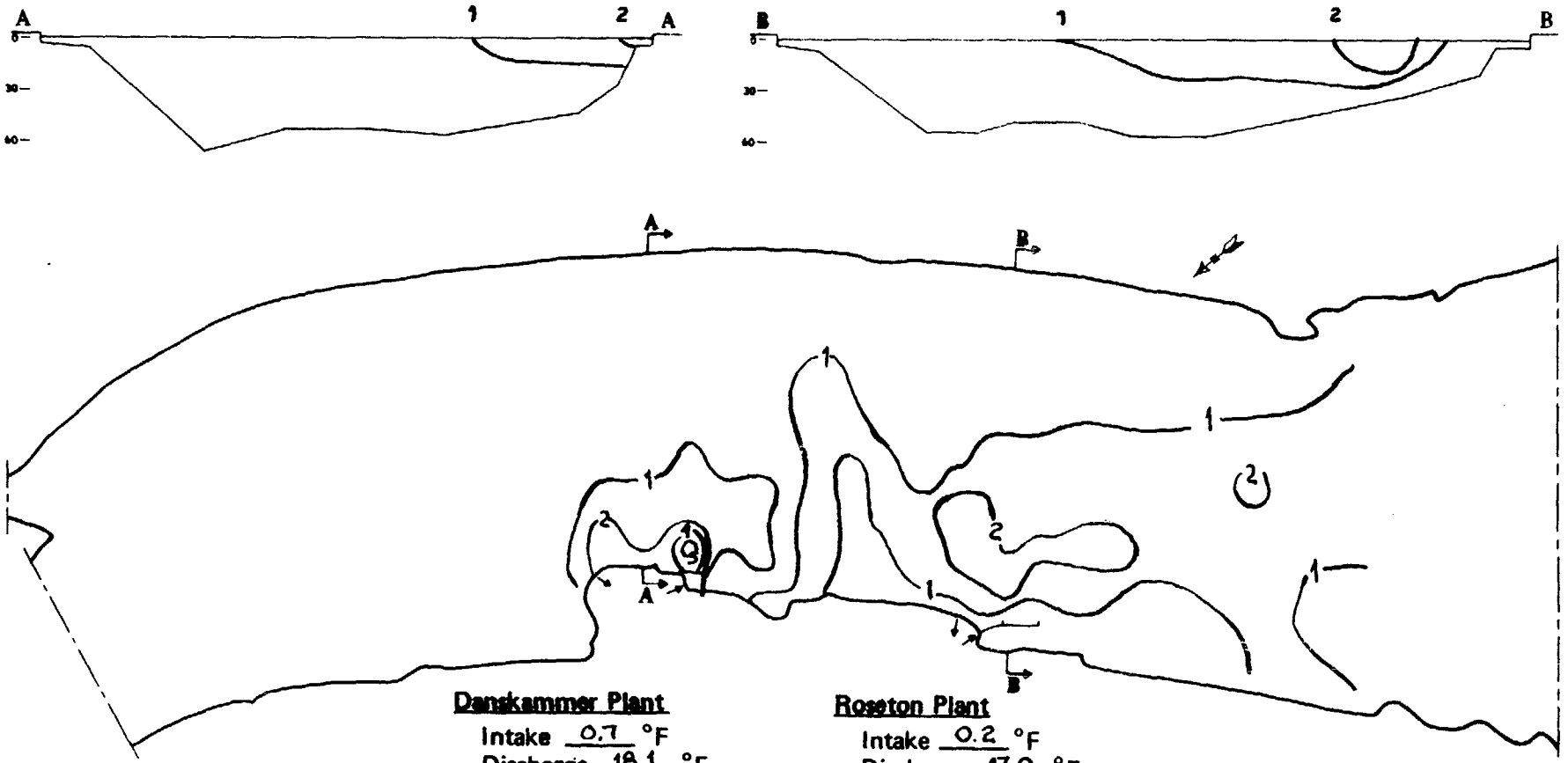


FIGURE A 106

Danskammer Plant

Intake 0.7 °F
Discharge 18.1 °F
ΔT 17.4 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 17.0 °F
ΔT 16.8 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 77.0 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

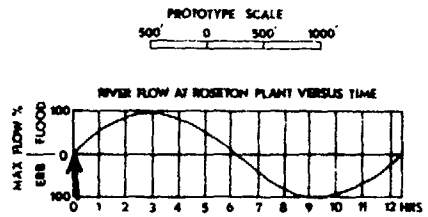
Fresh Water Flow 6000 cfs
Ambient Temperature 76.4 °F

Date 28 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

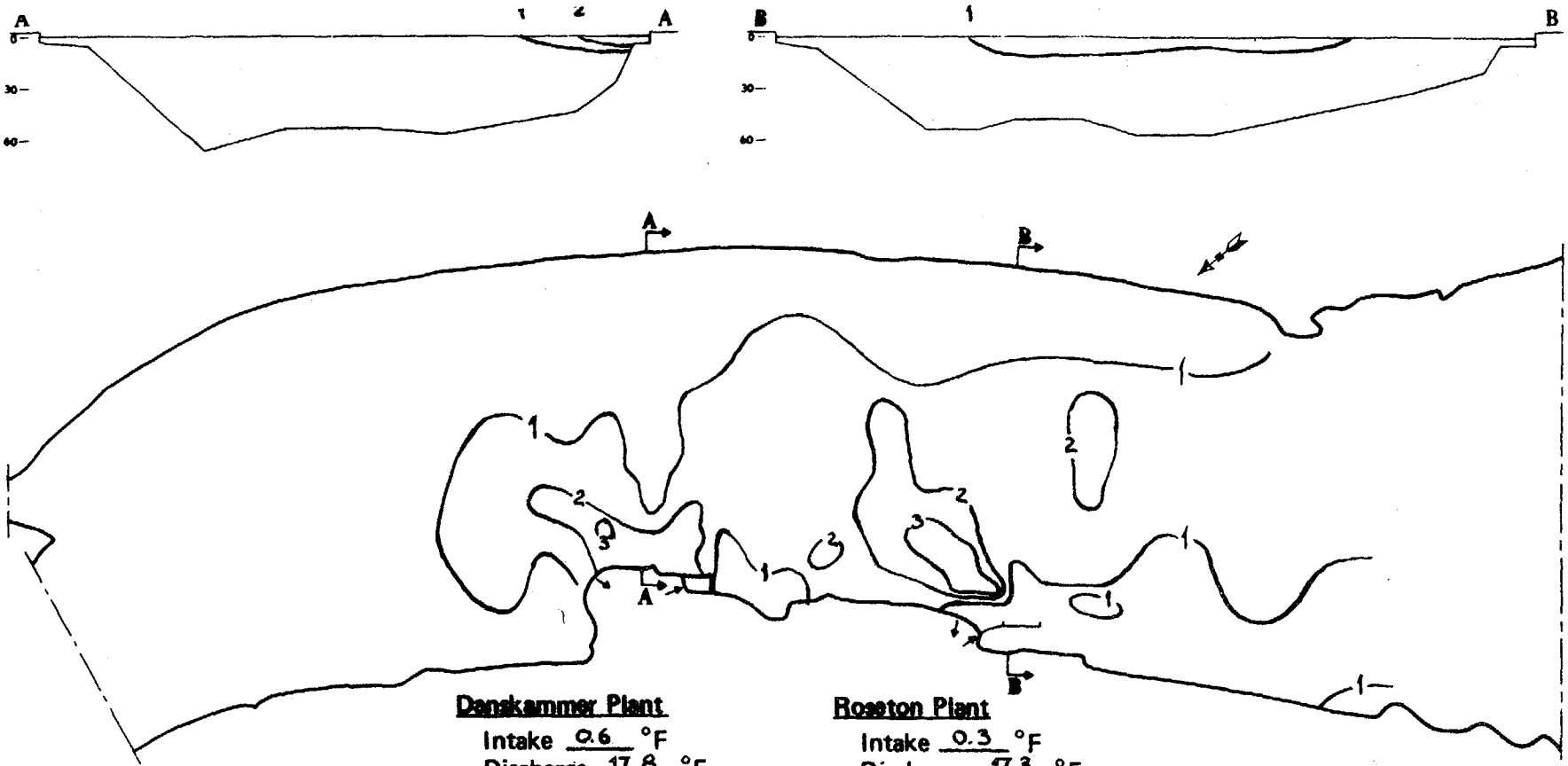
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.6 °F
Discharge 17.8 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.3 °F
Discharge 17.3 °F
ΔT 17.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 76.9 °F
Thermal Equilibrium Box Temperature -0.8 °F

River

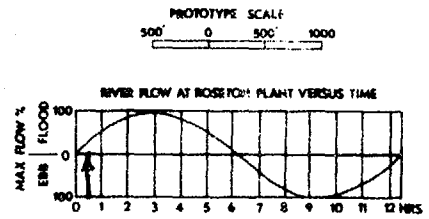
Fresh Water Flow 6000 cfs
Ambient Temperature 76.5 °F

Date 28 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

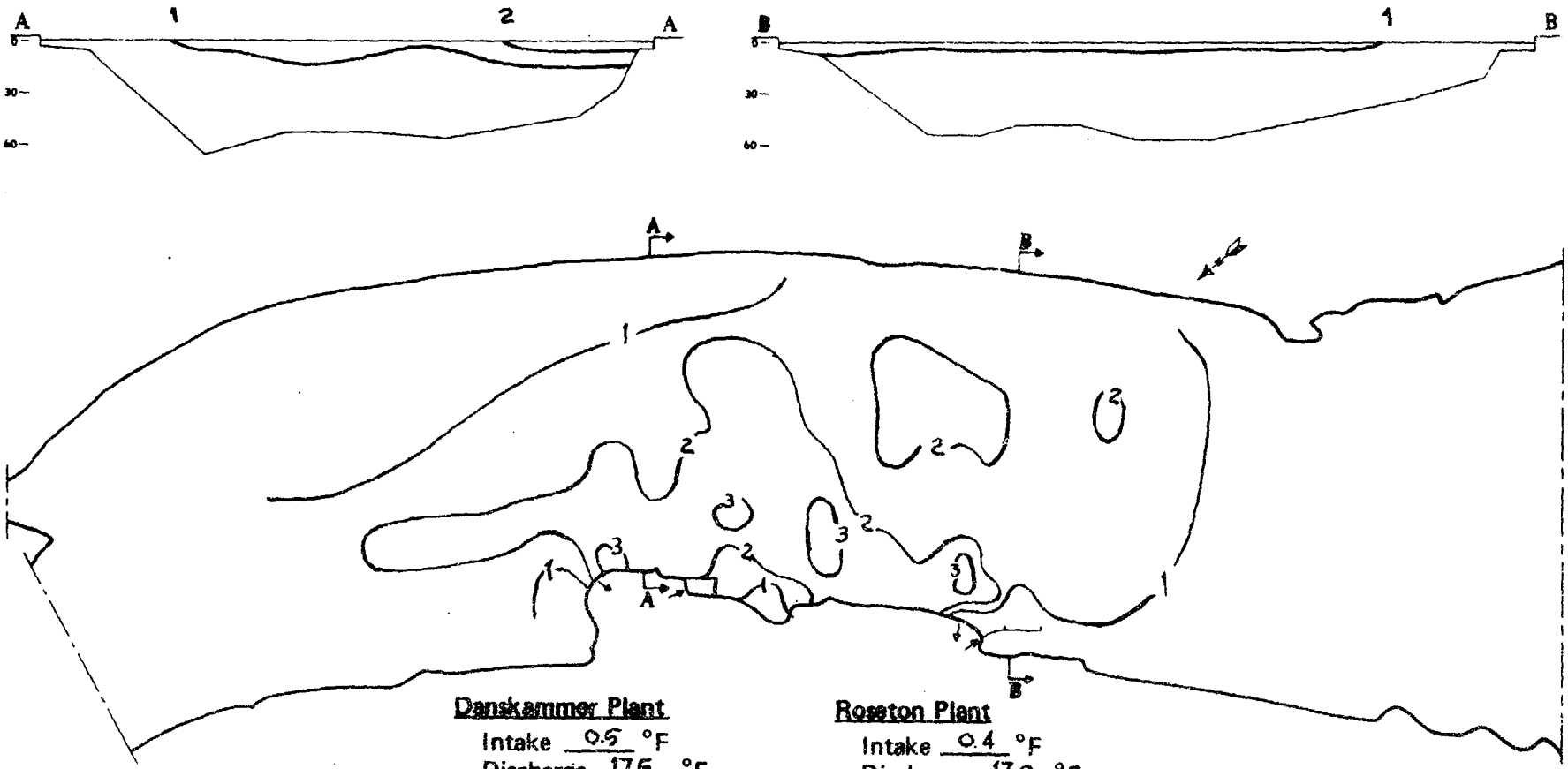


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 107



Danskammer Plant

Intake 0.5 °F
Discharge 17.5 °F
ΔT 17.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.4 °F
Discharge 17.0 °F
ΔT 16.6 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 85 %
Dry Bulb Temperature 77.0 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

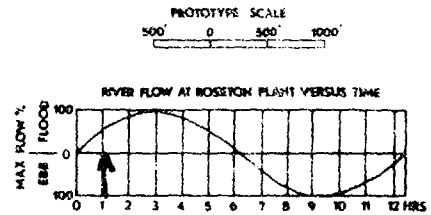
Fresh Water Flow 6000 cfs
Ambient Temperature 76.5 °F

Date 28 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

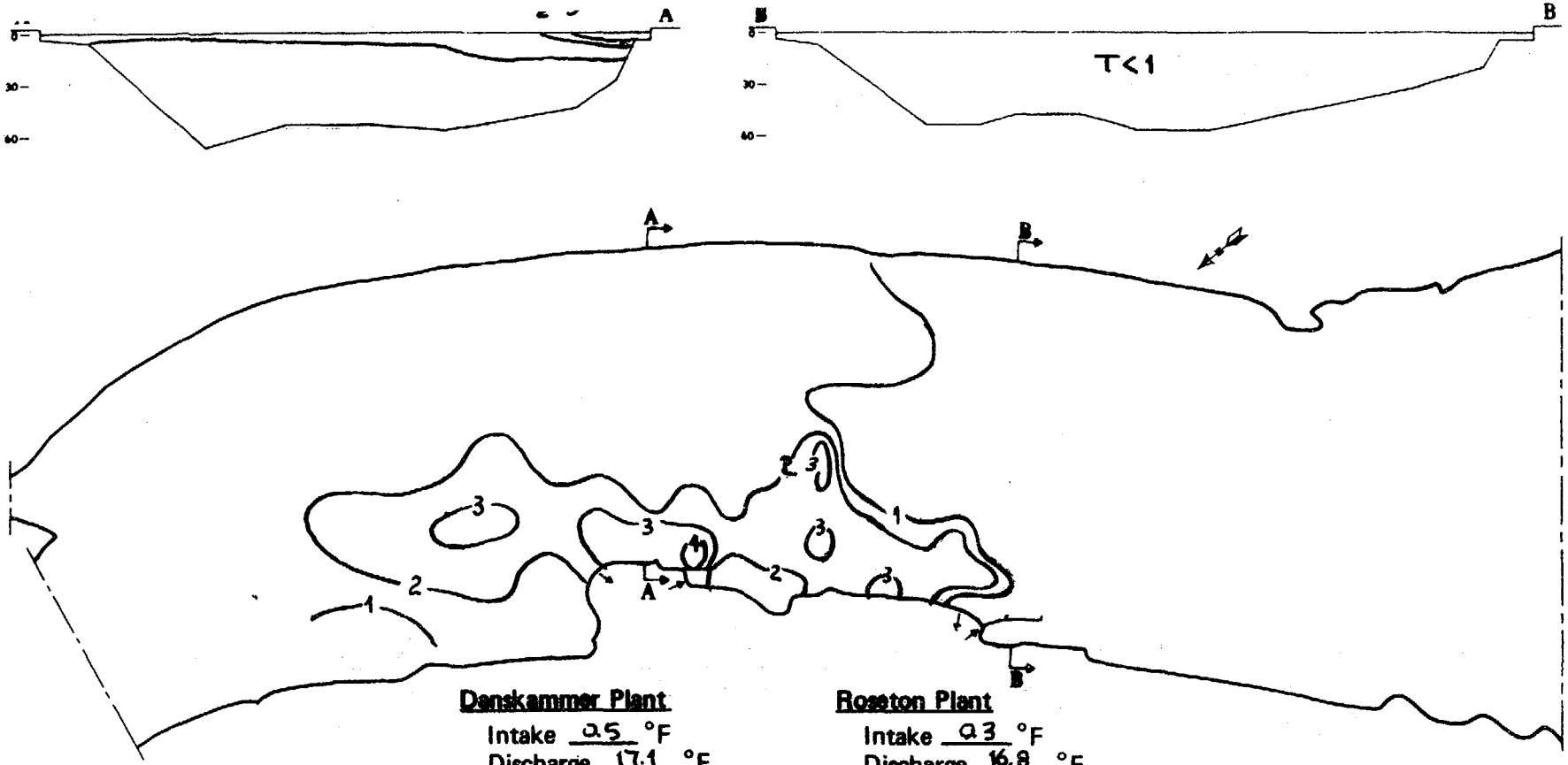


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 108



Danskammer Plant

Intake 85 °F
Discharge 17.1 °F
ΔT 16.6 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 83 °F
Discharge 16.8 °F
ΔT 16.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 86 %
Dry Bulb Temperature 76.9 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

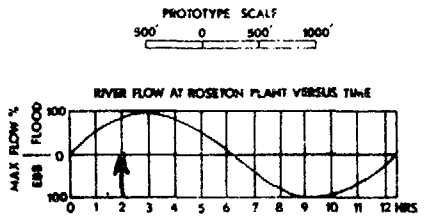
Fresh Water Flow 6000 cfs
Ambient Temperature 76.5 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 109

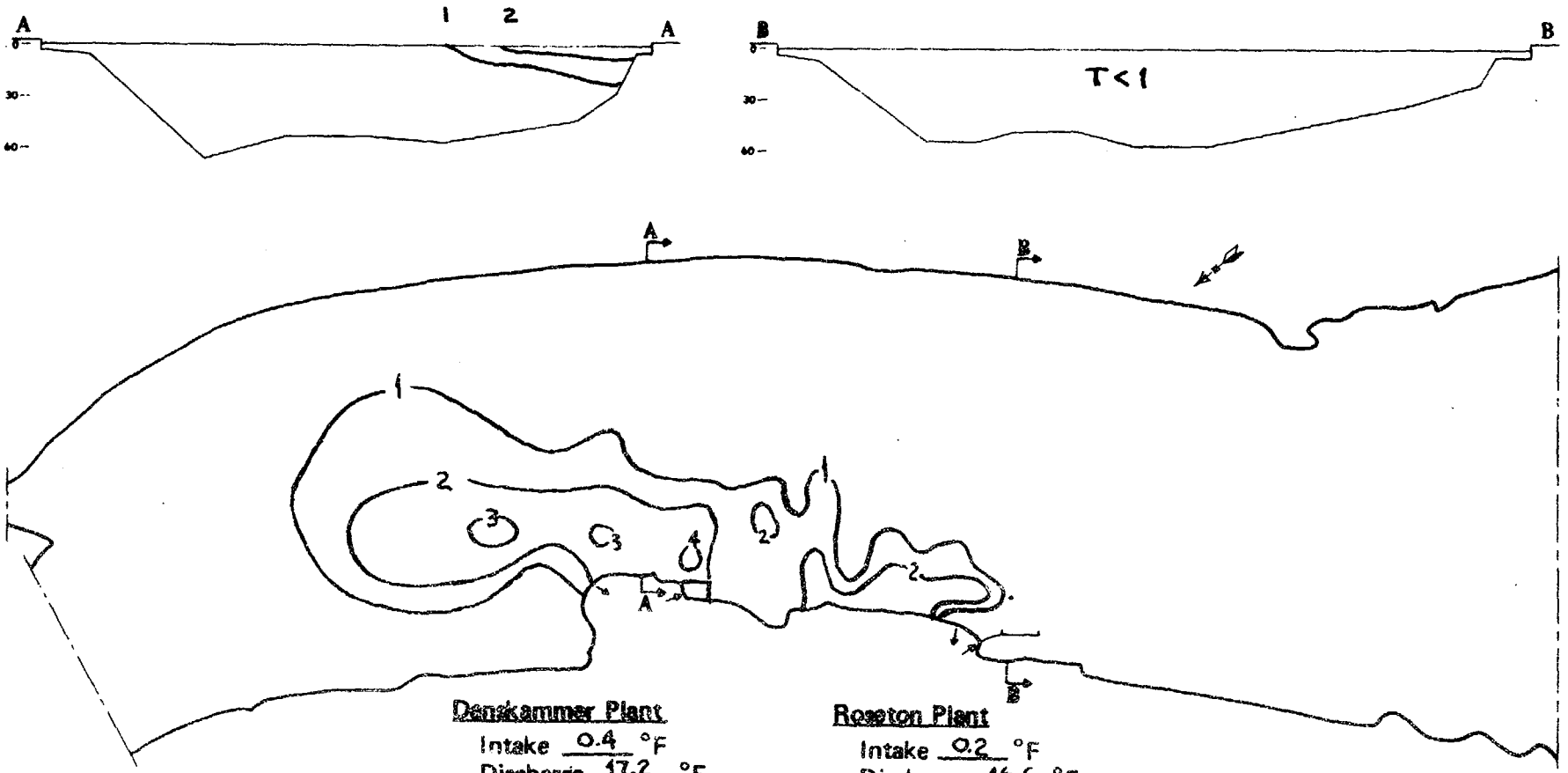


FIGURE A 110

Danskammer Plant

Intake 0.4 °F
Discharge 17.2 °F
ΔT 16.8 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 16.6 °F
ΔT 16.4 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 77.2 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

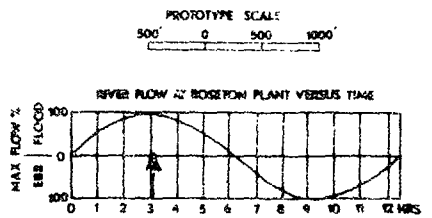
Fresh Water Flow 6000 cfs
Ambient Temperature 76.6 °F

Date 28 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

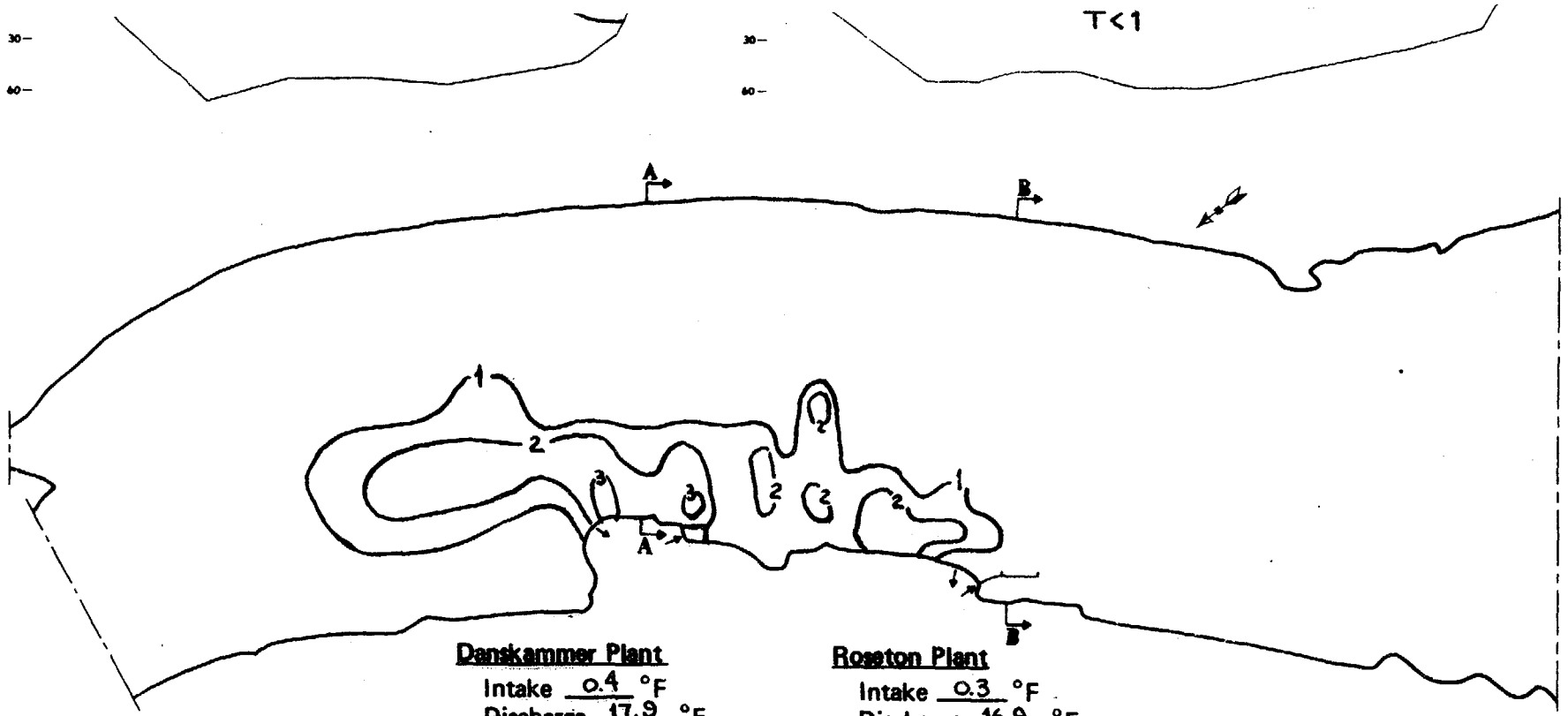
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake 0.4 °F
Discharge 17.9 °F
ΔT 17.5 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.3 °F
Discharge 16.9 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 77.3 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

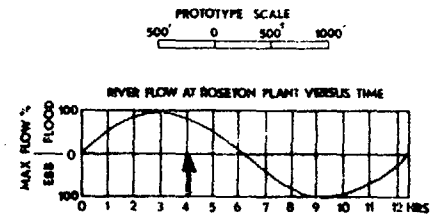
Fresh Water Flow 6000 cfs
Ambient Temperature 76.6 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

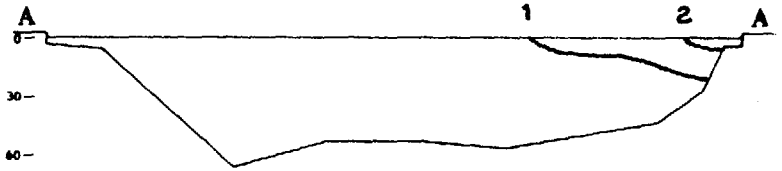


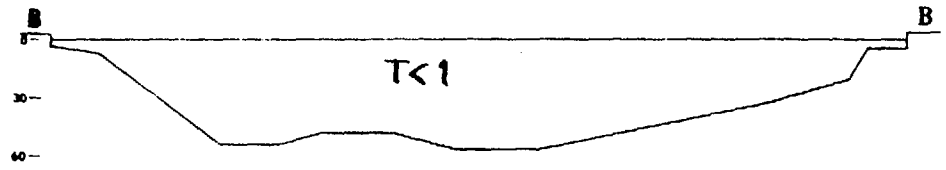
TEMPERATURE RISE ABOVE RIVER AMBIENT

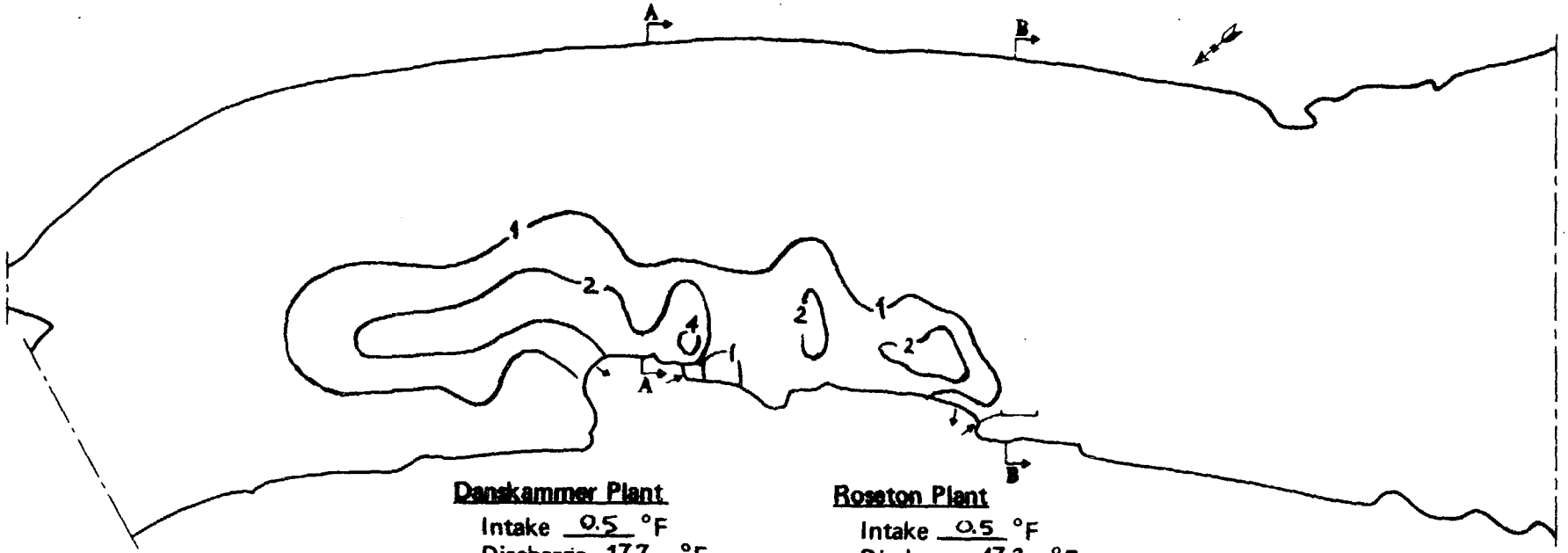
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A III







Danskammer Plant

Intake 0.5 °F
Discharge 17.7 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.5 °F
Discharge 17.2 °F
ΔT 16.7 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

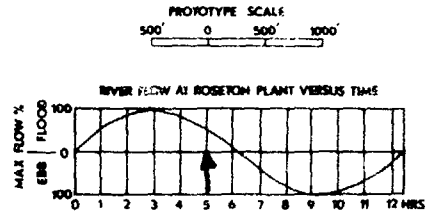
Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 77.1 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 76.7 °F

Date 28 SEPT 72

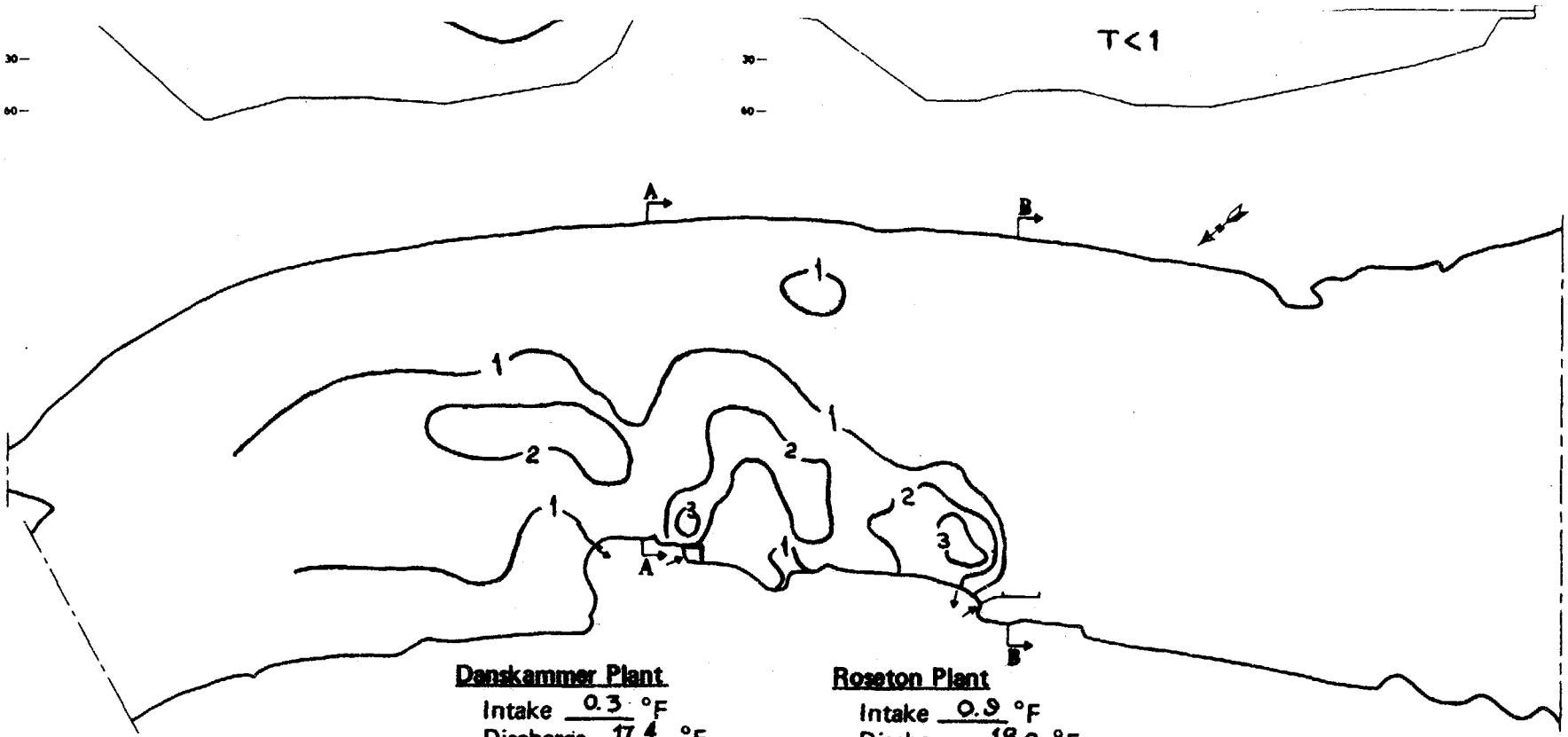


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 112



Danskammer Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.9 °F
Discharge 18.0 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 87 %
Dry Bulb Temperature 77.4 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

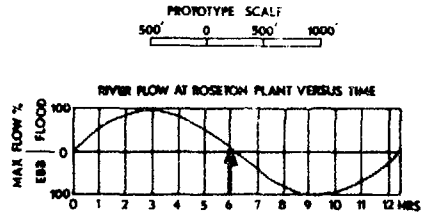
Fresh Water Flow 6000 cfs
Ambient Temperature 76.7 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 113

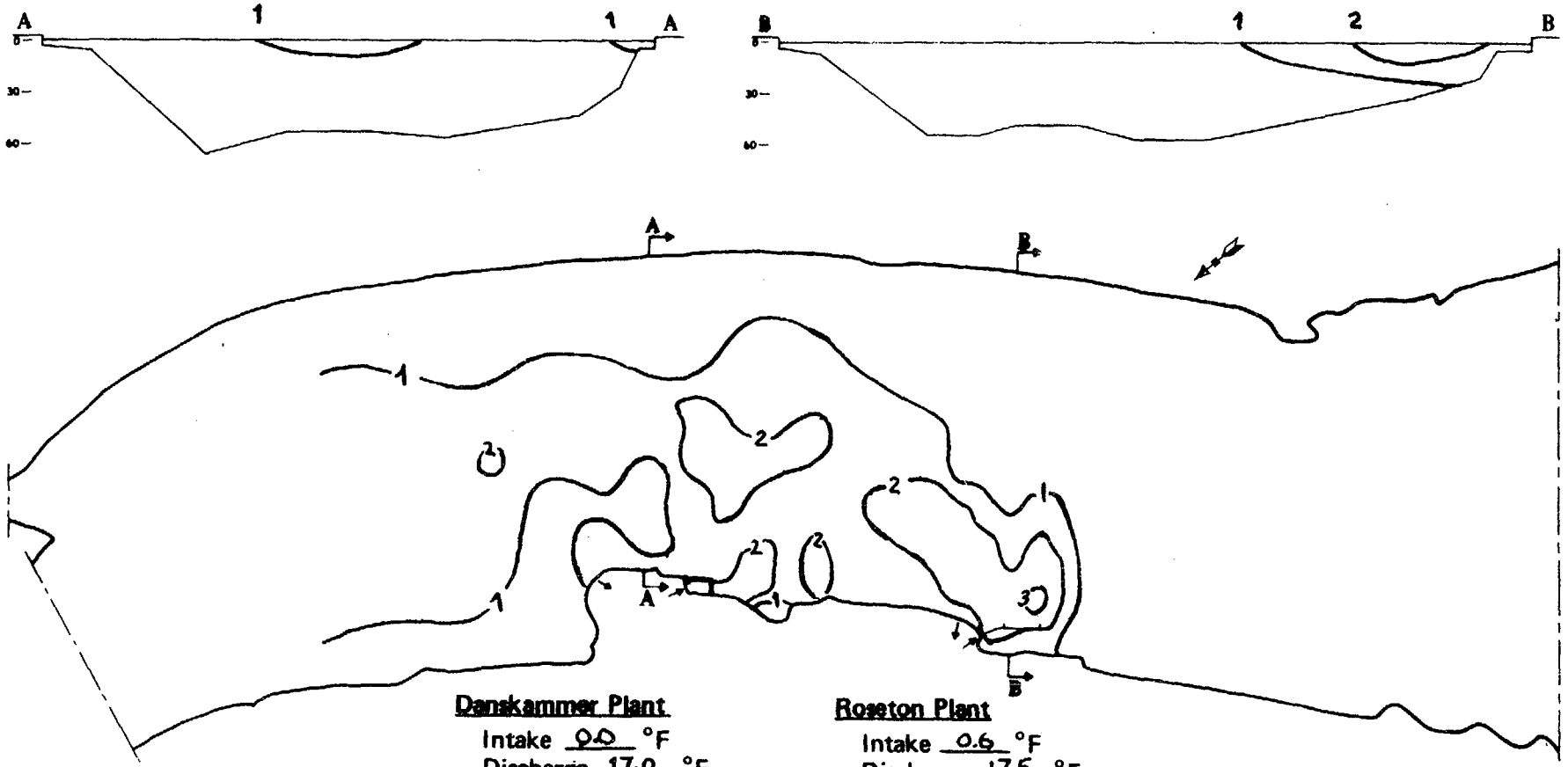


FIGURE A 114

Danskammer Plant

Intake 0.0 °F
Discharge 17.0 °F
ΔT 17.0 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.6 °F
Discharge 17.5 °F
ΔT 16.9 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 77.7 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

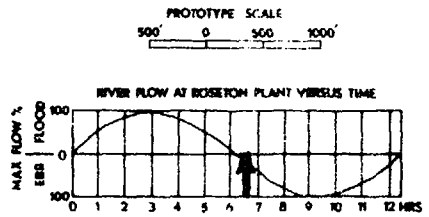
Fresh Water Flow 6000 cfs
Ambient Temperature 76.7 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

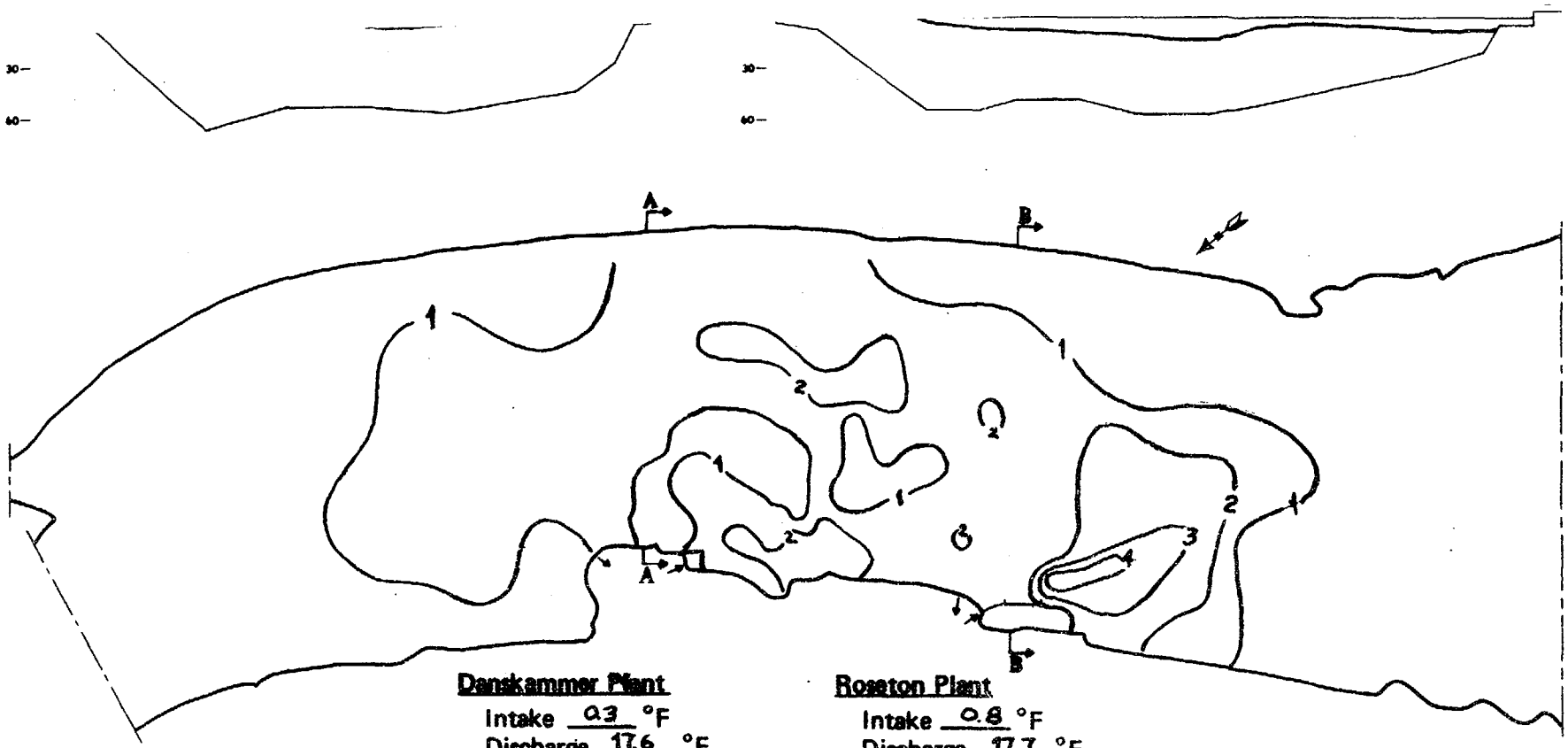
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 63 °F
Discharge 77.6 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 60.8 °F
Discharge 77.7 °F
ΔT 16.9 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 77.7 °F
Thermal Equilibrium Box Temperature 70.4 °F

River

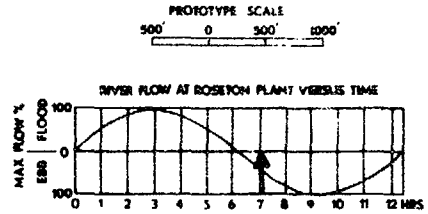
Fresh Water Flow 6000 cfs
Ambient Temperature 76.7 °F

Date 28 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

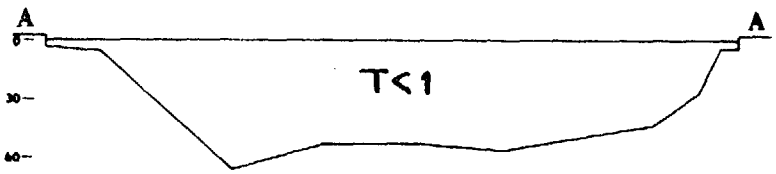


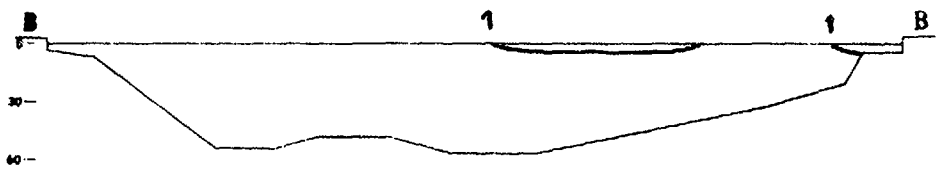
TEMPERATURE RISE ABOVE RIVER AMBIENT

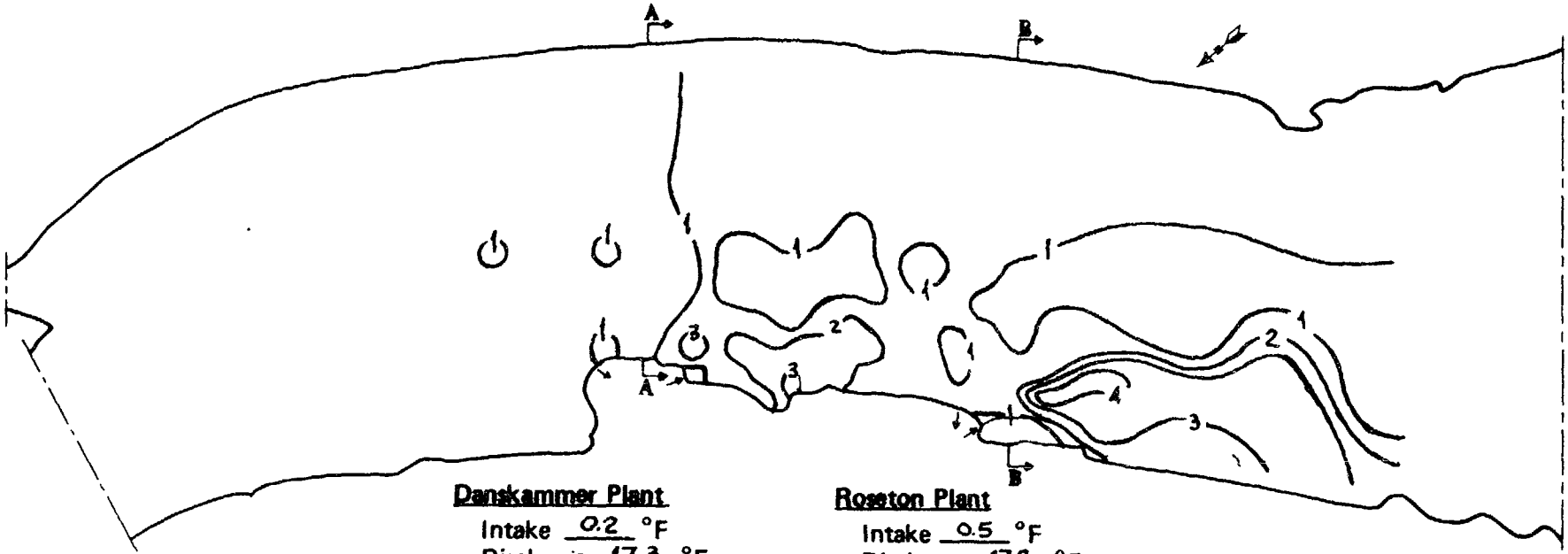
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 115







Danskammer Plant

Intake 0.2 °F
Discharge 17.3 °F
ΔT 17.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.5 °F
Discharge 17.2 °F
ΔT 16.7 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

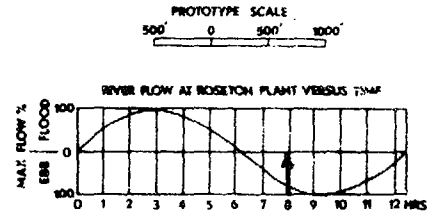
Room Atmosphere

Relative Humidity 85 %
Dry Bulb Temperature 77.7 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 76.8° F

Date 28 SEPT. 72

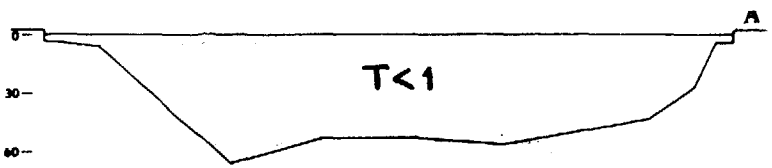


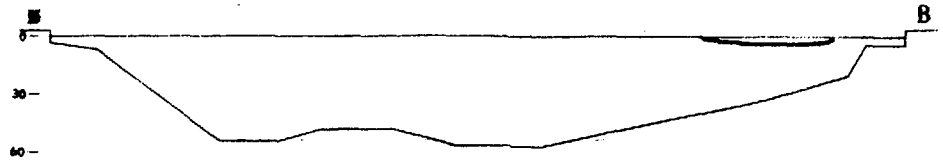
TEMPERATURE RISE ABOVE RIVER AMBIENT

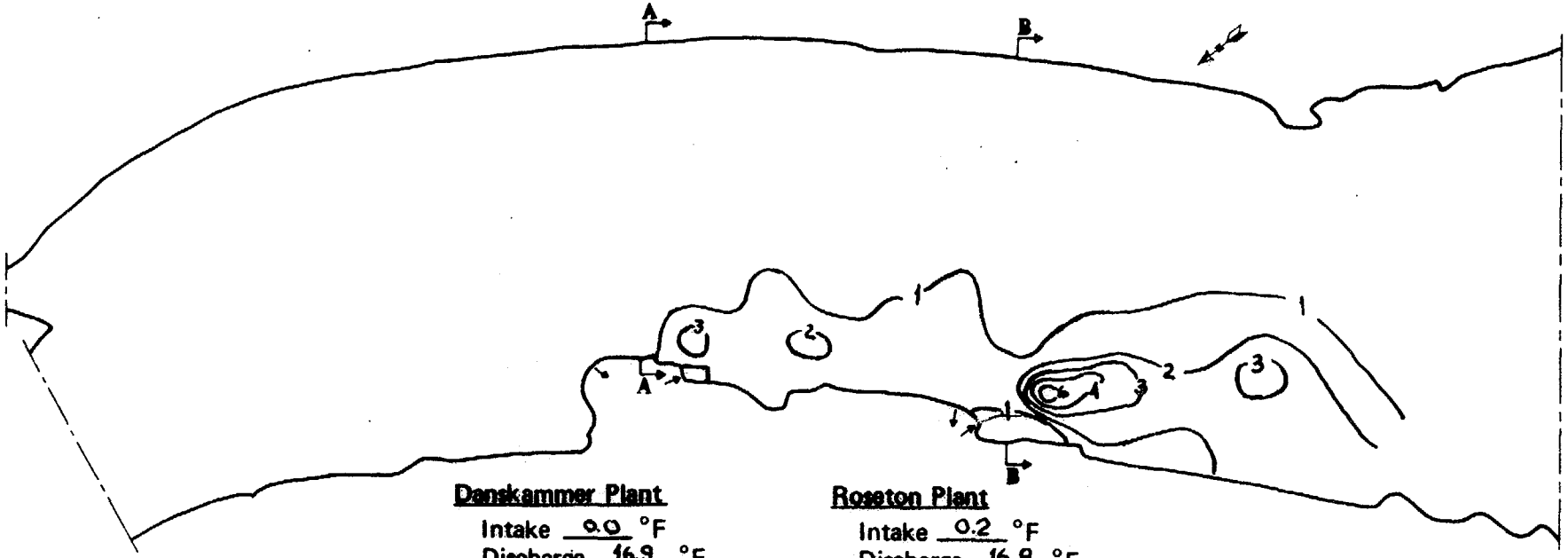
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 116







Danskammer Plant

Intake 0.0 °F
Discharge 16.9 °F
ΔT 16.9 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 16.8 °F
ΔT 16.6 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 85 %
Dry Bulb Temperature 77.3 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

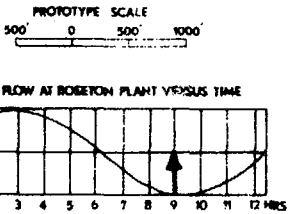
Fresh Water Flow 6000 cfs
Ambient Temperature 76.8 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

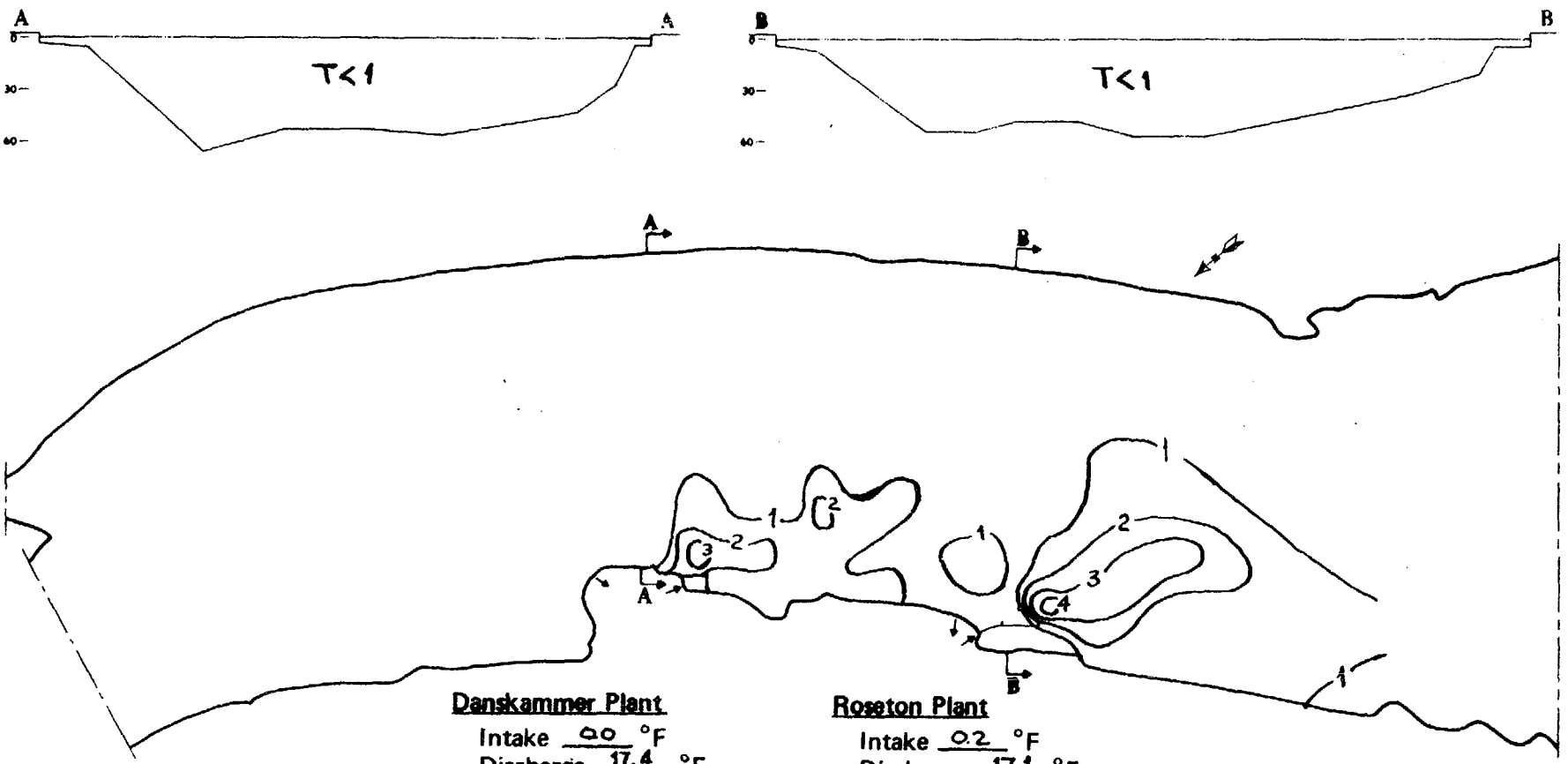


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 117



Danskammer Plant

Intake 60 °F
Discharge 77.4 °F
ΔT 17.4 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 60.2 °F
Discharge 77.1 °F
ΔT 16.9 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

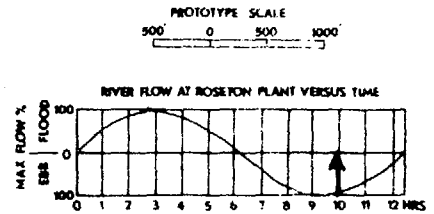
Room Atmosphere

Relative Humidity 84 %
Dry Bulb Temperature 77.4 °F
Thermal Equilibrium Box Temperature 76.3 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 76.8 °F

Date 28 SEPT. 72

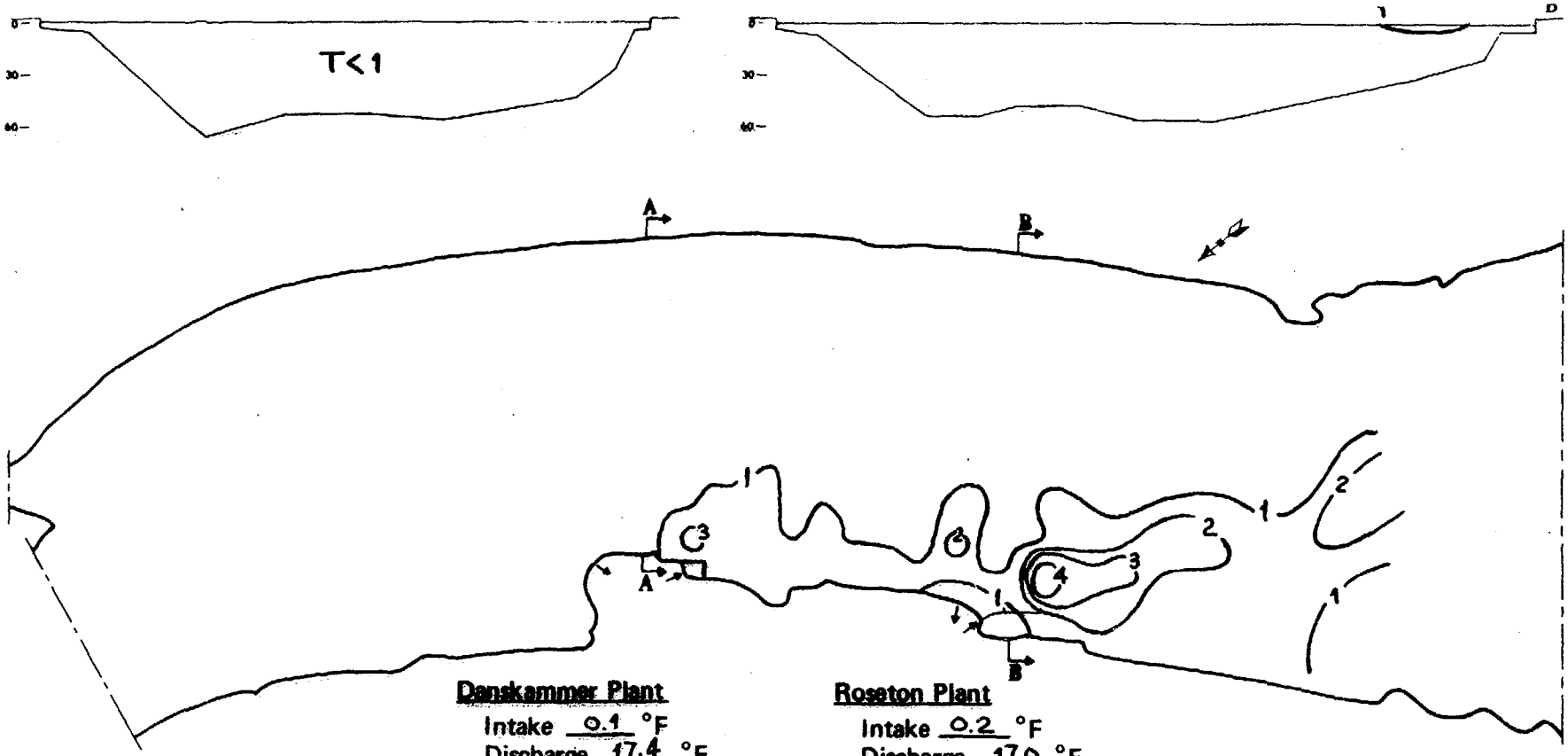


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 118



Danskammer Plant

Intake 0.1 °F
Discharge 17.4 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 17.0 °F
ΔT 16.8 °F
Flow 1400 cfs
**Outfall Configuration 1B

Room Atmosphere

Relative Humidity 82 %
Dry Bulb Temperature 77.2 °F
Thermal Equilibrium Box Temperature -93 °F

River

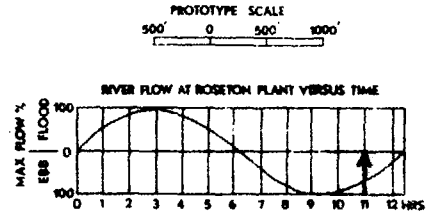
Fresh Water Flow 6000 cfs
Ambient Temperature 76.8° F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

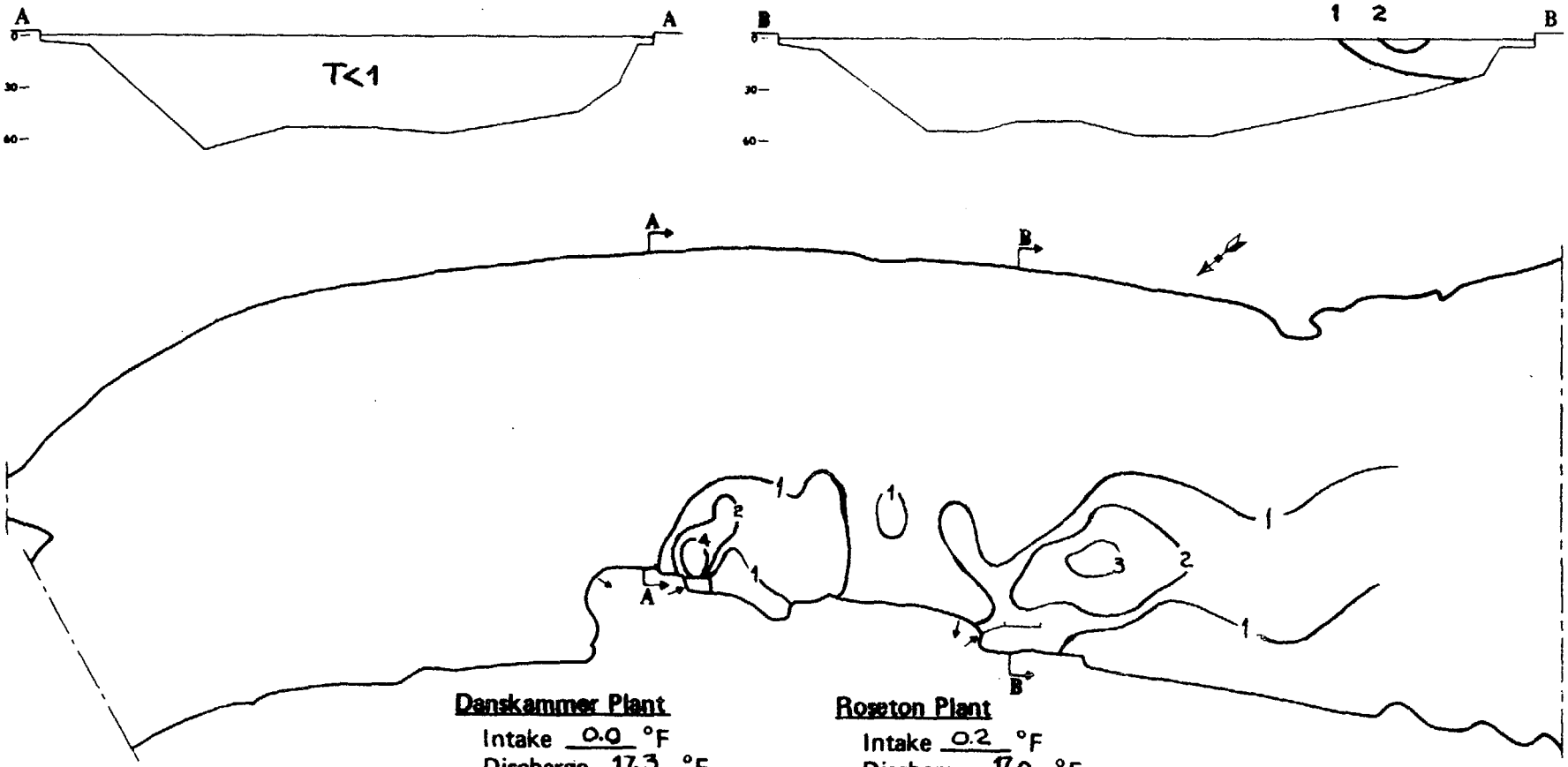


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 119



Danskammer Plant

Intake 0.0 °F
Discharge 17.3 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake 0.2 °F
Discharge 17.0 °F
ΔT 16.8 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 82 %
Dry Bulb Temperature 76.9 °F
Thermal Equilibrium Box Temperature -0.2 °F

River

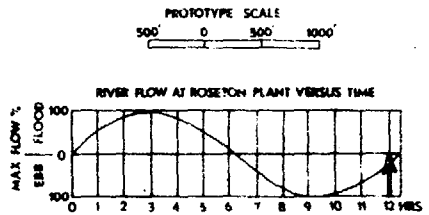
Fresh Water Flow 6000 cfs
Ambient Temperature 76.9 °F

Date 28 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 120

DANSKAMMER

LOAD	100%
DISCHARGE DESIGN	BULKHEAD
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	18.1 F

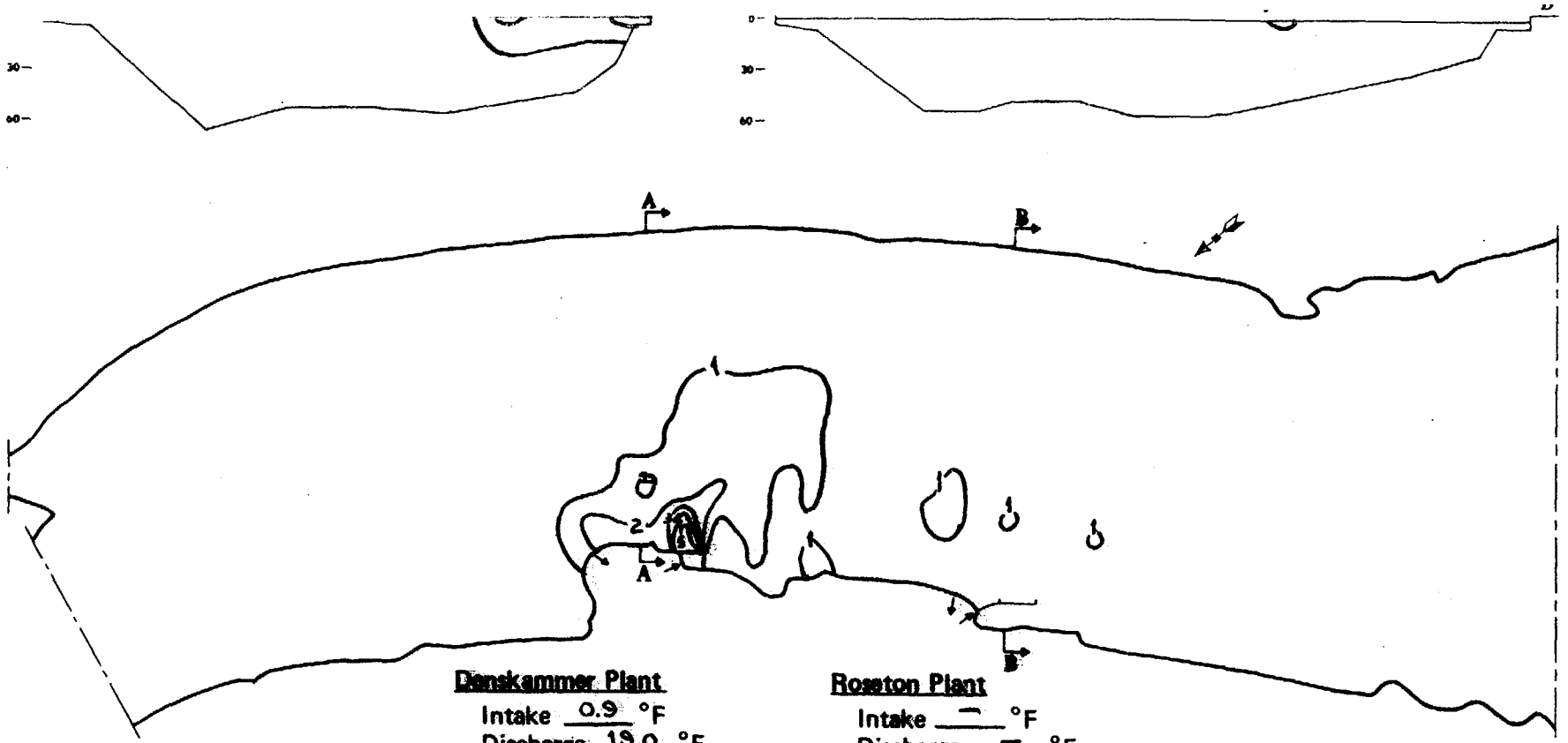
ROSETON NOT OPERATING

LOAD	
DISCHARGE DESIGN	
DISCHARGE FLOW	
TEMPERATURE RISE	
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	74.6 F
FRESH WATER FLOW	6000 CFS

TEST DATE 29 SEPT. 1972



Danskammer Plant

Intake 0.9 °F
Discharge 19.0 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 75.5 °F
Thermal Equilibrium Box Temperature -1.0 °F

River

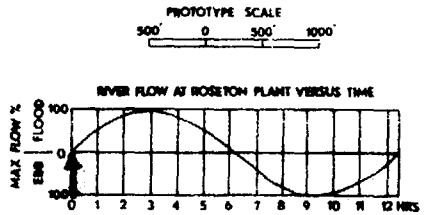
Fresh Water Flow 6000 cfs
Ambient Temperature 74.3 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

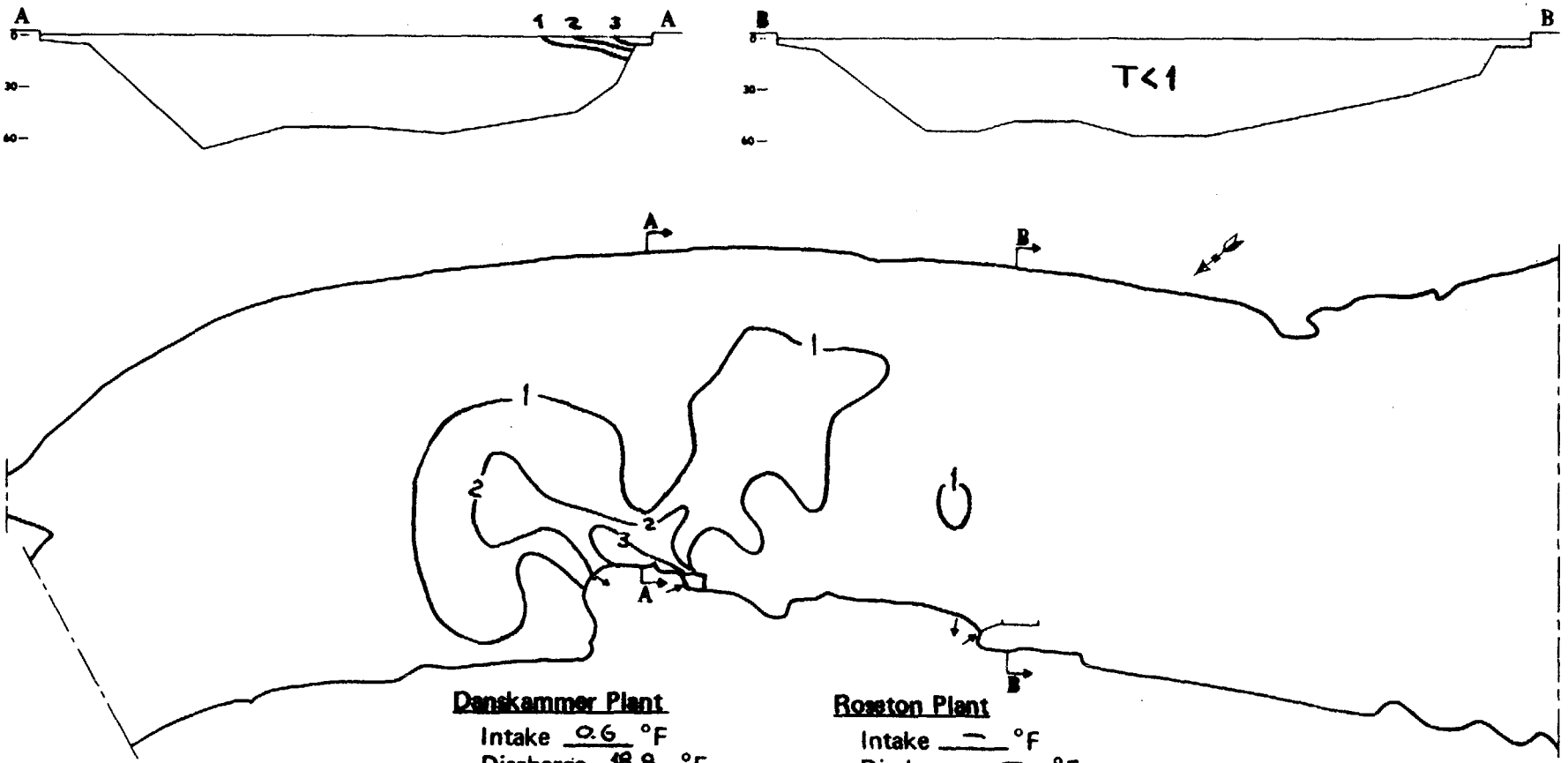


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 121



Danskammer Plant

Intake 0.6 °F
Discharge 18.8 °F
ΔT 18.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 75.5 °F
Thermal Equilibrium Box Temperature -0.9 °F

River

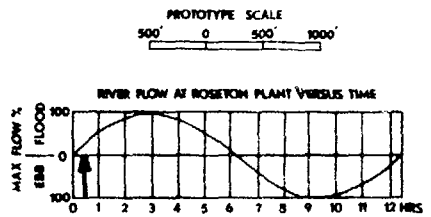
Fresh Water Flow 6000 cfs
Ambient Temperature 74.3 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

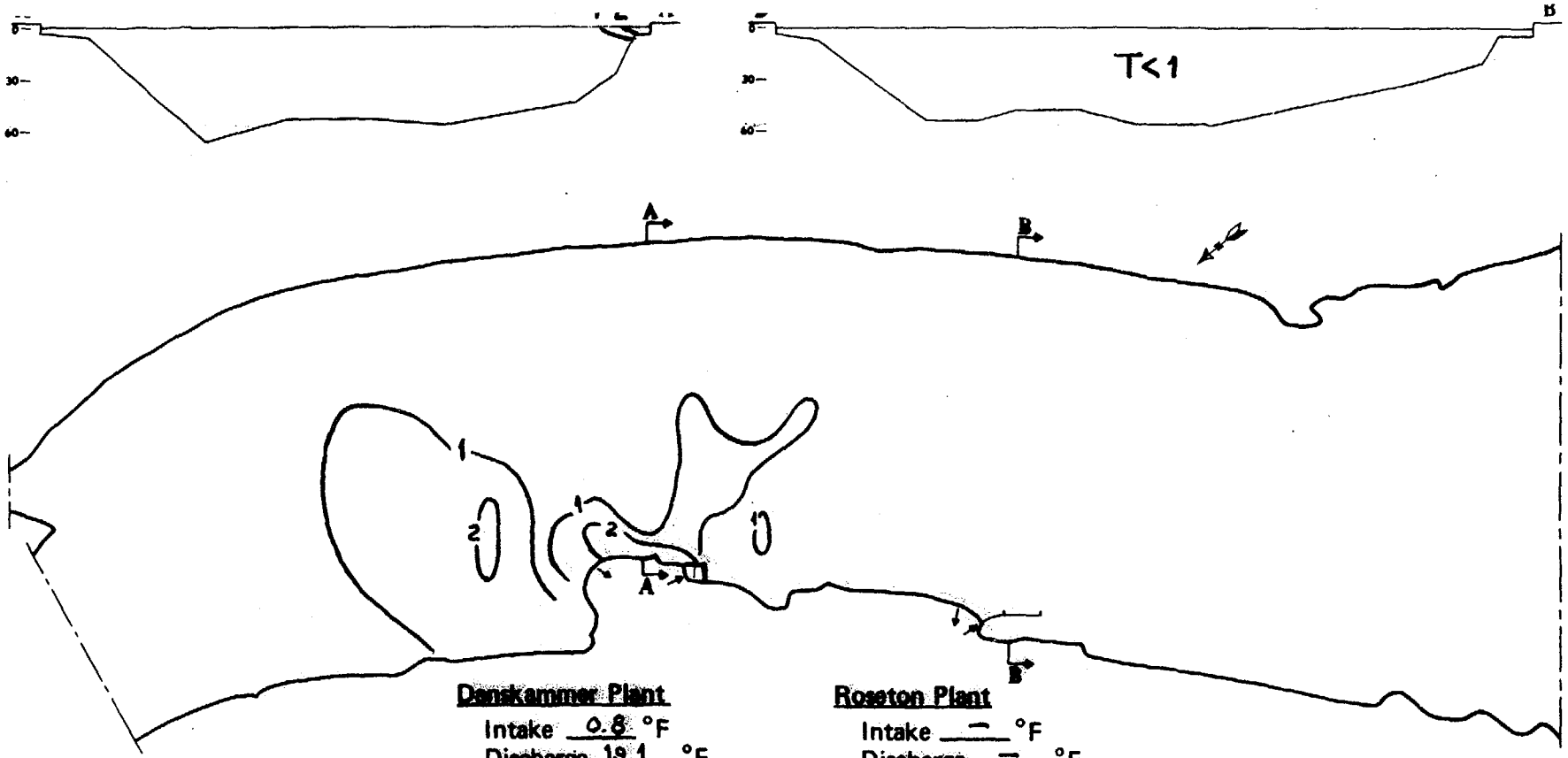


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 122



Danskammer Plant

Intake 0.8 °F
Discharge 19.1 °F
ΔT 18.3 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 75.6 °F
Thermal Equilibrium Box Temperature -1.0 °F

River

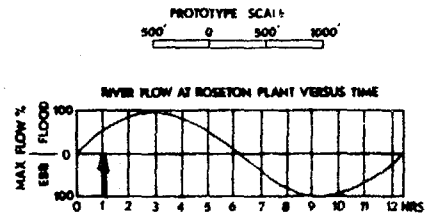
Fresh Water Flow 6000 cfs
Ambient Temperature 74.3 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

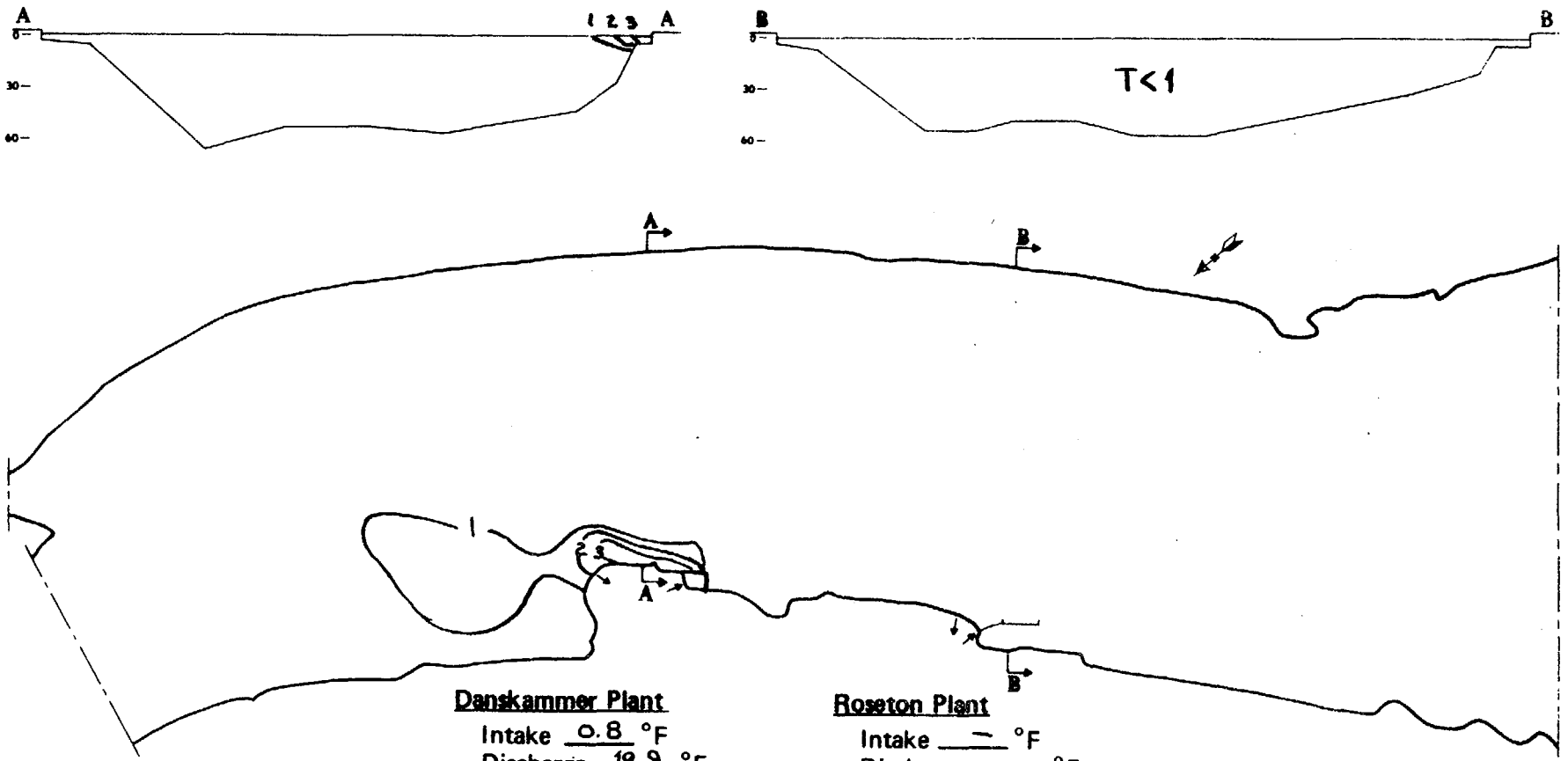


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 123



Danskammer Plant

Intake 0.8 °F
Discharge 18.9 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow ____ cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 75.8 °F
Thermal Equilibrium Box Temperature -0.9 °F

River

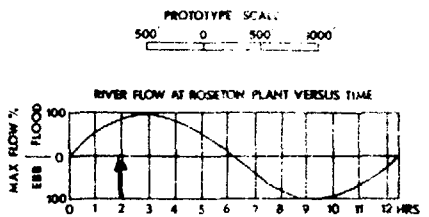
Fresh Water Flow 6000 cfs
Ambient Temperature 74.4 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

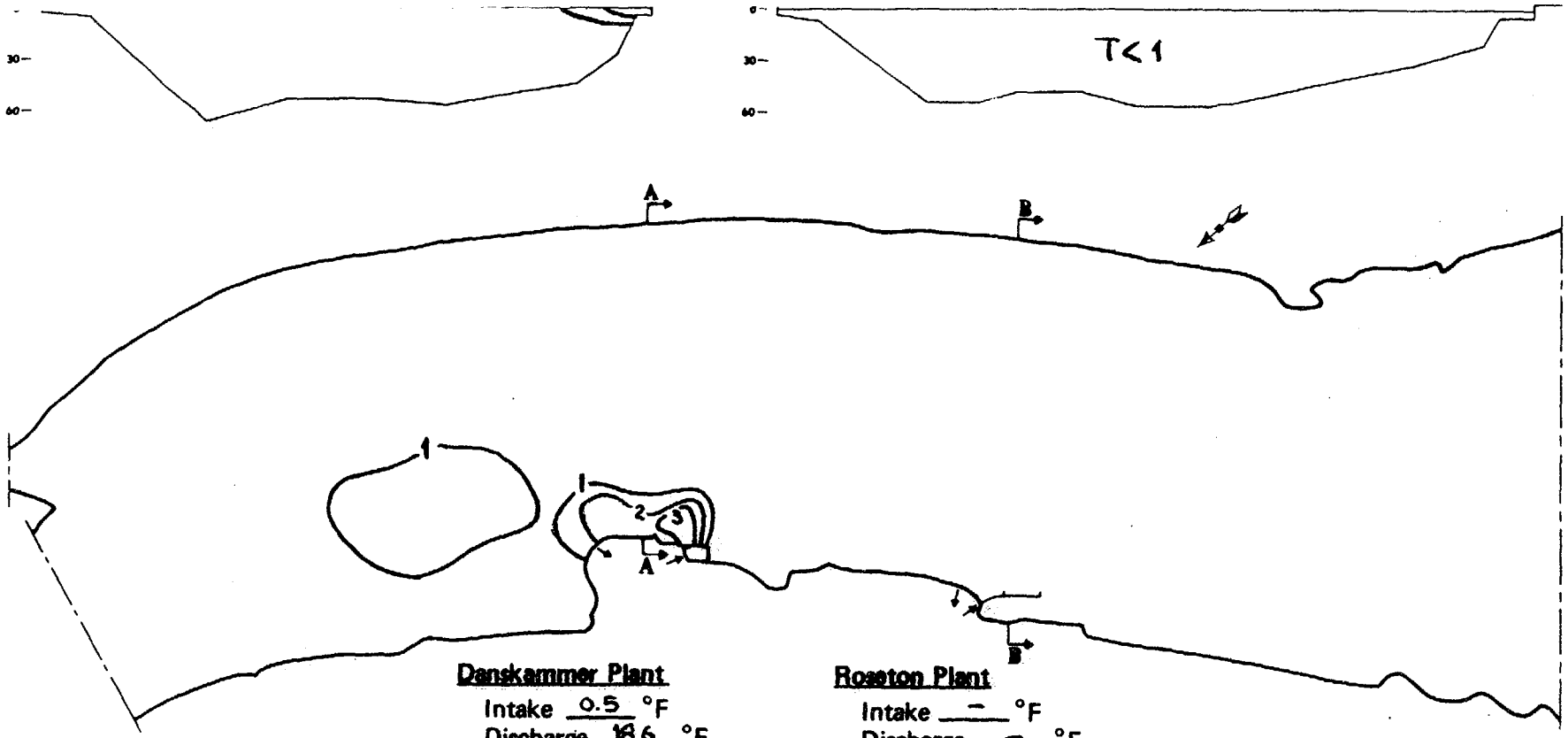


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ANDL

FIGURE A 124



Danskammer Plant

Intake 0.5 °F
Discharge 18.6 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 76.0 °F
Thermal Equilibrium Box Temperature ~0.8 °F

River

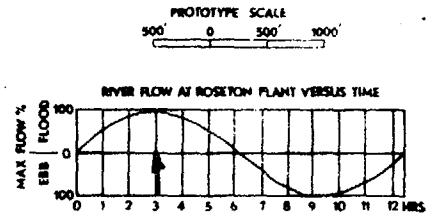
Fresh Water Flow 6000 cfs
Ambient Temperature 74.4 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

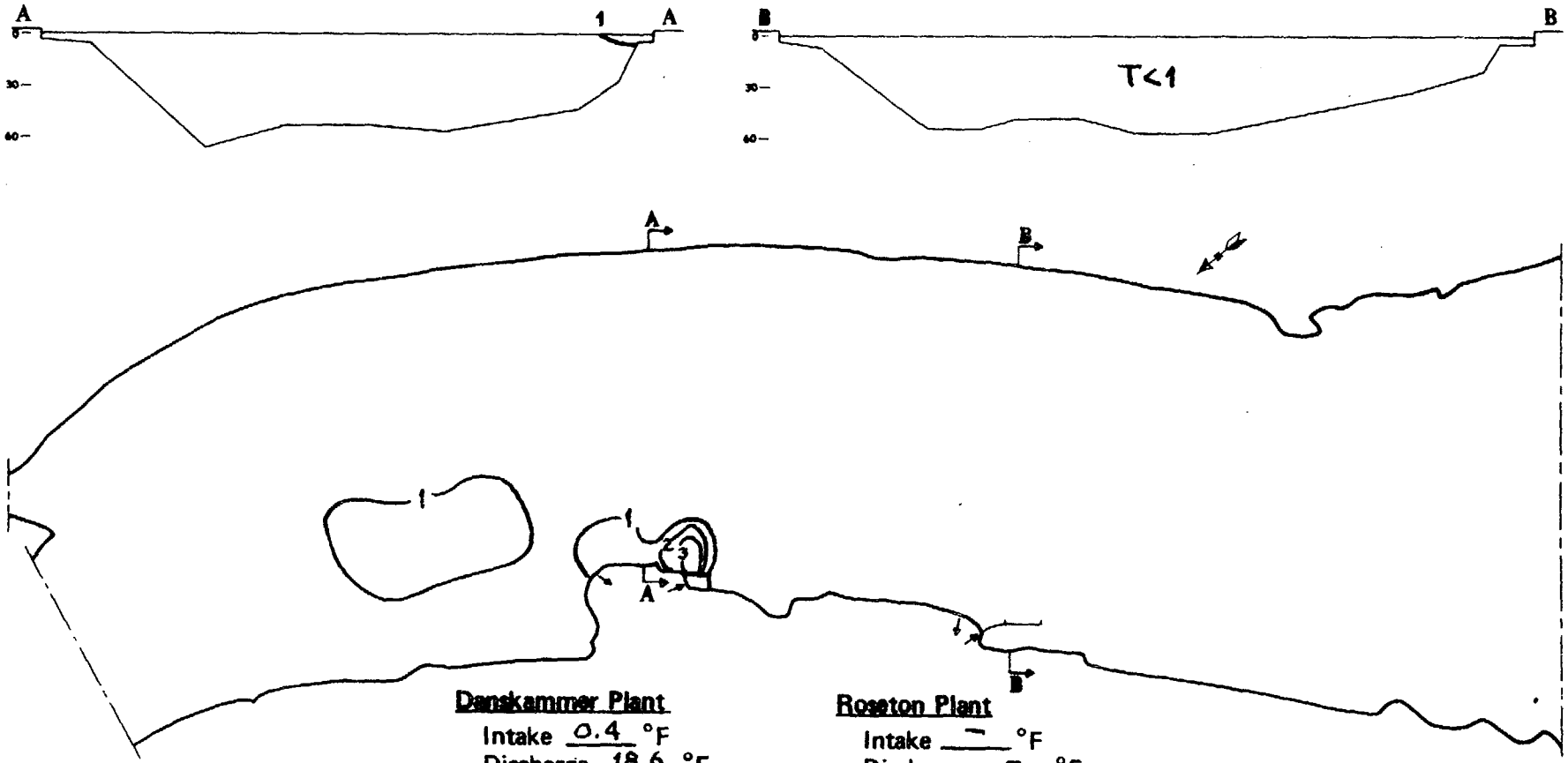


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 125



Danskammer Plant

Intake 0.4 °F
Discharge 18.6 °F
ΔT 18.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 76.2 °F
Thermal Equilibrium Box Temperature 70.8 °F

River

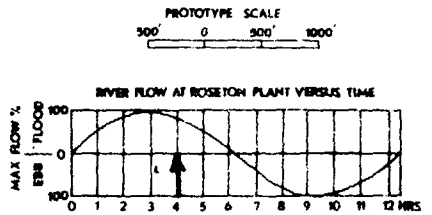
Fresh Water Flow 6000 cfs
Ambient Temperature 74.4 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

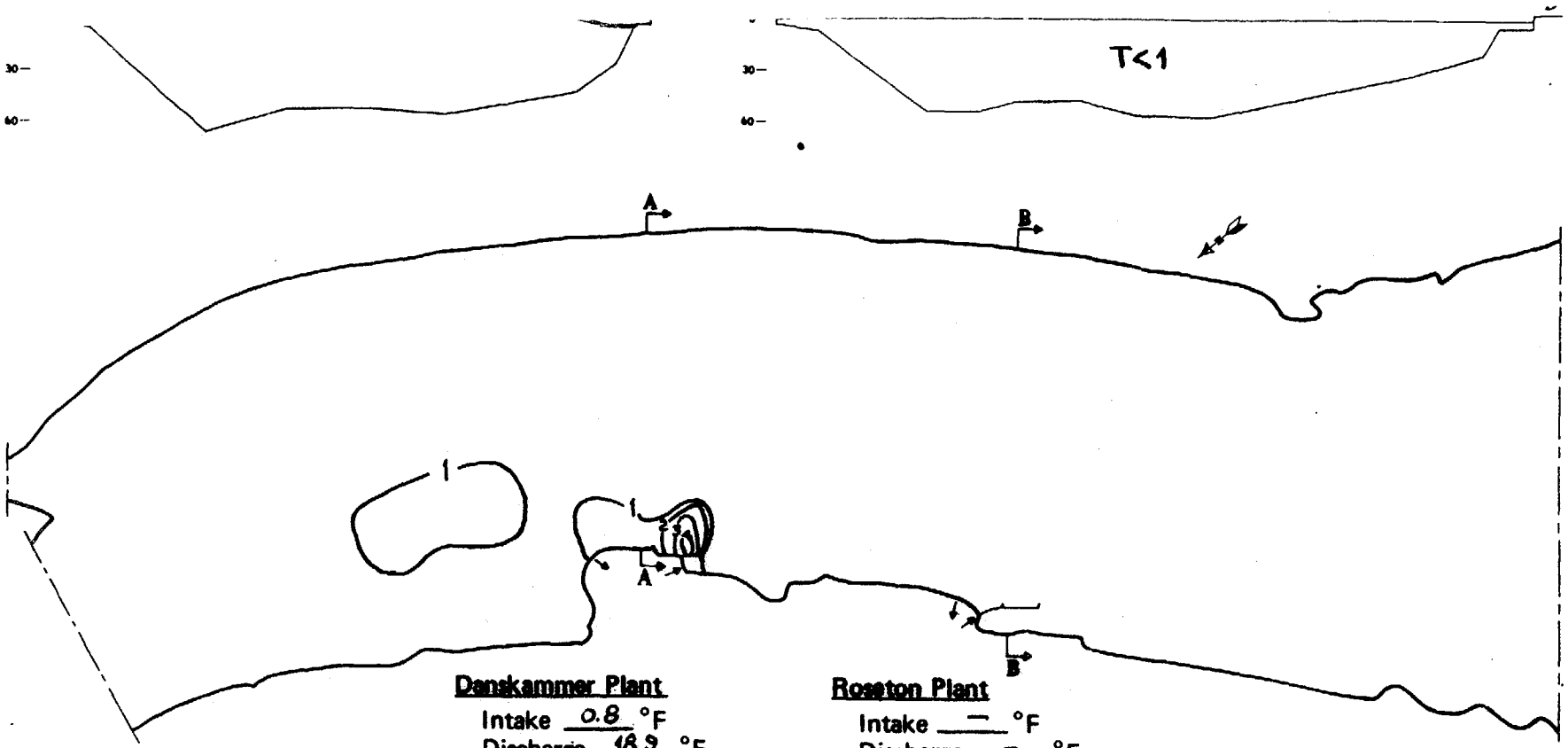


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 126



Danskammer Plant

Intake 0.8 °F
Discharge 18.9 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 76.4 °F
Thermal Equilibrium Box Temperature -0.8 °F

River

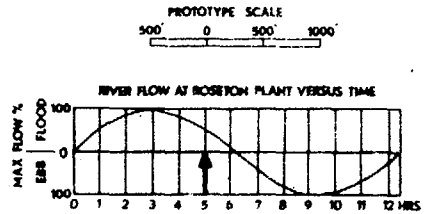
Fresh Water Flow 6000 cfs
Ambient Temperature 74.5 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 127

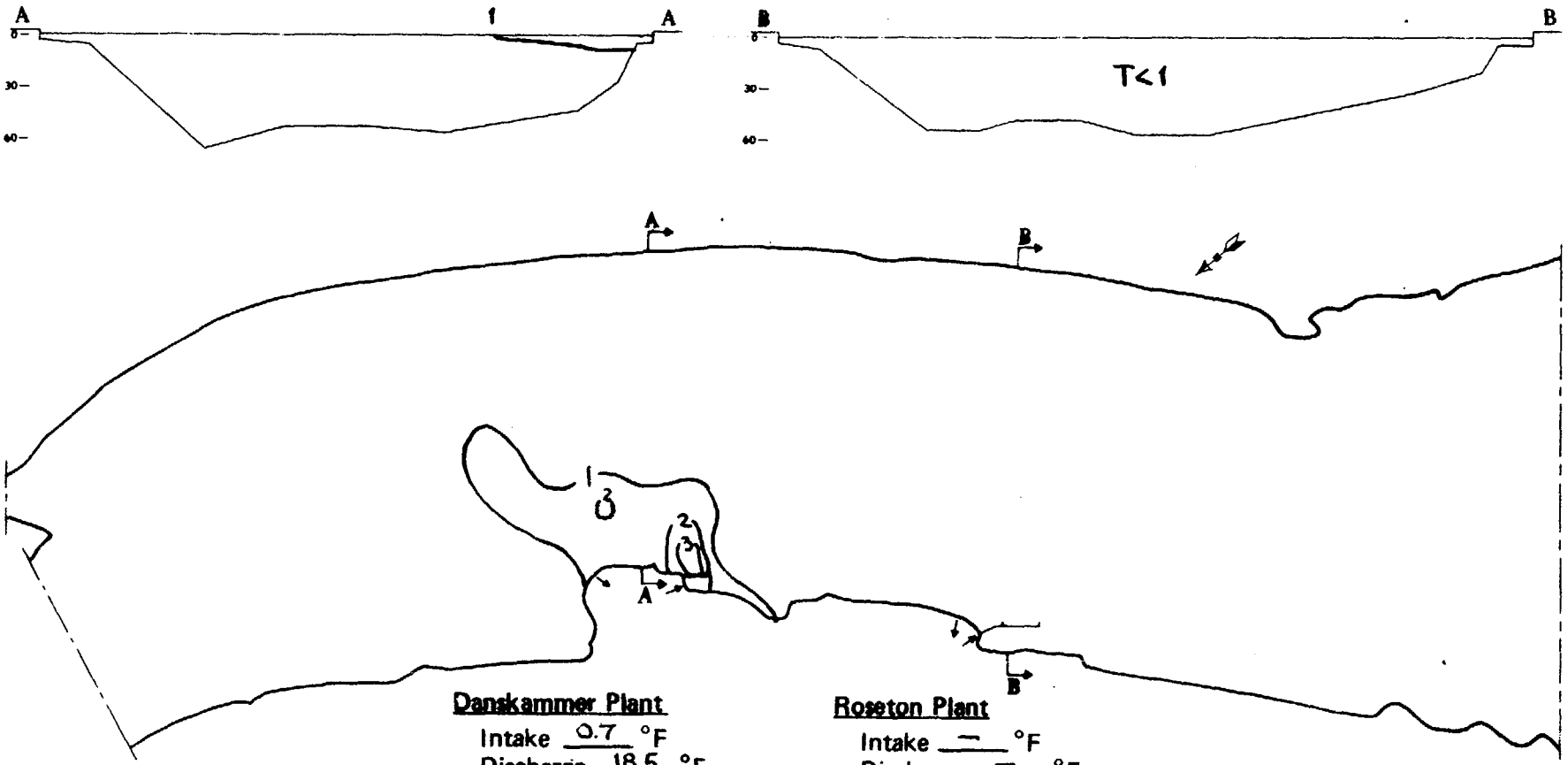


FIGURE A 128

Danskammer Plant

Intake 0.7 °F
Discharge 18.5 °F
ΔT 17.8 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 76.7 °F
Thermal Equilibrium Box Temperature 70.7 °F

River

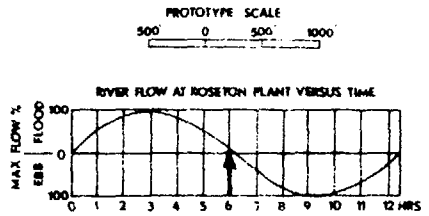
Fresh Water Flow 6000 cfs
Ambient Temperature 74.5 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

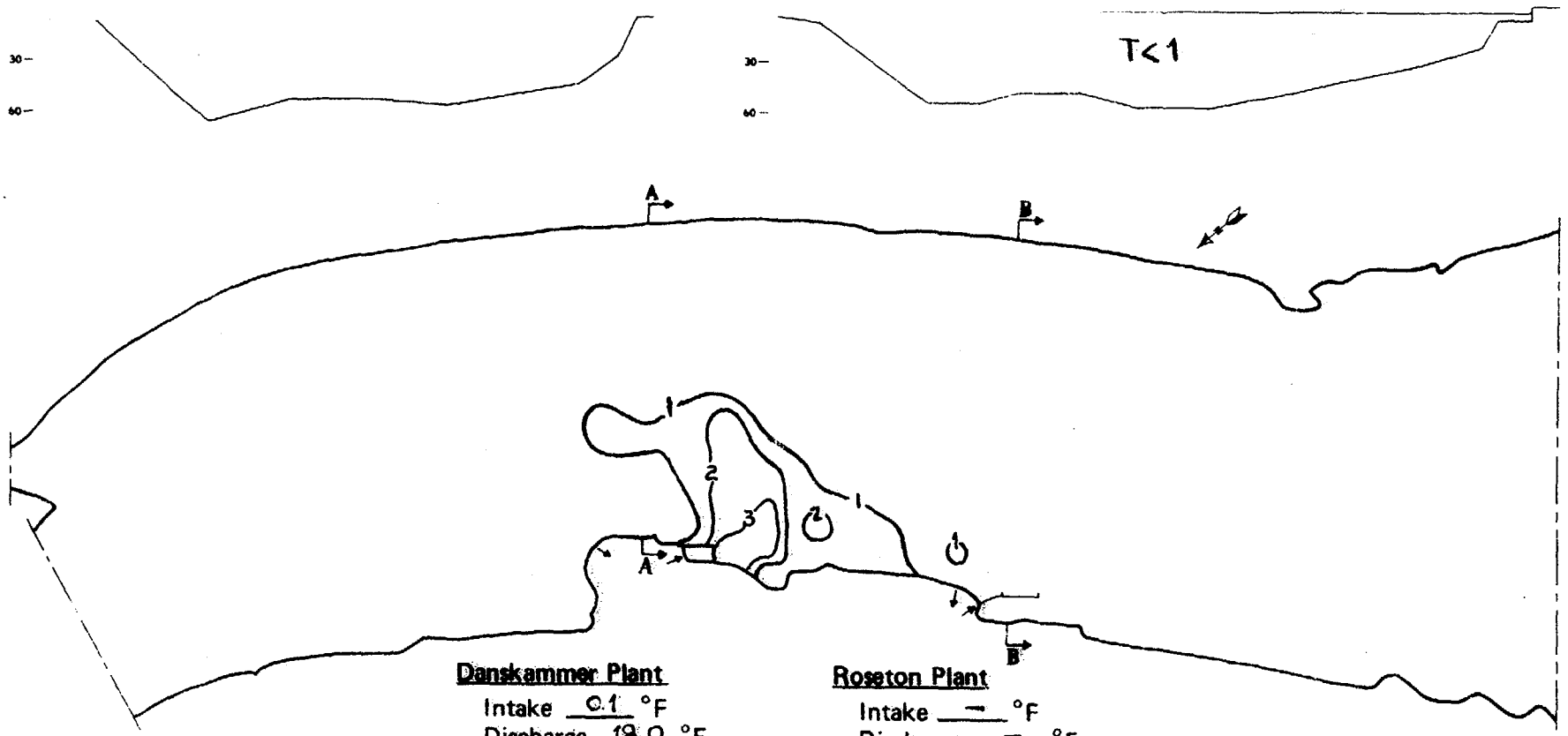
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ANL



Danskammer Plant

Intake 0.1 °F
Discharge 18.0 °F
ΔT 17.9 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 76.8 °F
Thermal Equilibrium Box Temperature ~0.7 °F

River

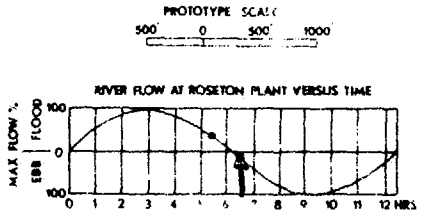
Fresh Water Flow 6000 cfs
Ambient Temperature 74.5 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

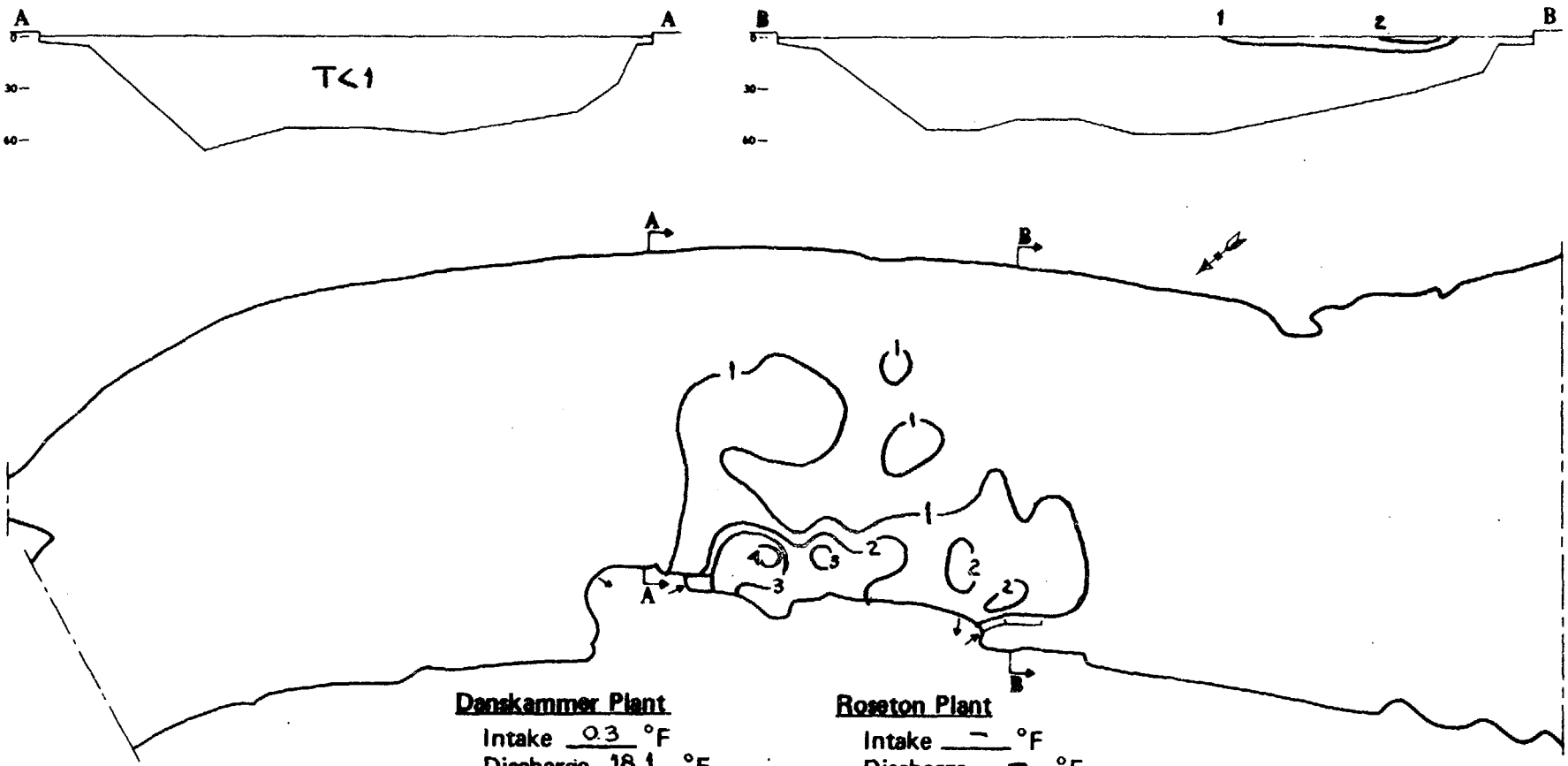


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 129



Danskammer Plant

Intake 0.3 °F
Discharge 18.1 °F
ΔT 17.8 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 77.0 °F
Thermal Equilibrium Box Temperature 76 °F

River

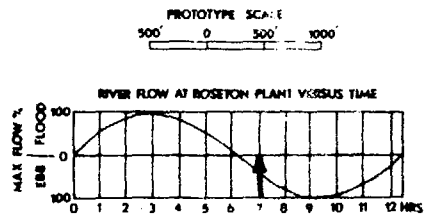
Fresh Water Flow 6000 cfs
Ambient Temperature 74.5° F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

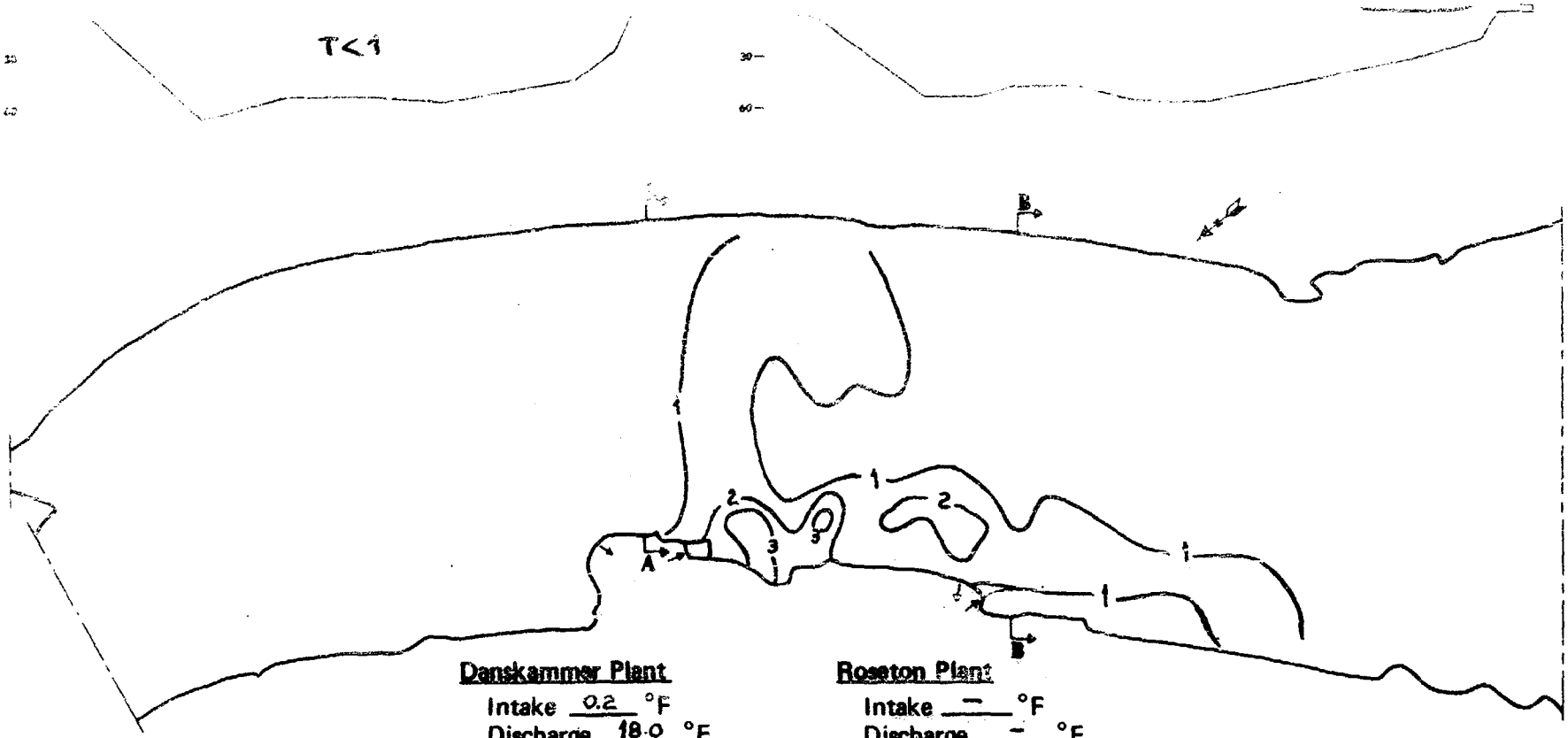


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 130



Danskammer Plant

Intake 0.2 °F
Discharge 18.0 °F
ΔT 17.8 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 77.1 °F
Thermal Equilibrium Box Temperature 70.7 °F

River

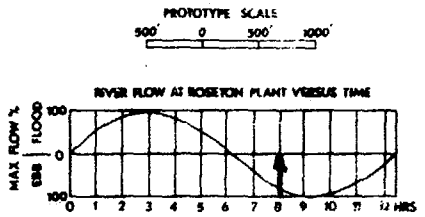
Fresh Water Flow 6000 cfs
Ambient Temperature 74.6 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

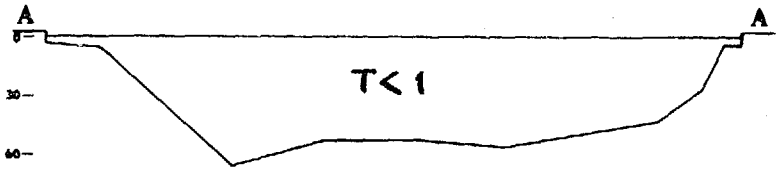


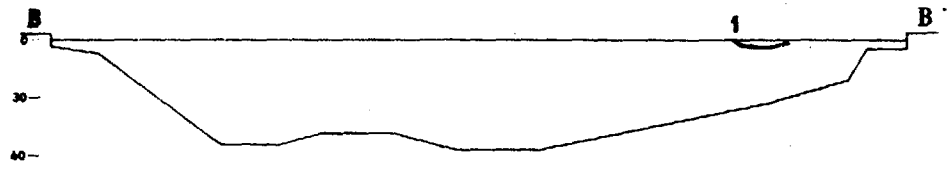
TEMPERATURE RISE ABOVE RIVER AMBIENT

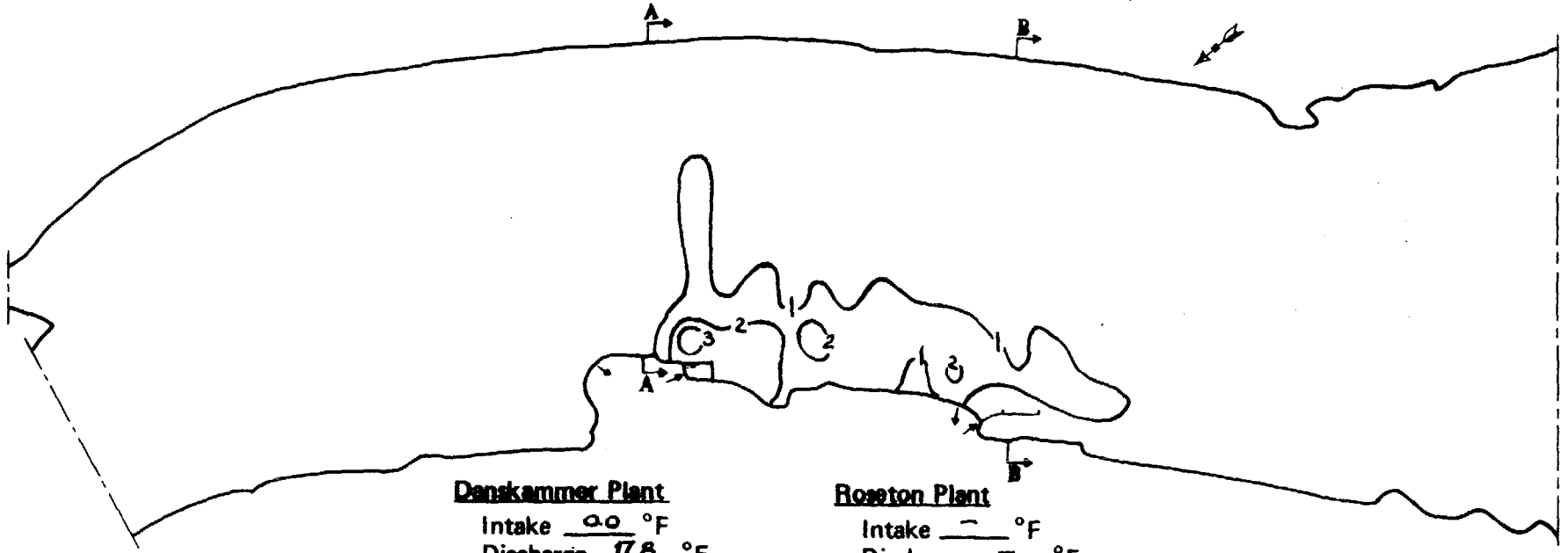
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 131







Danskammer Plant

Intake 80 °F
Discharge 97.8 °F
ΔT 17.8 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 76.7 °F
Thermal Equilibrium Box Temperature 76 °F

River

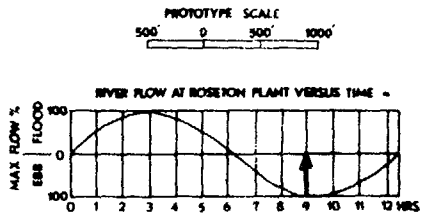
Fresh Water Flow 6000 cfs
Ambient Temperature 74.6 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

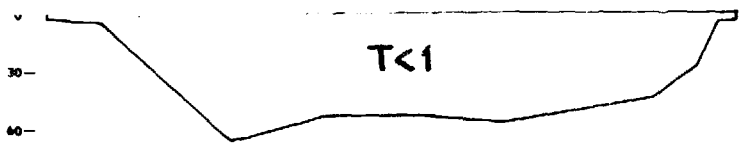


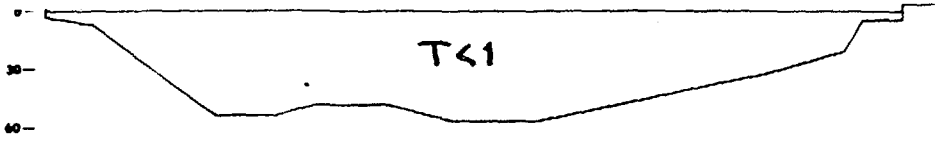
TEMPERATURE RISE ABOVE RIVER AMBIENT

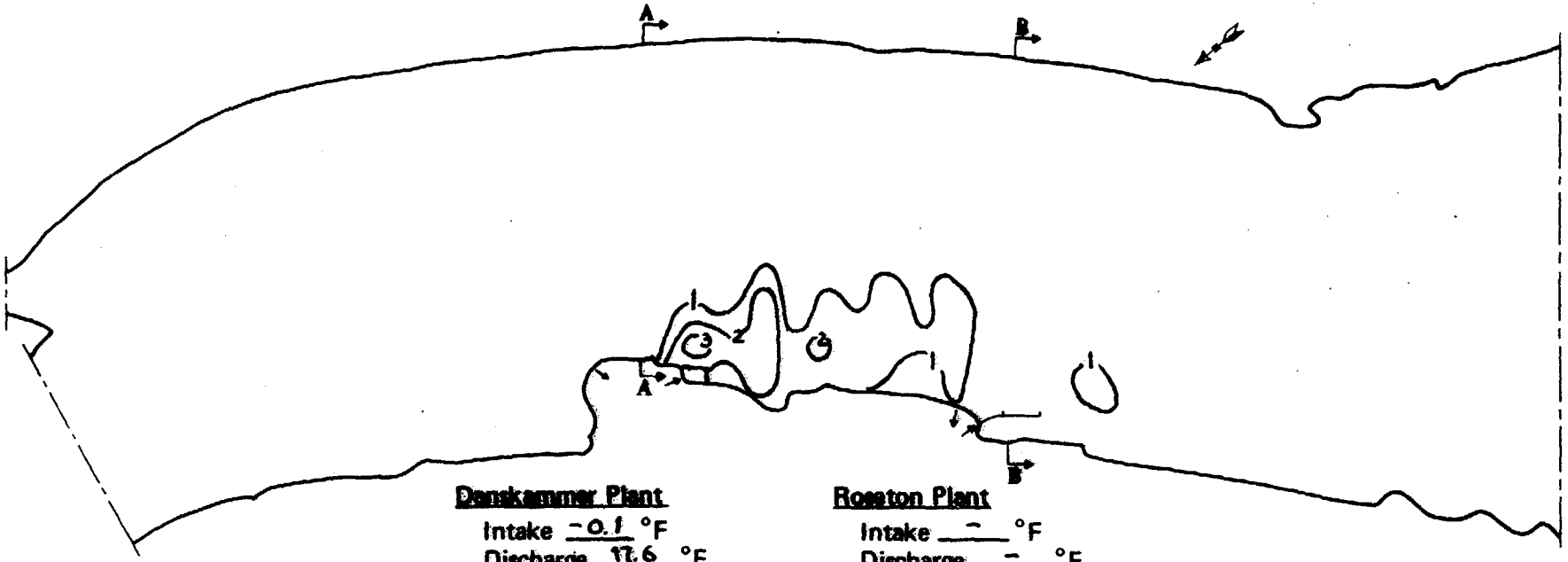
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 132







Danskammer Plant

Intake -0.1 °F
Discharge 17.6 °F
ΔT 17.7 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 76.6 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

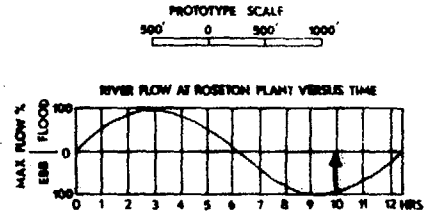
Fresh Water Flow 6000 cfs
Ambient Temperature 74.6 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



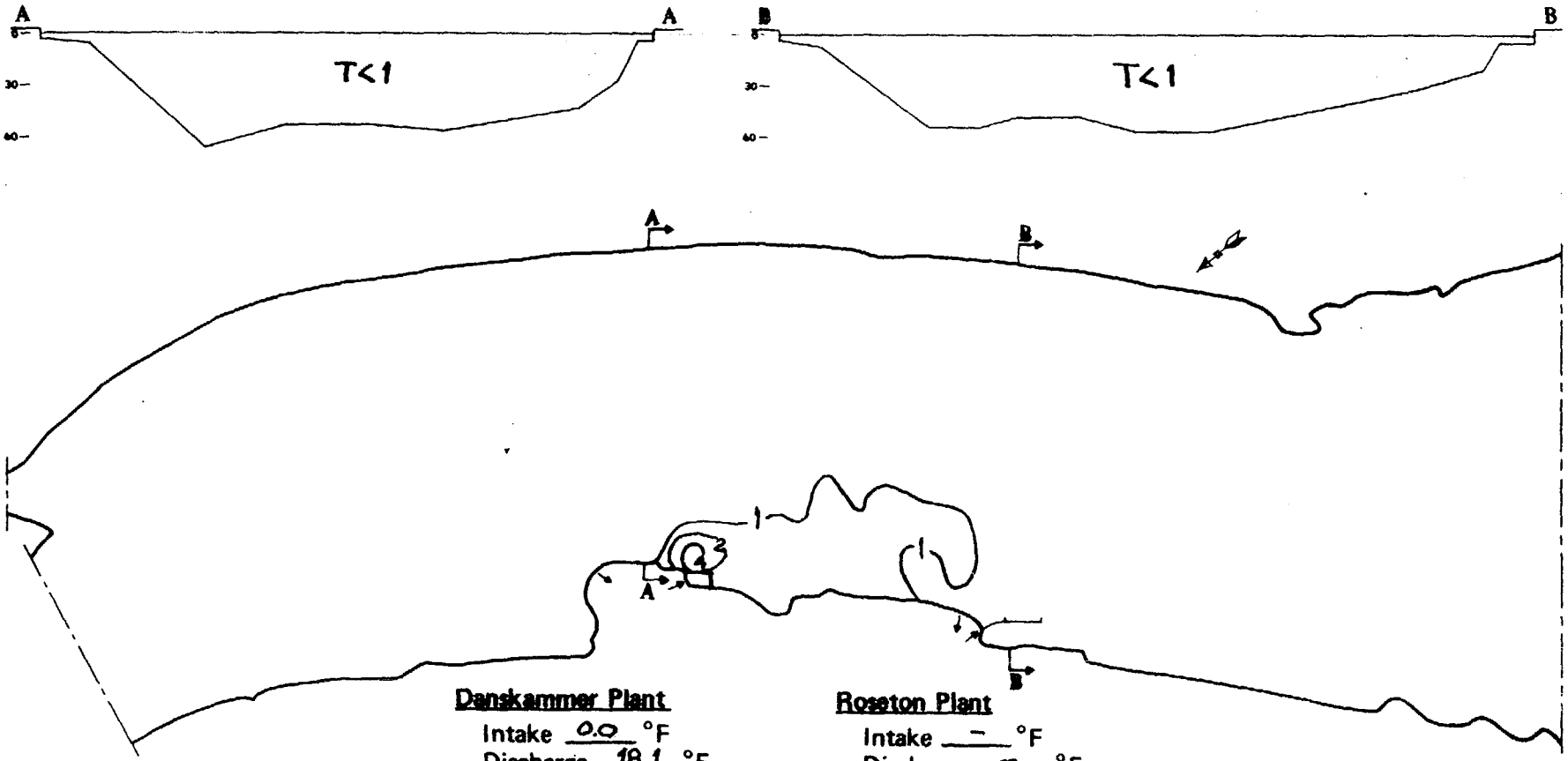
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 133

FIGURE A 134



Danskammer Plant

Intake 0.0 °F
Discharge 18.1 °F
ΔT 18.1 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 76.5 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

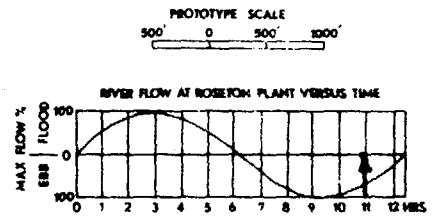
Fresh Water Flow 6000 cfs
Ambient Temperature 74.7 °F

Date 29 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

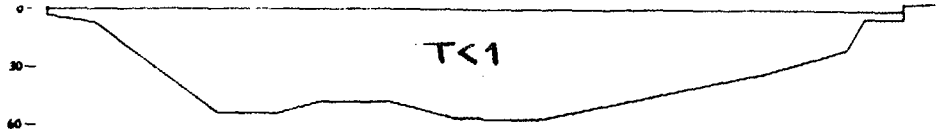


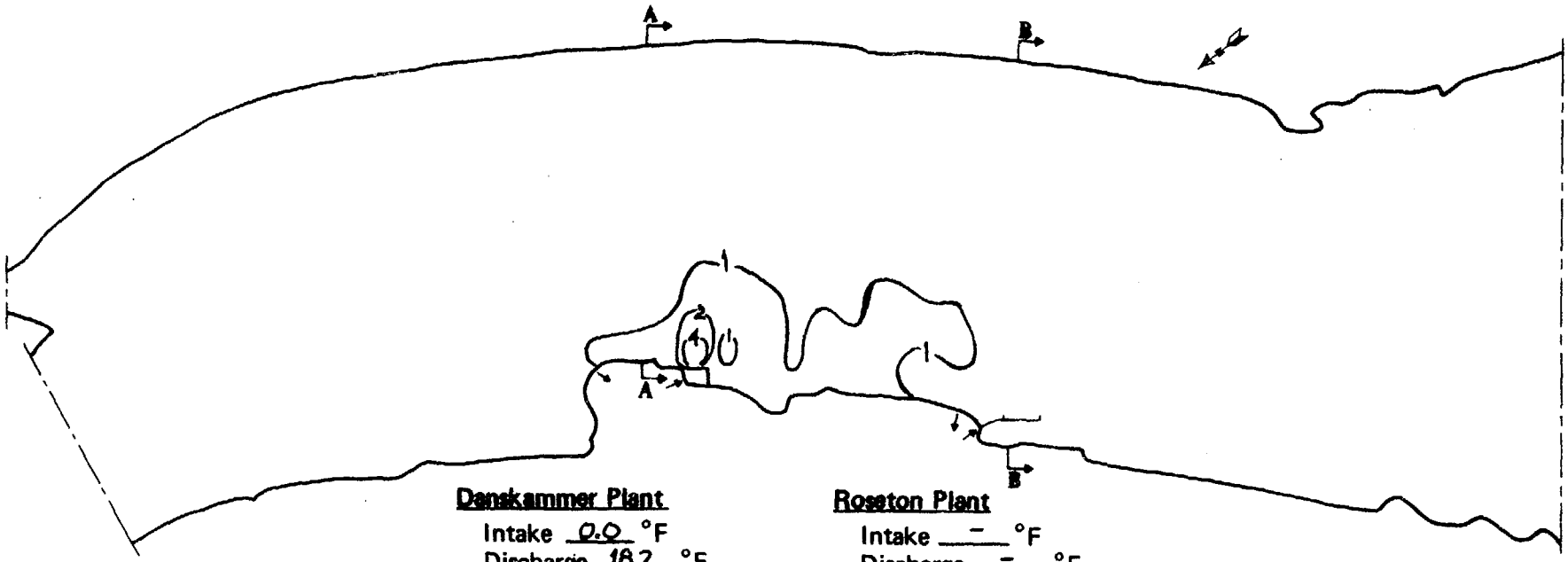
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL







Danskammer Plant

Intake 0.0 °F
Discharge 18.2 °F
ΔT 18.2 °F
Flow 700 cfs
* Outfall Configuration 2

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 88 %
Dry Bulb Temperature 76.3 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

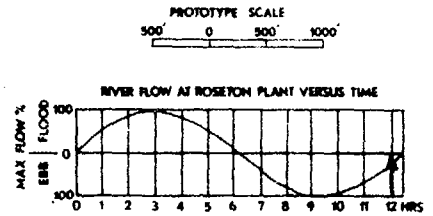
Fresh Water Flow 6000 cfs
Ambient Temperature 74.7 °F

Date 29 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 135

DANSKAMMER

LOAD	100%
DISCHARGE DESIGN	7 PORT DIFFUSER
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	16.2 F

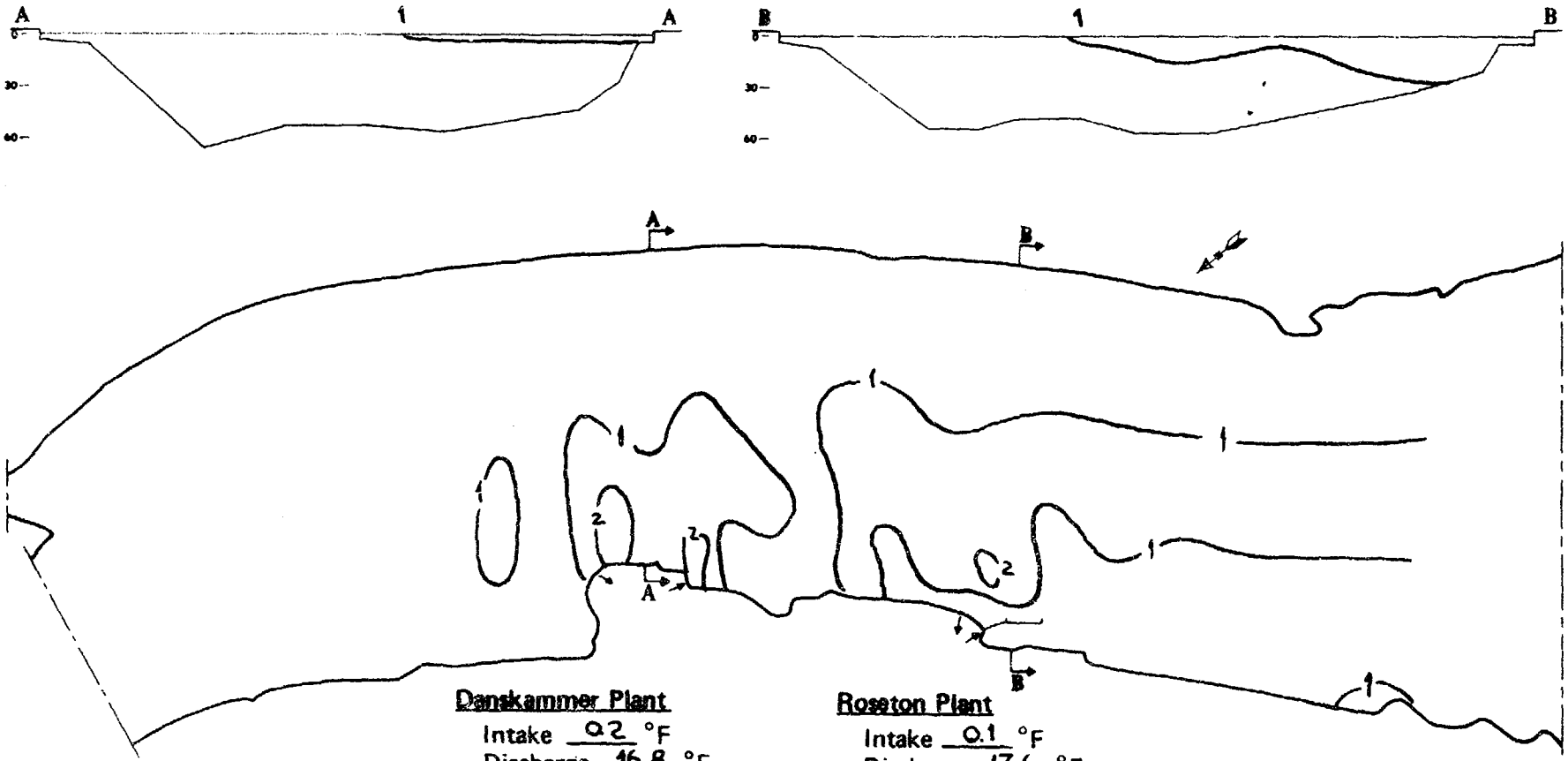
ROSETON

LOAD	100%
DISCHARGE DESIGN	14 PORT DIFFUSER
DISCHARGE FLOW	1400 CFS
TEMPERATURE RISE	17.2 F
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	74.8 F
FRESH WATER FLOW	6000 CFS

TEST DATE 20 SEPT. 1972



Danskammer Plant

Intake 52 °F
Discharge 16.8 °F
ΔT 16.6 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.1 °F
Discharge 17.6 °F
ΔT 17.5 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 79 %
Dry Bulb Temperature 74.1 °F
Thermal Equilibrium Box Temperature -0.8 °F

River

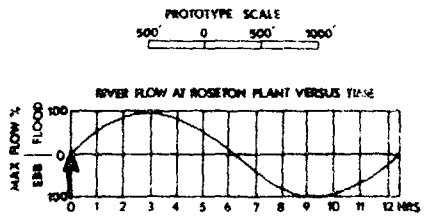
Fresh Water Flow 6000 cfs
Ambient Temperature 71.1 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

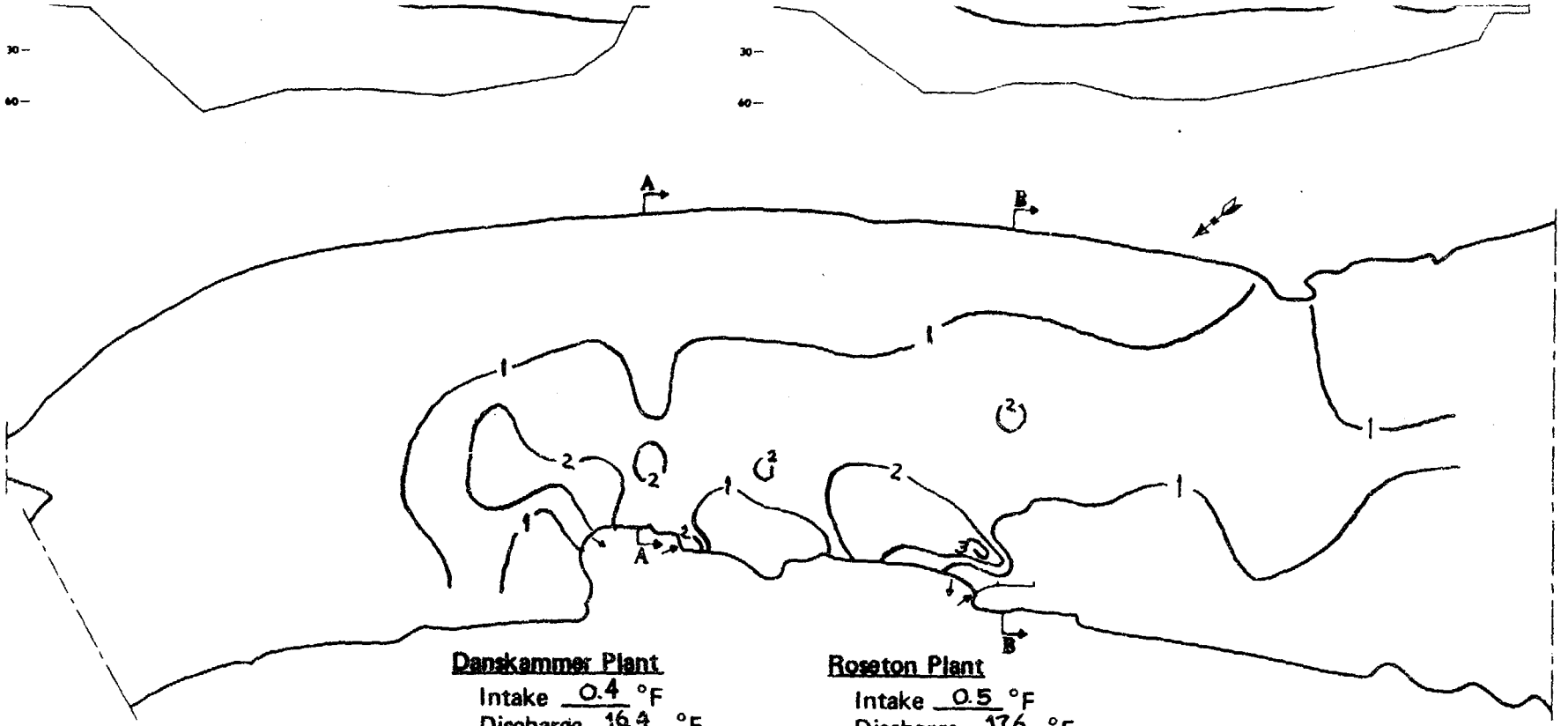


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 136



Danskammer Plant

Intake 0.4 °F
Discharge 16.4 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.5 °F
Discharge 17.6 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 78 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature ~0.5 °F

River

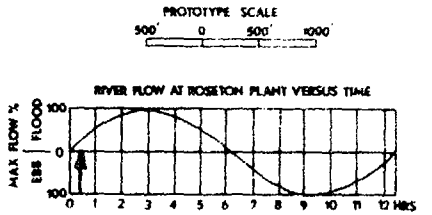
Fresh Water Flow 6000 cfs
Ambient Temperature 74.1 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

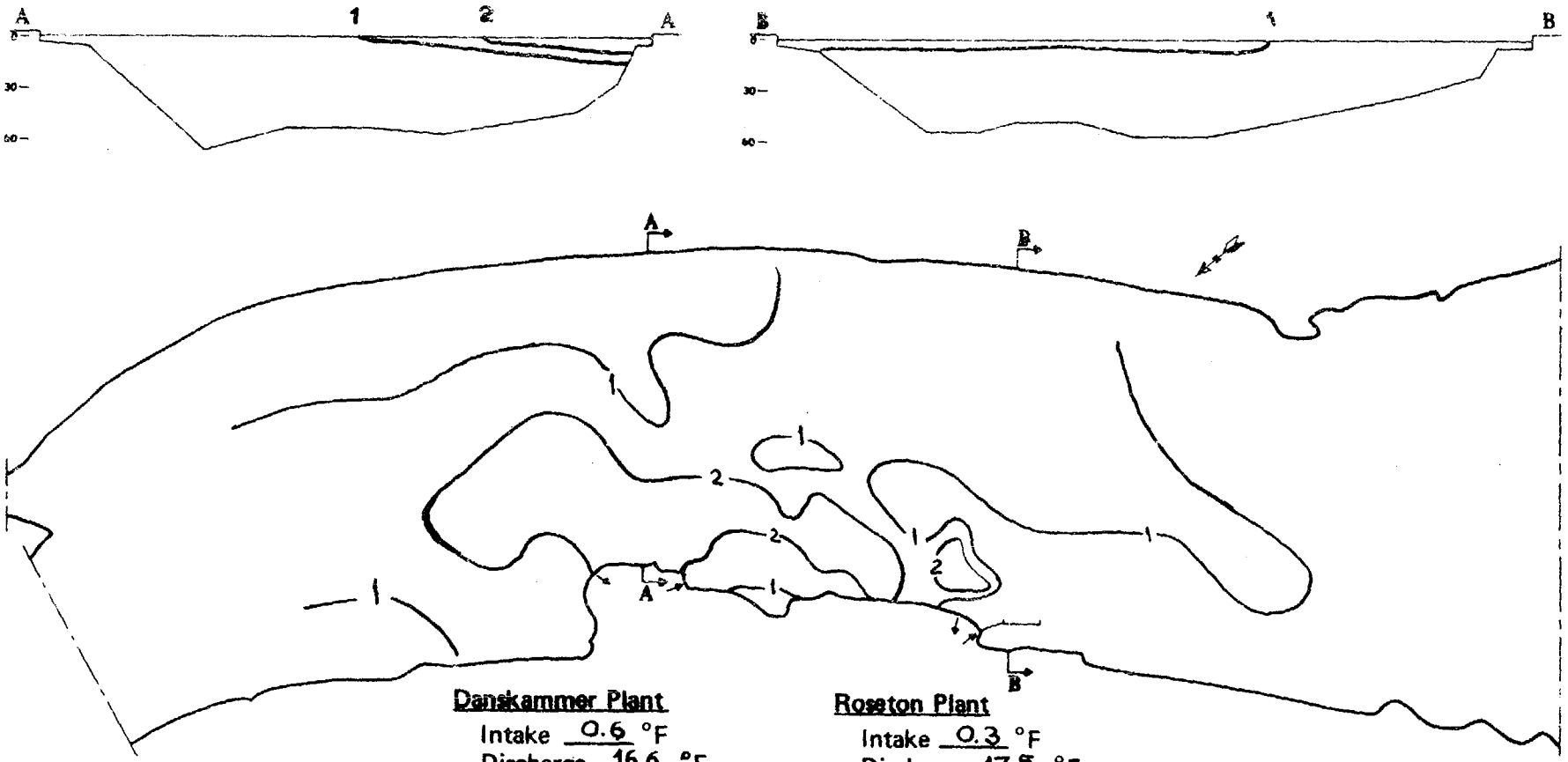


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 137



Danskammer Plant

Intake 0.6 °F
Discharge 16.6 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.5 °F
ΔT 17.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 79 %
Dry Bulb Temperature 74.7 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

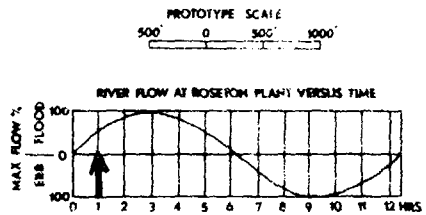
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

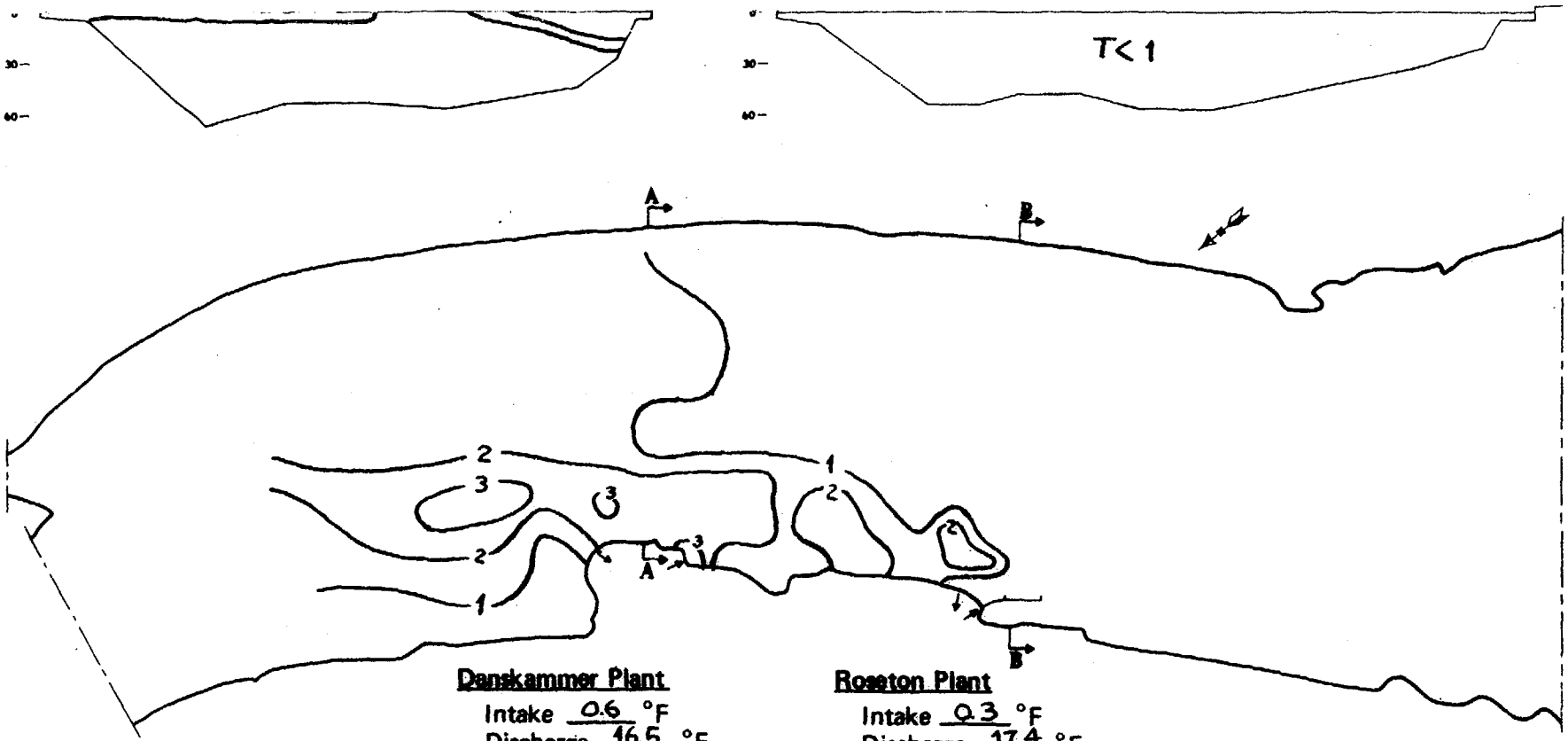


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 138



Danskammer Plant

Intake 0.6 °F
Discharge 16.5 °F
ΔT 15.9 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 82 %
Dry Bulb Temperature 74.7 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

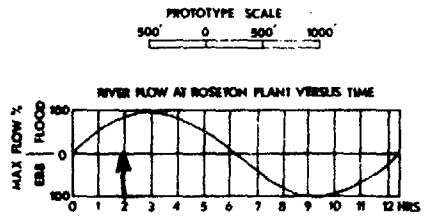
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8° F

Date 20 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

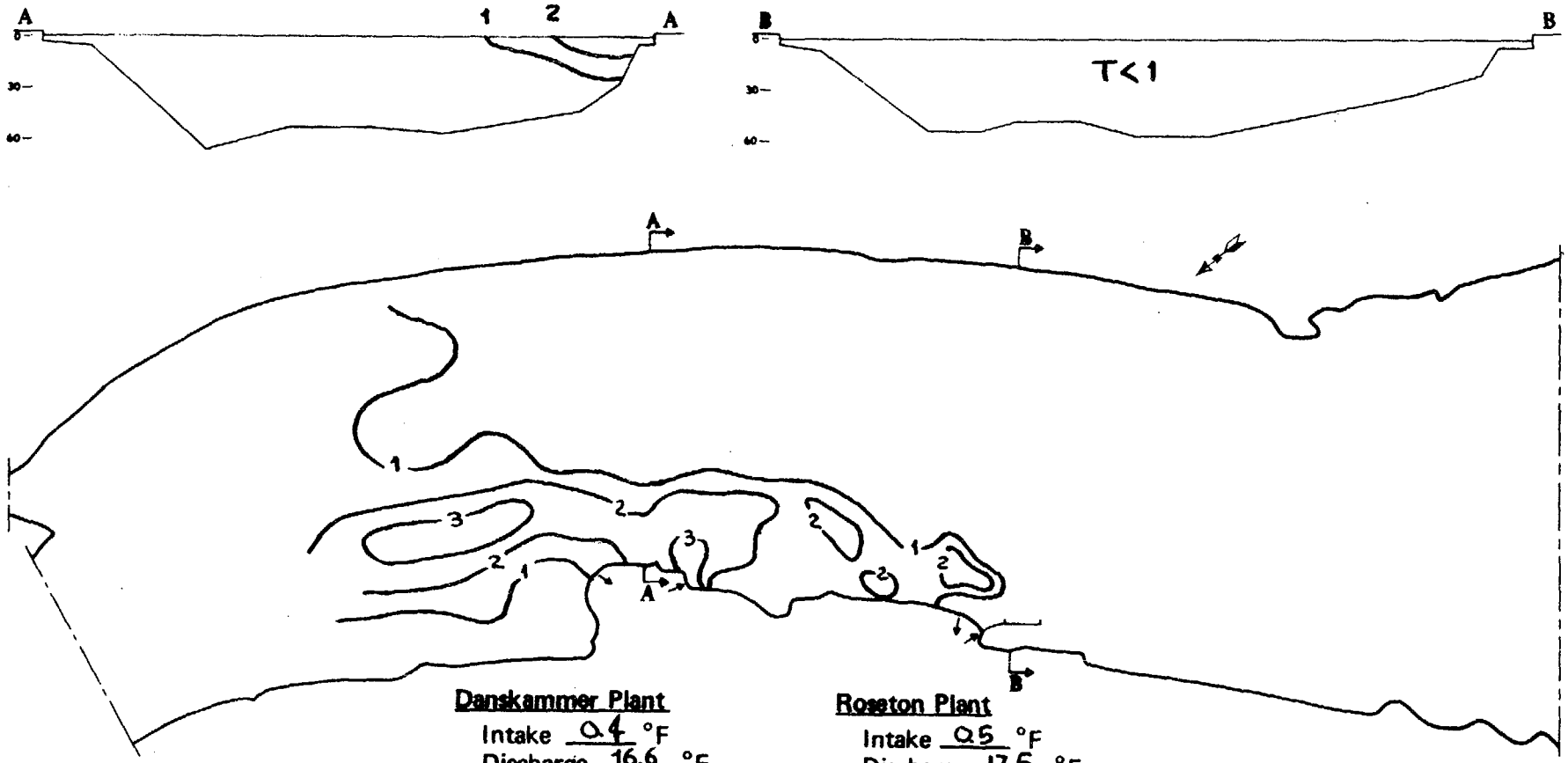


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 139



Danskammer Plant

Intake 0.4 °F
Discharge 16.6 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.5 °F
Discharge 17.5 °F
ΔT 17.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

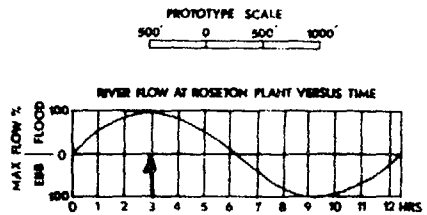
Room Atmosphere

Relative Humidity 80 %
Dry Bulb Temperature 74.8 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 74.8° F

Date 20 SEPT. 72

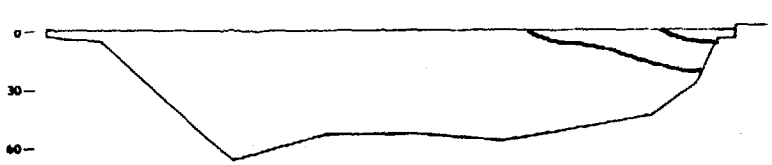


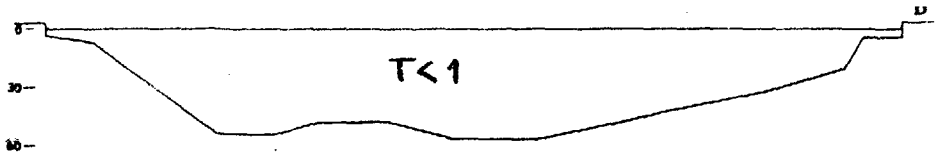
TEMPERATURE RISE ABOVE RIVER AMBIENT

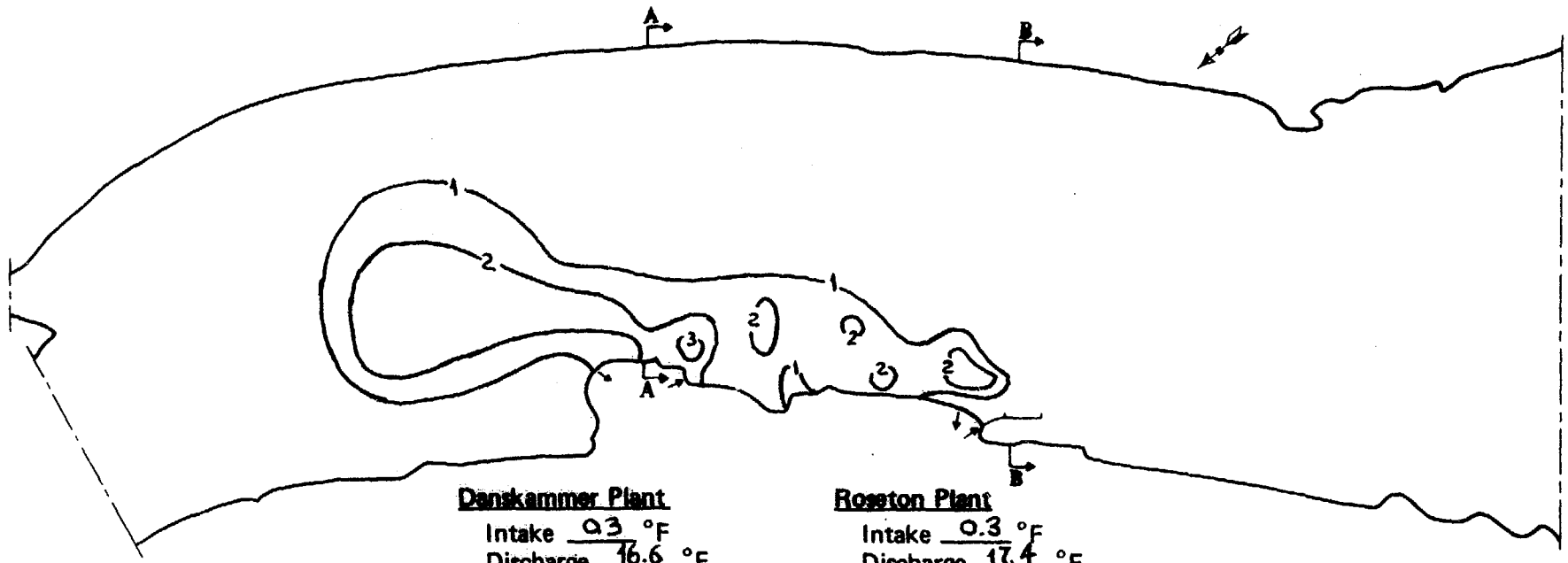
Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 140







Danskammer Plant

Intake 93 °F
Discharge 16.6 °F
ΔT 16.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 83 %
Dry Bulb Temperature 74.5 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

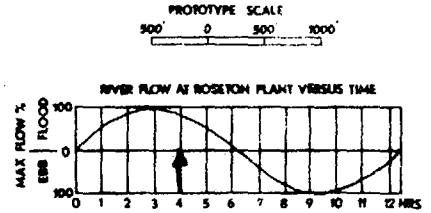
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

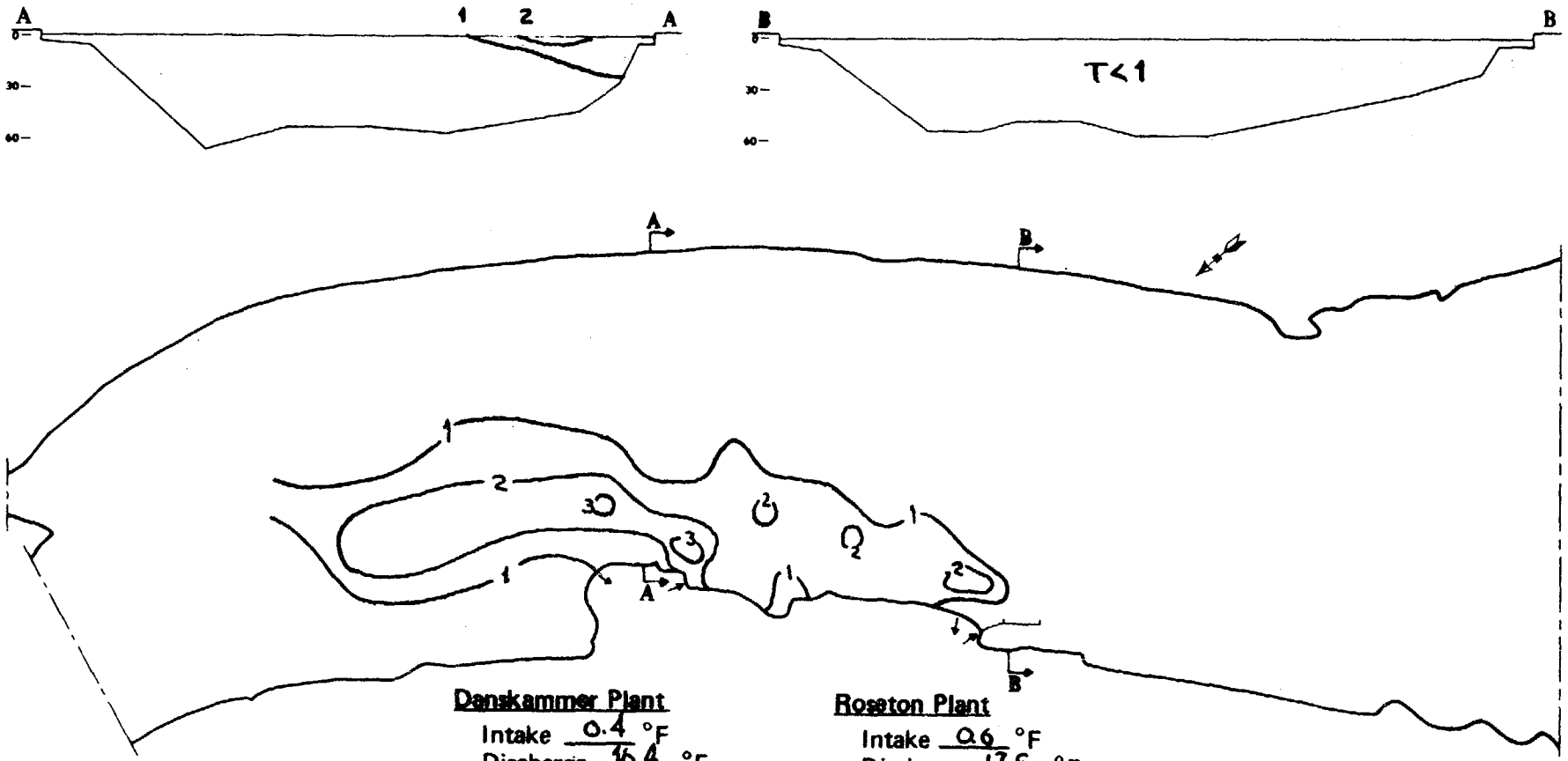


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

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FIGURE A 141



Danskammer Plant

Intake 0.4 °F
Discharge 16.4 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.6 °F
Discharge 17.5 °F
ΔT 16.9 °F
Flow 1400 cfs
**Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

Room Atmosphere

Relative Humidity 77 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.6 °F

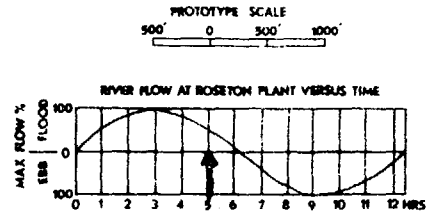
**1. All 14 Ports

River

Fresh Water Flow 6000 cfs
Ambient Temperature 71.8 °F

A. With Barge
B. Without Barge

Date 20 SEPT. 72

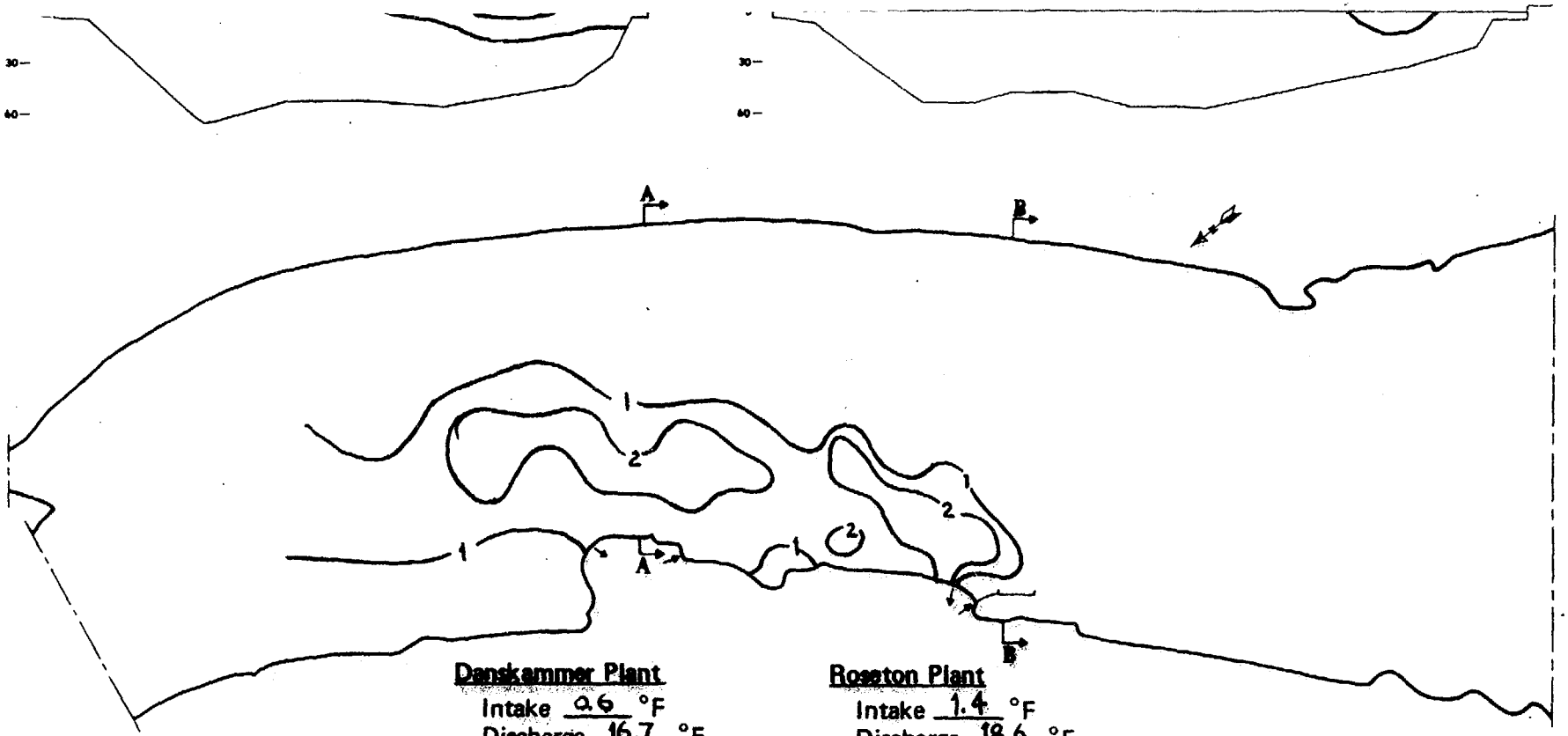


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

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FIGURE A 142



Danskammer Plant

Intake 0.6 °F
Discharge 16.7 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 1.4 °F
Discharge 18.6 °F
ΔT 17.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 78 %
Dry Bulb Temperature 74.5 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

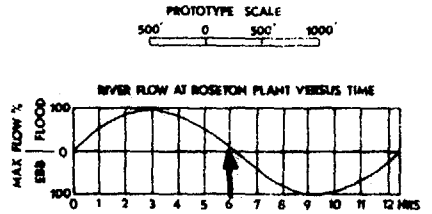
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

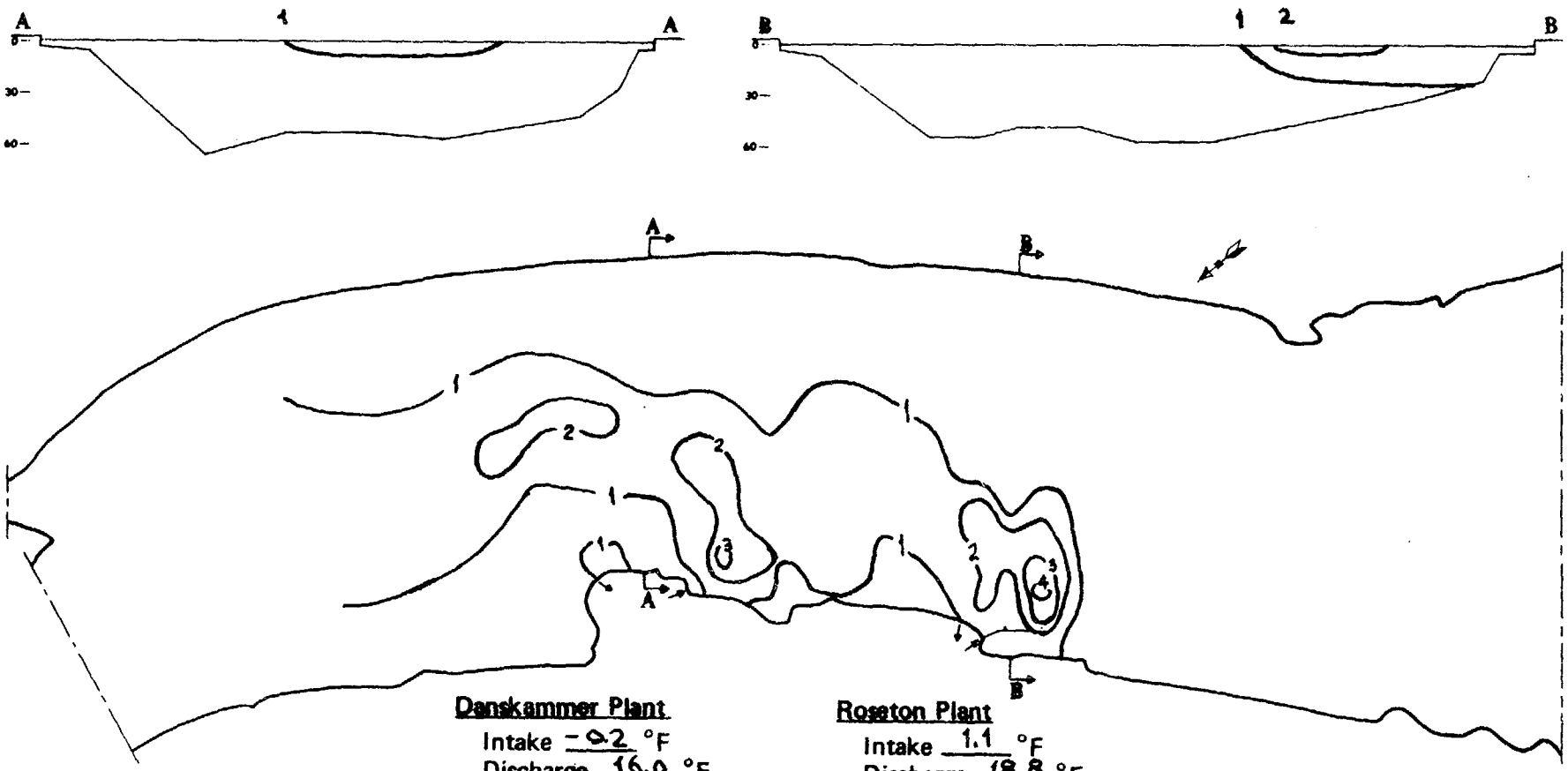


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 143



Danskammer Plant

Intake -0.2 °F
Discharge 16.0 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 1.1 °F
Discharge 18.8 °F
ΔT 17.7 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

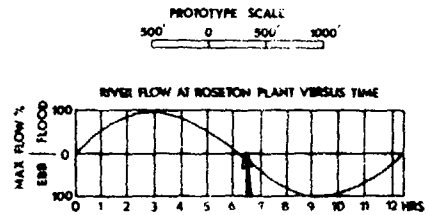
Room Atmosphere

Relative Humidity 77 %
Dry Bulb Temperature 74.6 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 74.8 °F

Date 20. SEPT. 72

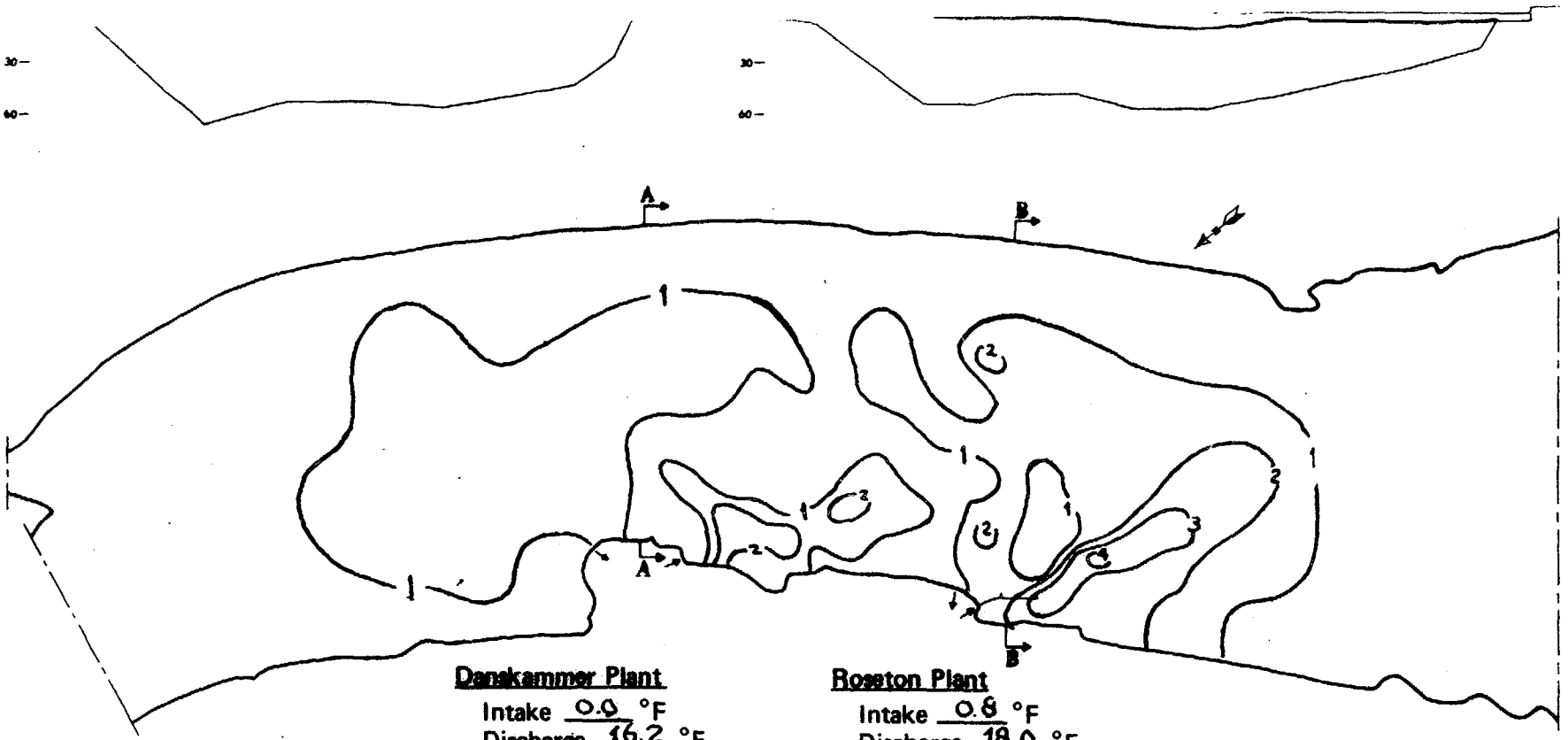


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 144



Danskammer Plant

Intake 0.0 °F
Discharge 16.2 °F
ΔT 16.0 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.8 °F
Discharge 18.0 °F
ΔT 17.2 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 76 %
Dry Bulb Temperature 74.5 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

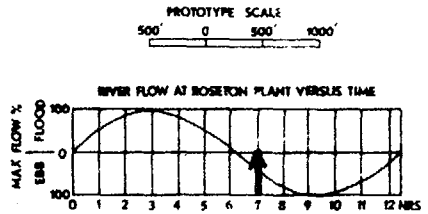
Fresh Water Flow 6000 cfs
Ambient Temperature 74.8° F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

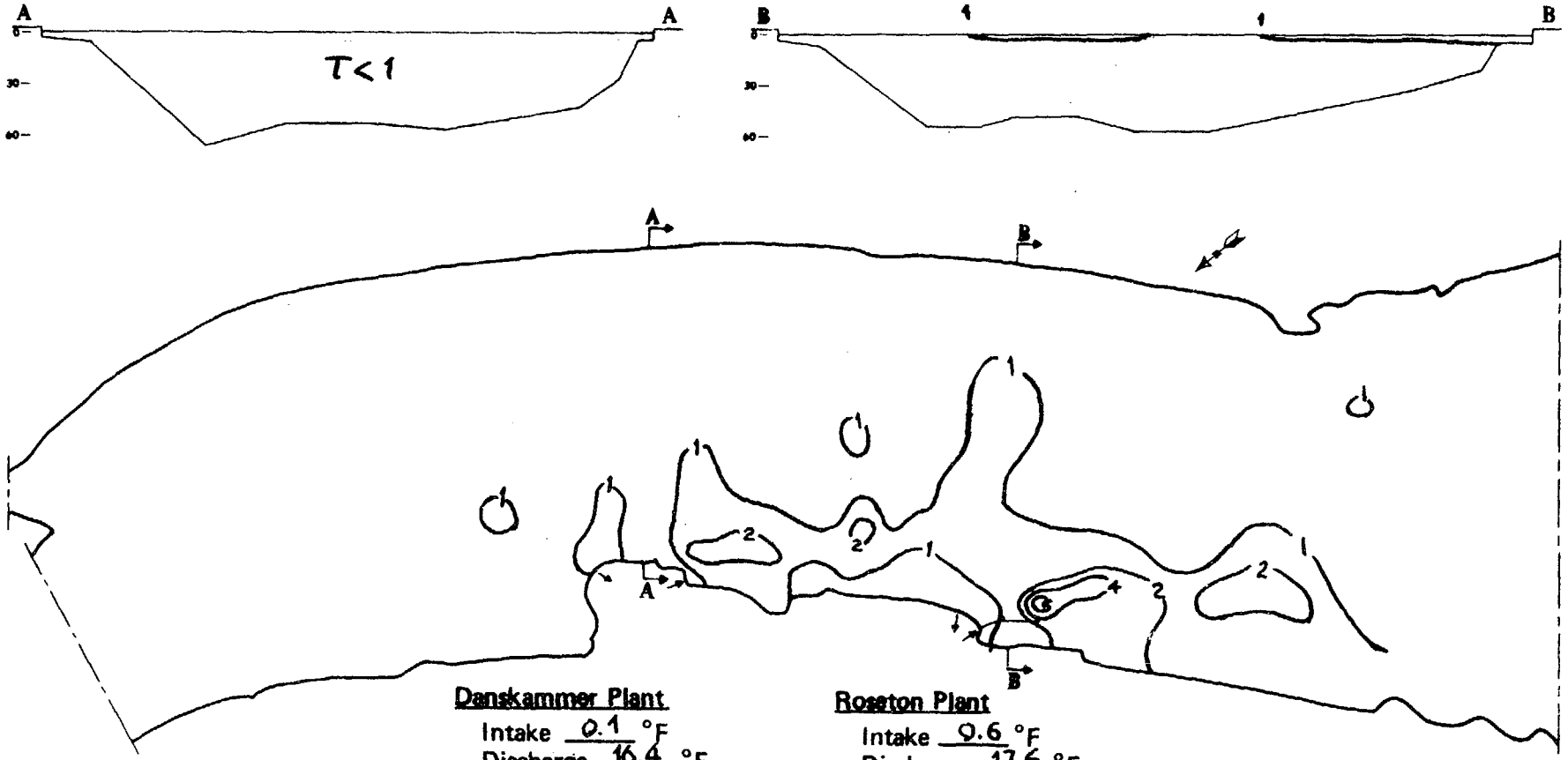


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 145



Danskammer Plant

Intake 0.1 °F
Discharge 16.4 °F
ΔT 16.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.6 °F
Discharge 17.6 °F
ΔT 17.0 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 65 %
Dry Bulb Temperature 74.5 °F
Thermal Equilibrium Box Temperature ~0.6 °F

River

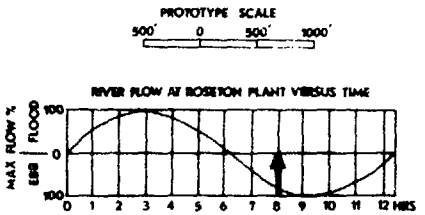
Fresh Water Flow 6000 cfs
Ambient Temperature 74.9° F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

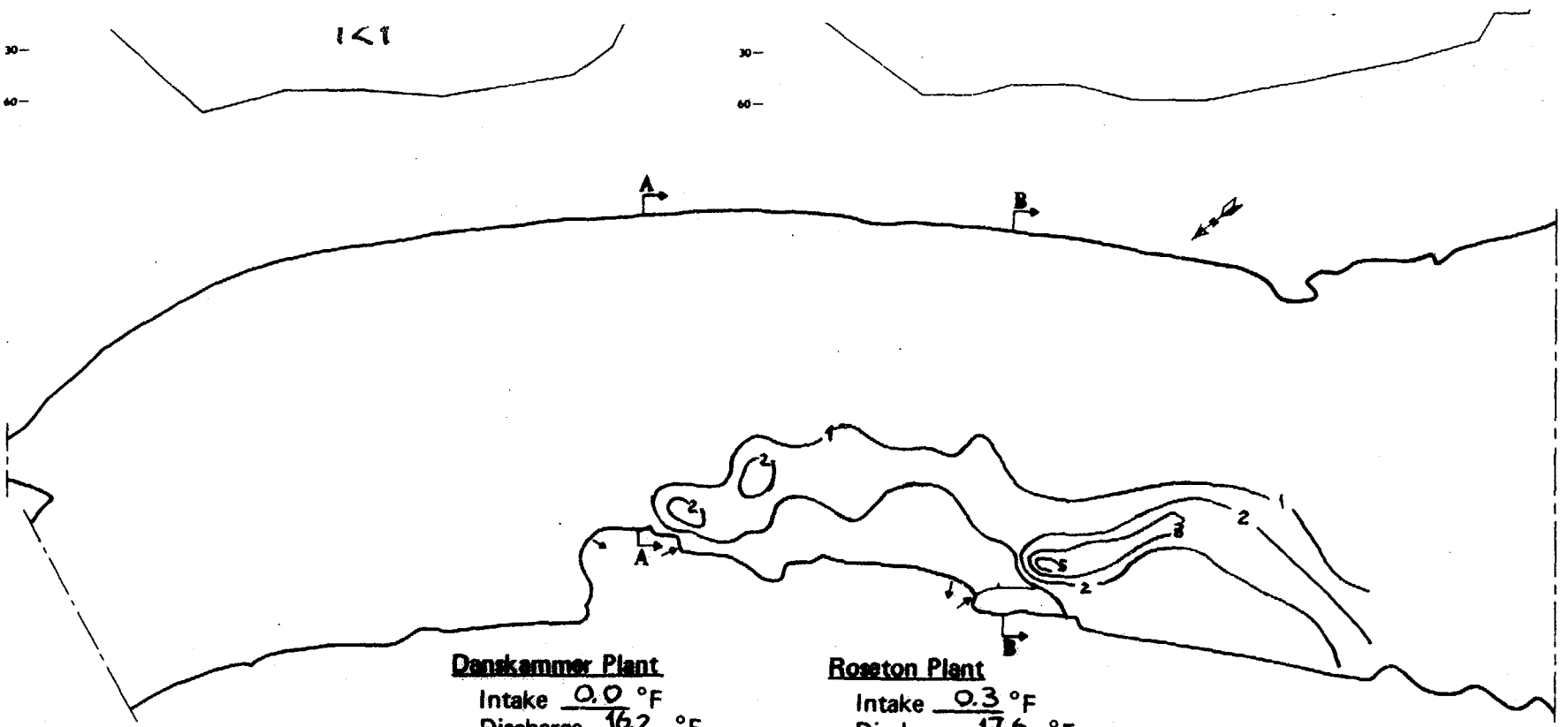


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 146



Danskammer Plant

Intake 0.0 °F
Discharge 16.2 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.6 °F
ΔT 17.3 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 80 %
Dry Bulb Temperature 74.8 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

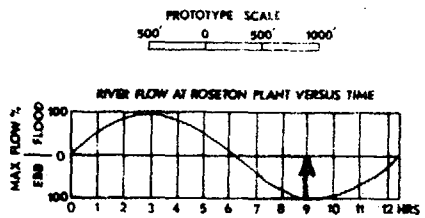
Fresh Water Flow 6000 cfs
Ambient Temperature 74.2 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

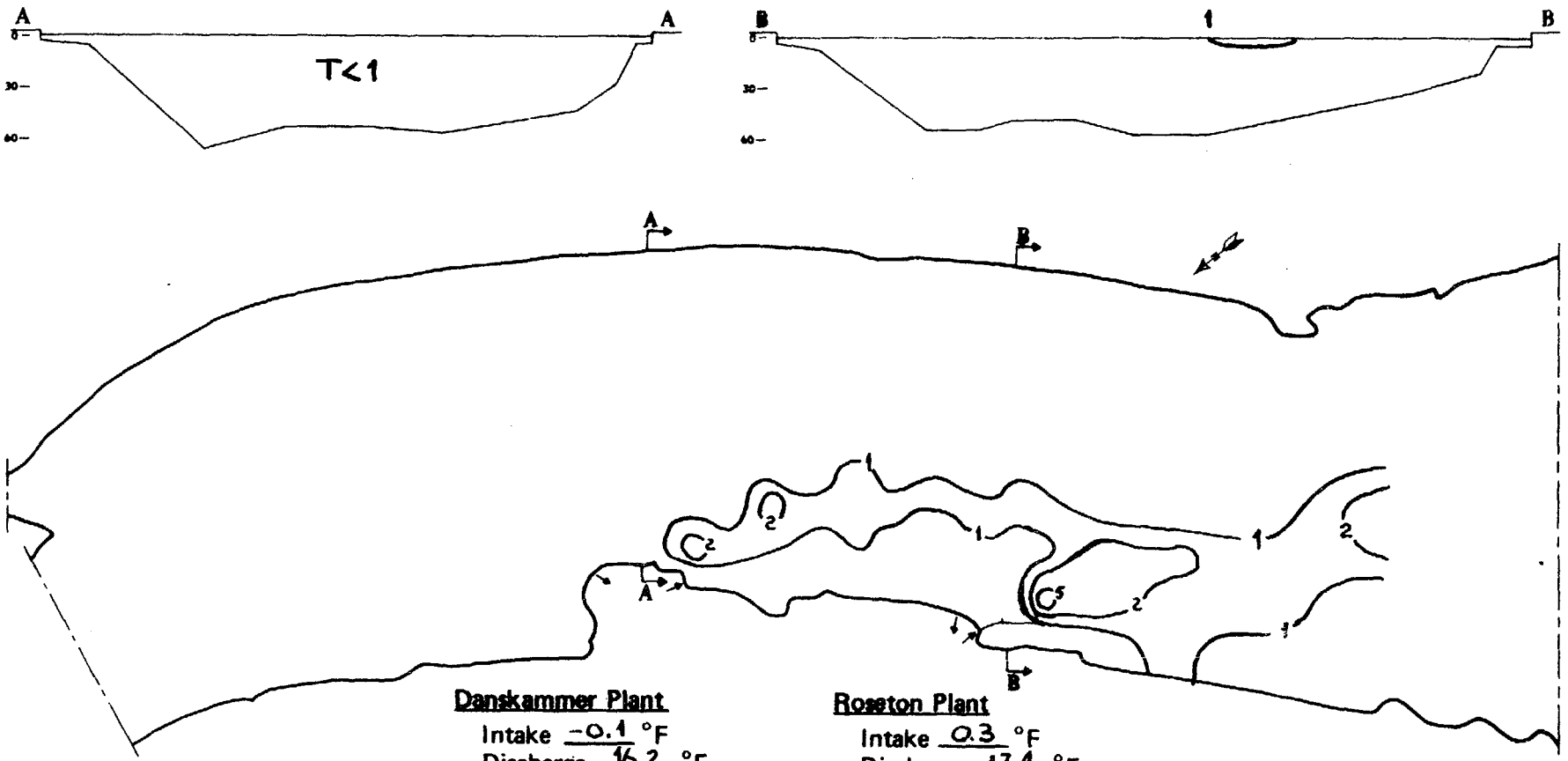


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 147



Danskammer Plant

Intake -0.1 °F
Discharge 16.2 °F
ΔT 16.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 75 %
Dry Bulb Temperature 74.8 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

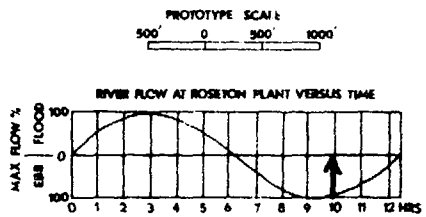
Fresh Water Flow 6000 cfs
Ambient Temperature 74.9 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

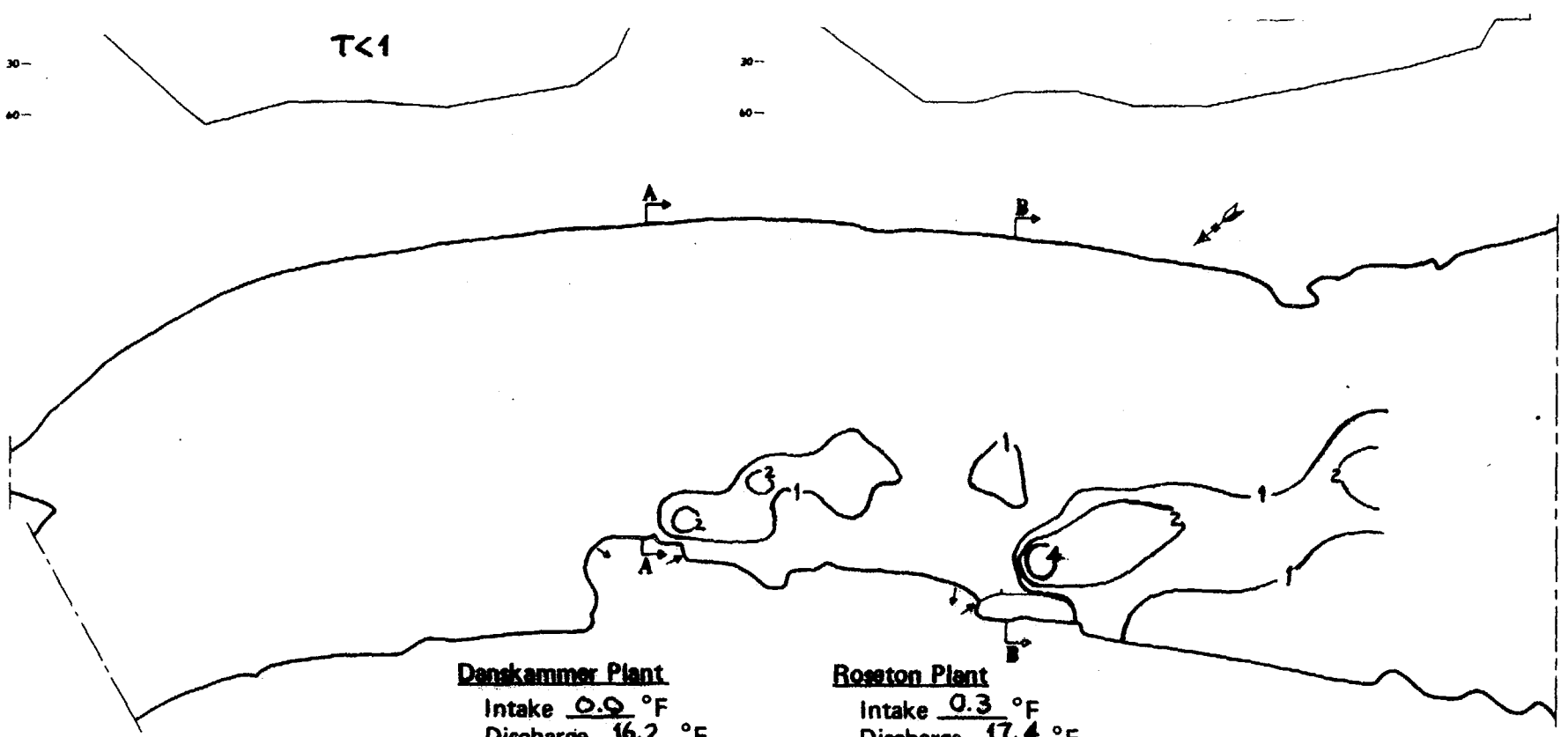


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 148



Danskammer Plant

Intake 0.0 °F
Discharge 16.2 °F
ΔT 16.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.3 °F
Discharge 17.4 °F
ΔT 17.1 °F
Flow 1400 cfs
** Outfall Configuration 1B

Room Atmosphere

Relative Humidity 82 %
Dry Bulb Temperature 74.7 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

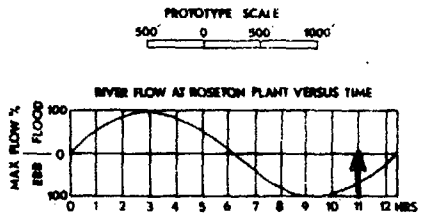
Fresh Water Flow 6000 cfs
Ambient Temperature 74.9 °F

Date 20 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

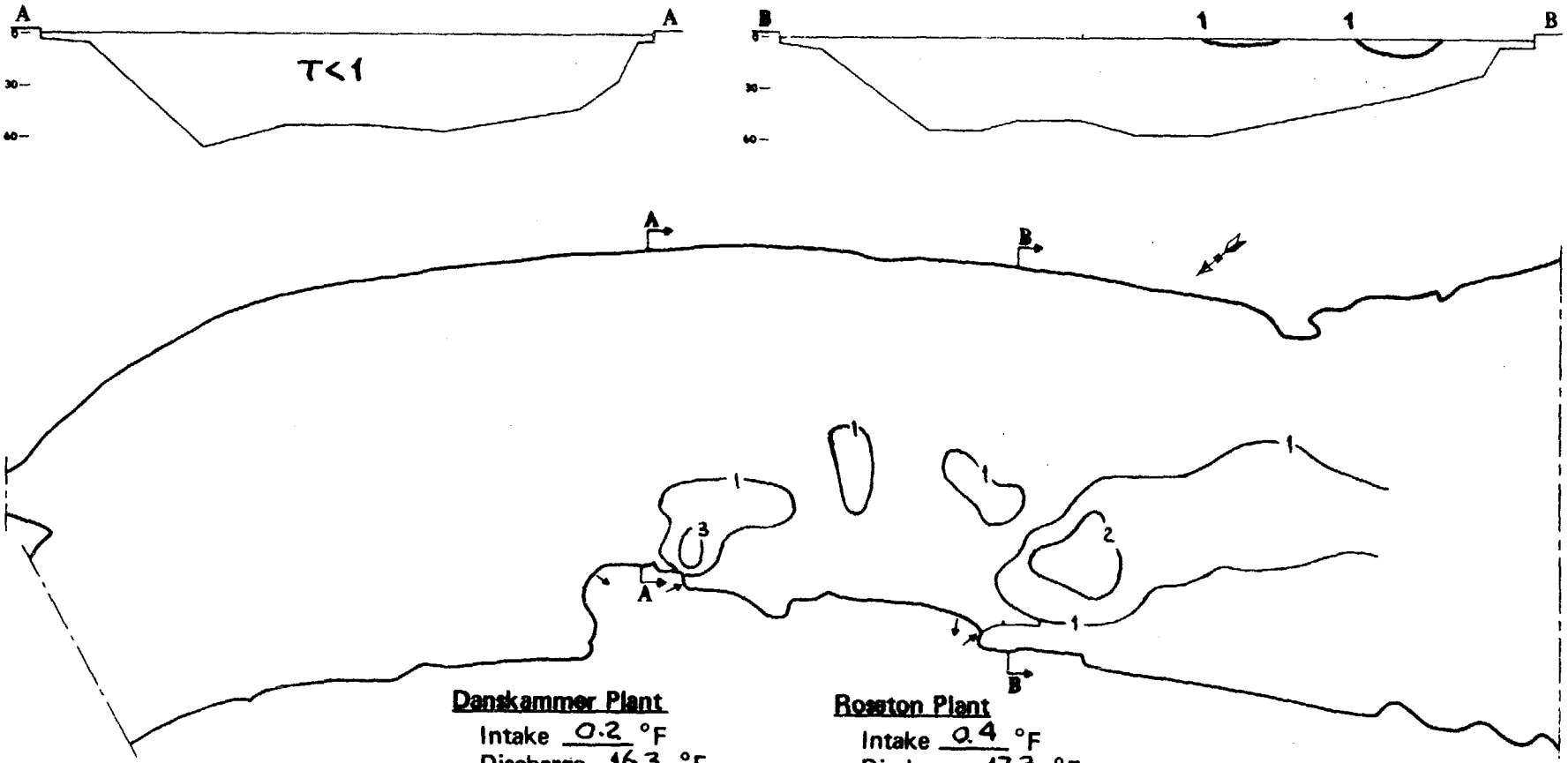


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 149



Danskammer Plant

Intake 0.2 °F
Discharge 16.3 °F
ΔT 16.1 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake 0.4 °F
Discharge 17.3 °F
ΔT 16.9 °F
Flow 1400 cfs
** Outfall Configuration 1B

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

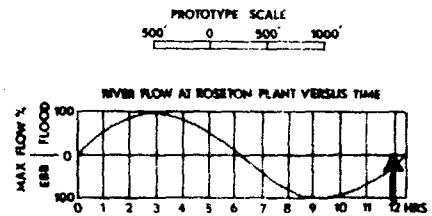
Room Atmosphere

Relative Humidity 78 %
Dry Bulb Temperature 74.1 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 74.9 °F

Date 20 SEPT. 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 150

DANSKAMMER

LOAD	100%
DISCHARGE DESIGN	7 PORT DIFFUSER
DISCHARGE FLOW	700 CFS
TEMPERATURE RISE	17.3 F

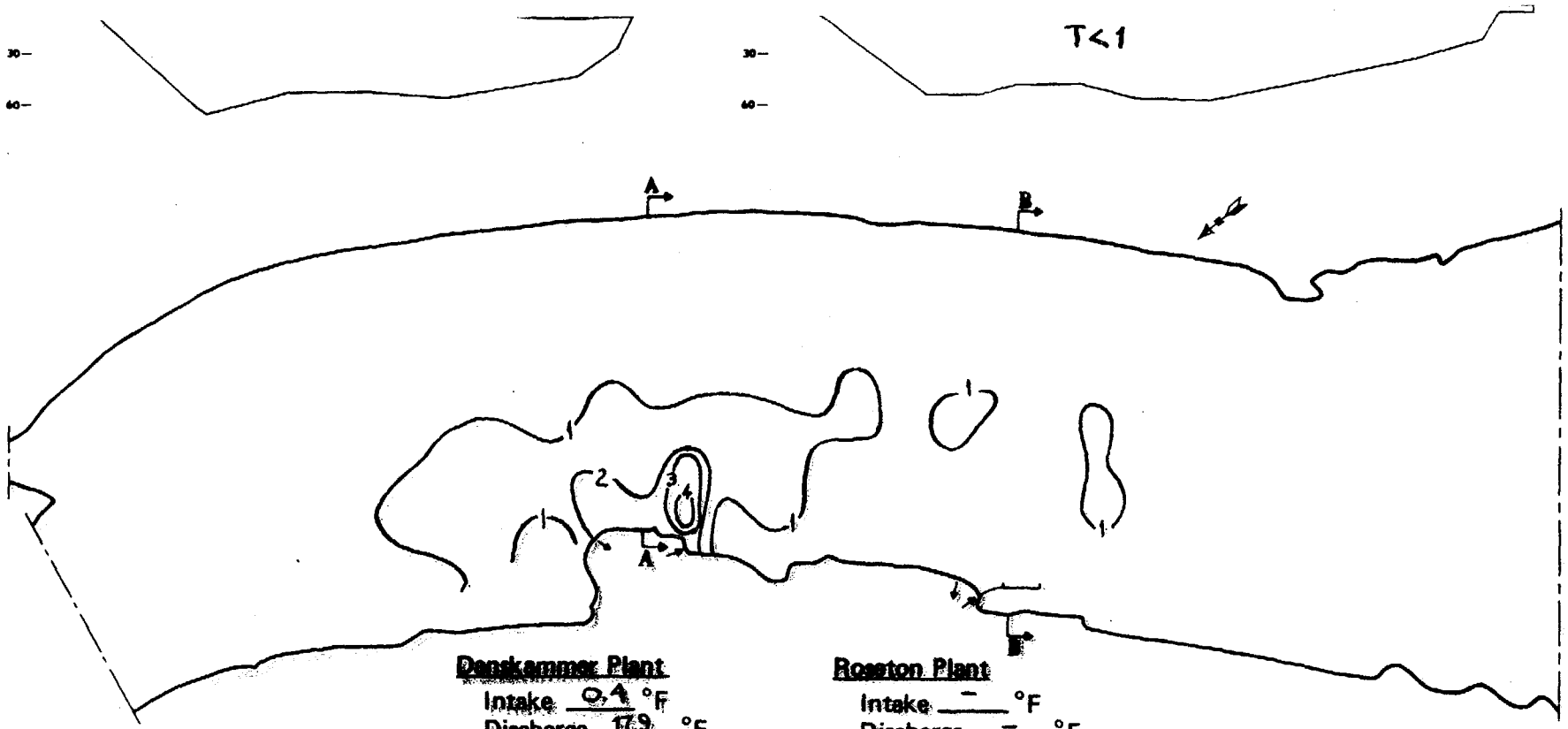
ROSETON NOT OPERATING

LOAD	
DISCHARGE DESIGN	
DISCHARGE FLOW	
TEMPERATURE RISE	
OIL BARGE	NOT INCLUDED

RIVER CONDITIONS

AMBIENT TEMPERATURE	69.9 F
FRESH WATER FLOW	6000 CFS

TEST DATE 21 SEPT. 1972



Danskammer Plant

Intake 0.4 °F
Discharge 17.9 °F
ΔT 17.5 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 70.6 °F
Thermal Equilibrium Box Temperature -0.8 °F

River

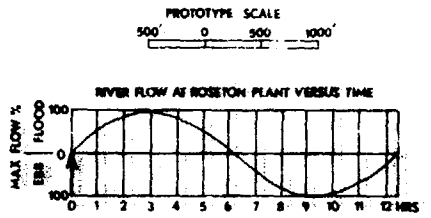
Fresh Water Flow 6000 cfs
Ambient Temperature 69.7 °F

Date 21 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

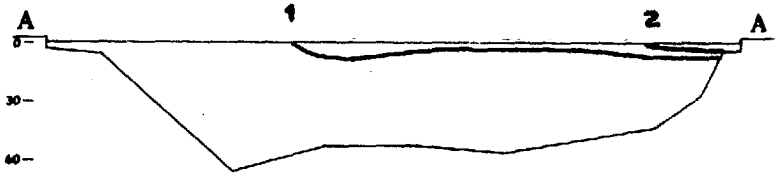


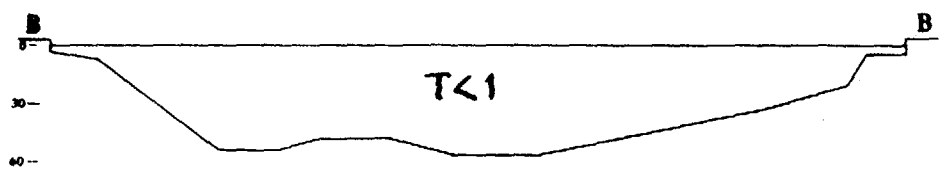
TEMPERATURE RISE ABOVE RIVER AMBIENT

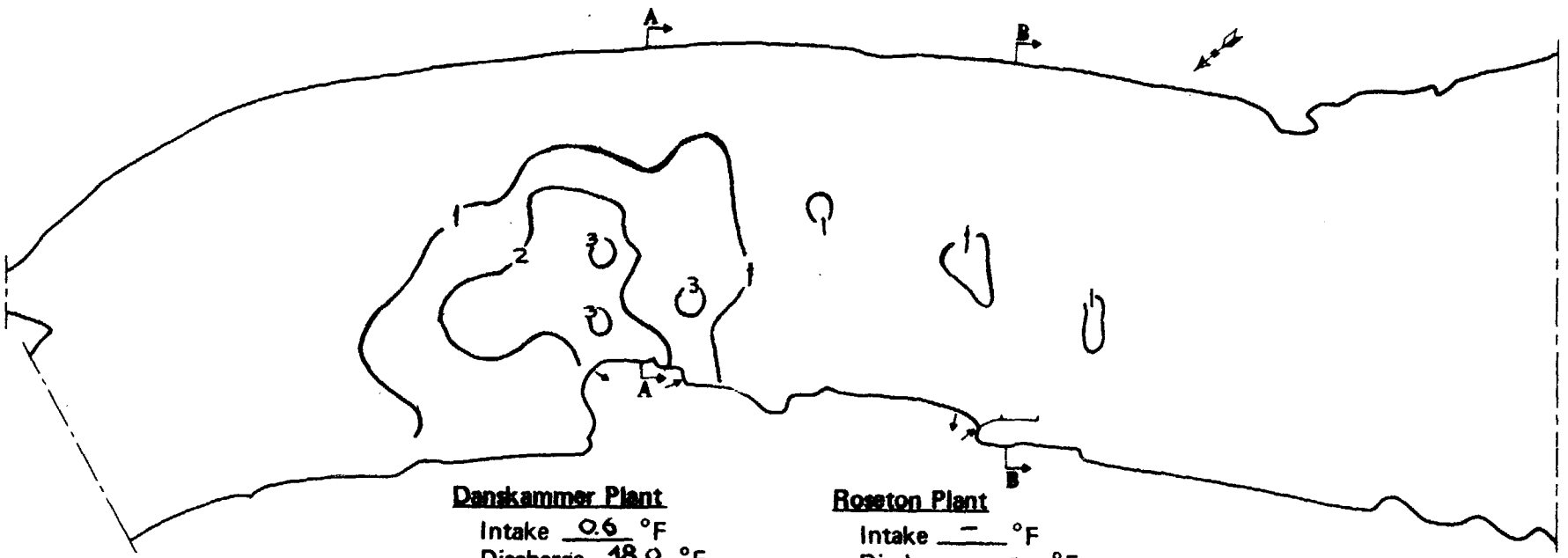
Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 151







Danskammer Plant

Intake 0.6 °F
Discharge 18.0 °F
ΔT 17.4 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
**Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 70.6 °F
Thermal Equilibrium Box Temperature -0.8 °F

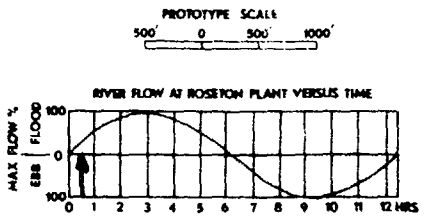
River

Fresh Water Flow 6000 cfs
Ambient Temperature 69.8°F

**1. All 14 Ports

A. With Barge
B. Without Barge

Date 21 SEPT. 72

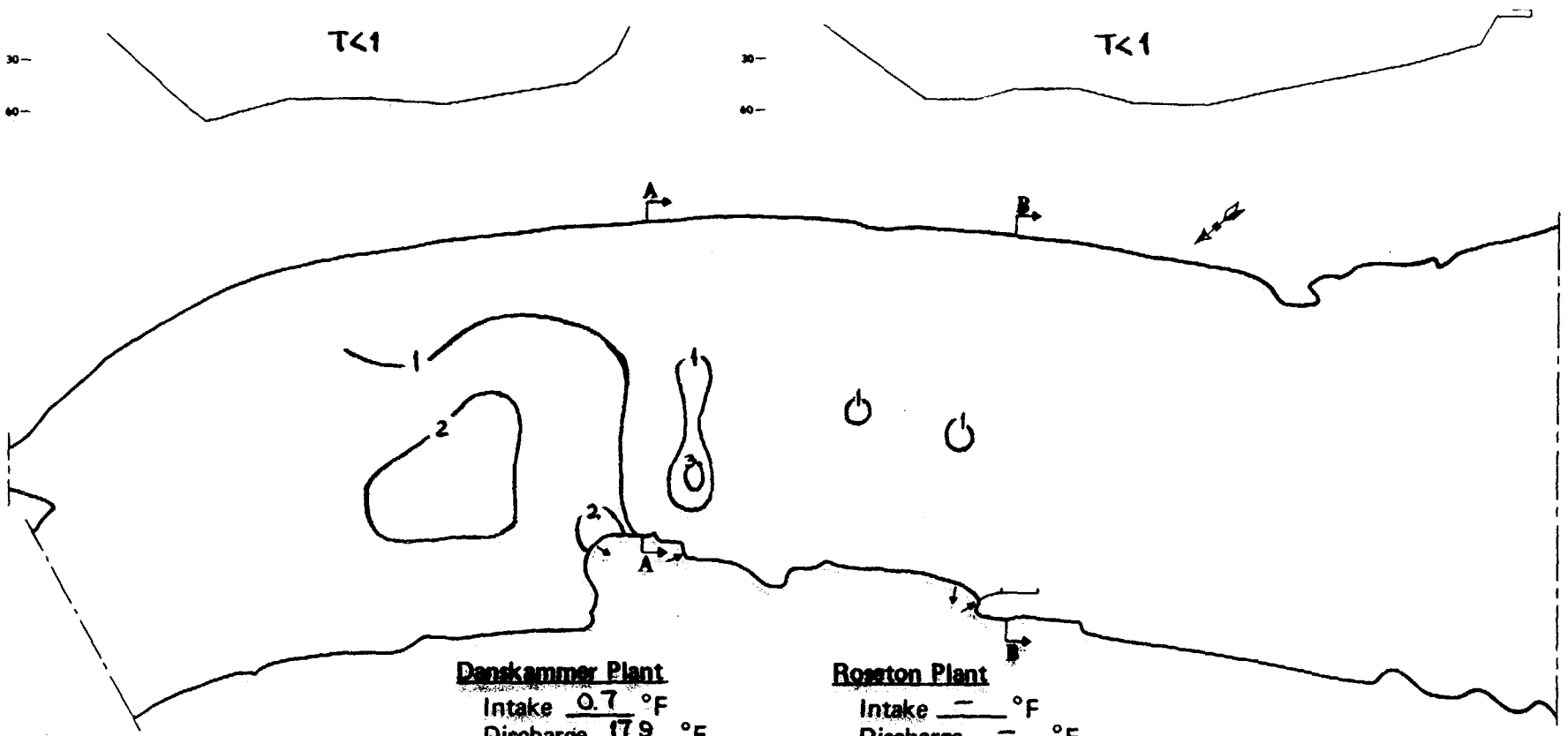


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 152



Danskammer Plant

Intake 0.7 °F
Discharge 17.9 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 70.6 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

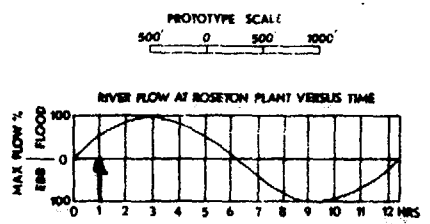
Fresh Water Flow 6000 cfs
Ambient Temperature 69.8° F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



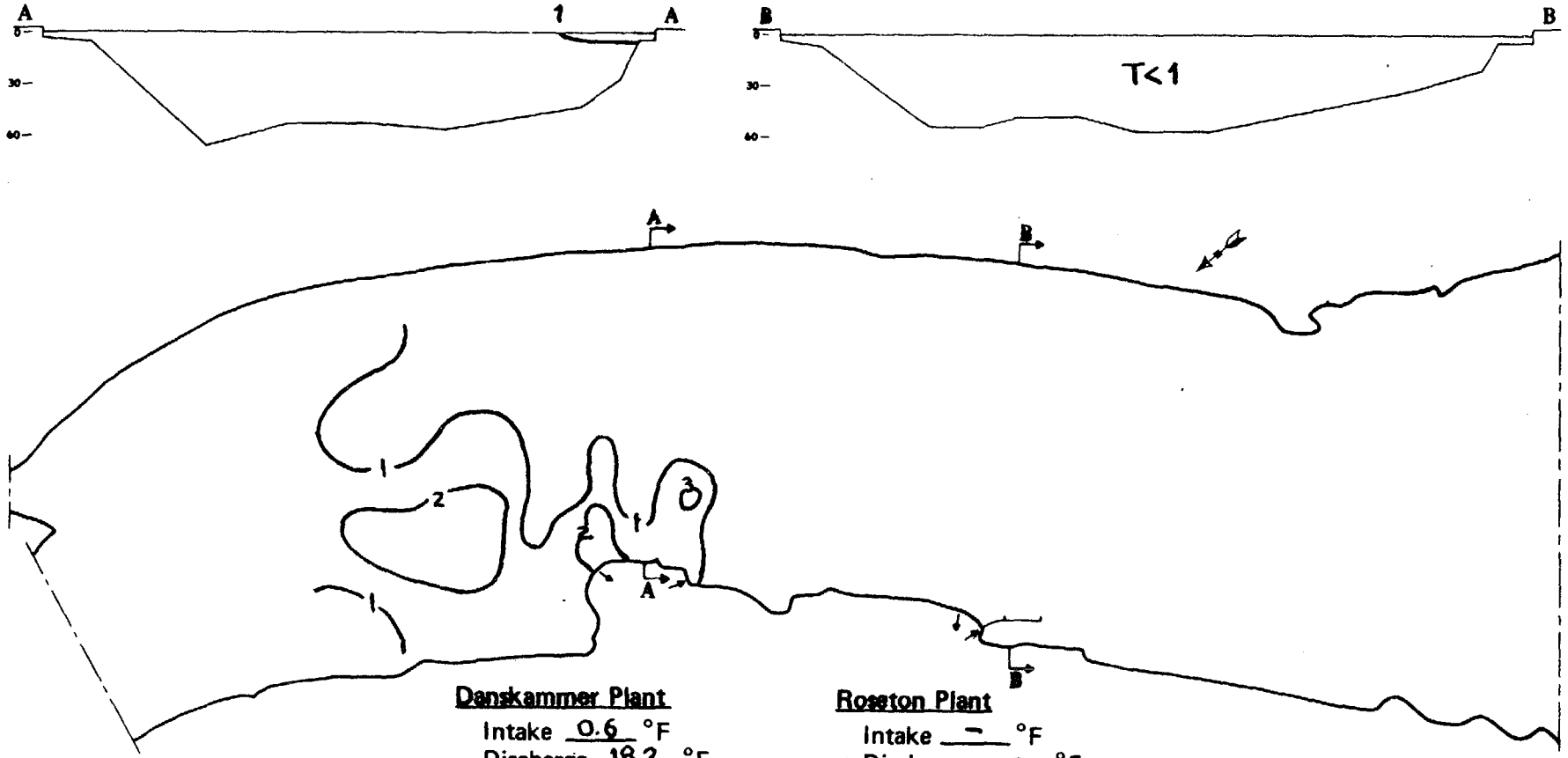
TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 153

FIGURE A 154



Danskammer Plant

Intake 0.6 °F
Discharge 18.2 °F
ΔT 17.6 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 70.7 °F
Thermal Equilibrium Box Temperature -0.7 °F

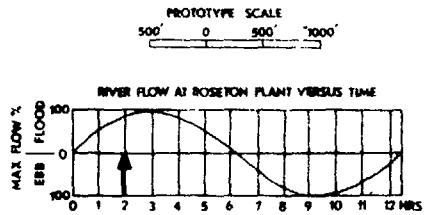
**1. All 14 Ports

River

Fresh Water Flow 6000 cfs
Ambient Temperature 69.8 °F

A. With Barge
B. Without Barge

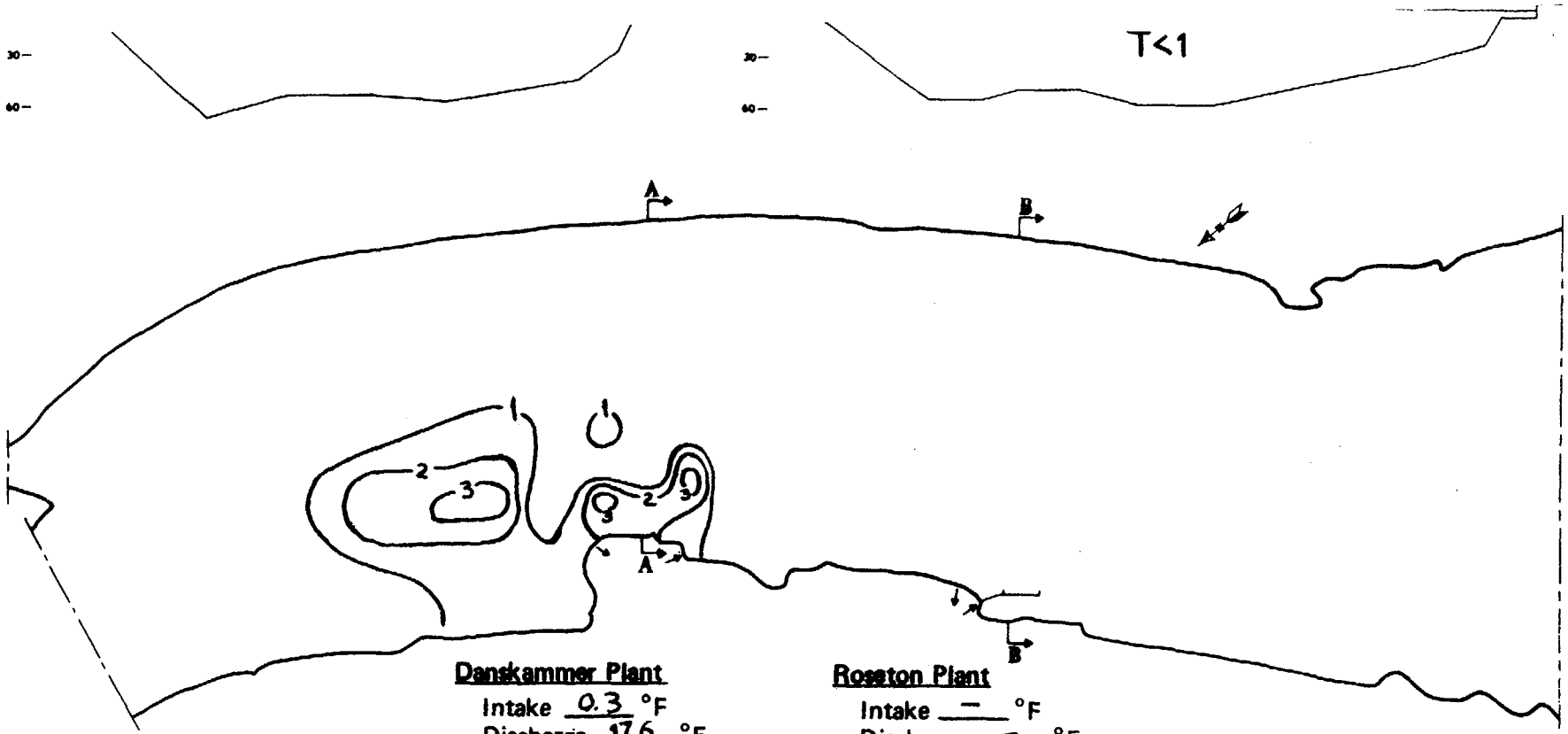
Date 21 SEPT. 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake 0.3 °F
Discharge 17.6 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 3

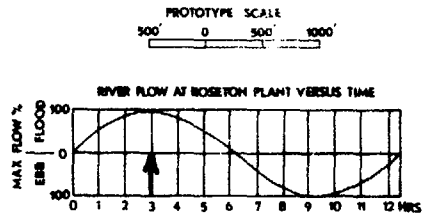
Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 70.7 °F
Thermal Equilibrium Box Temperature -0.7 °F



River

Fresh Water Flow 6000 cfs
Ambient Temperature 69.8 °F

**1. All 14 Ports

A. With Barge
B. Without Barge

Date 21 SEPT. 72

TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 155

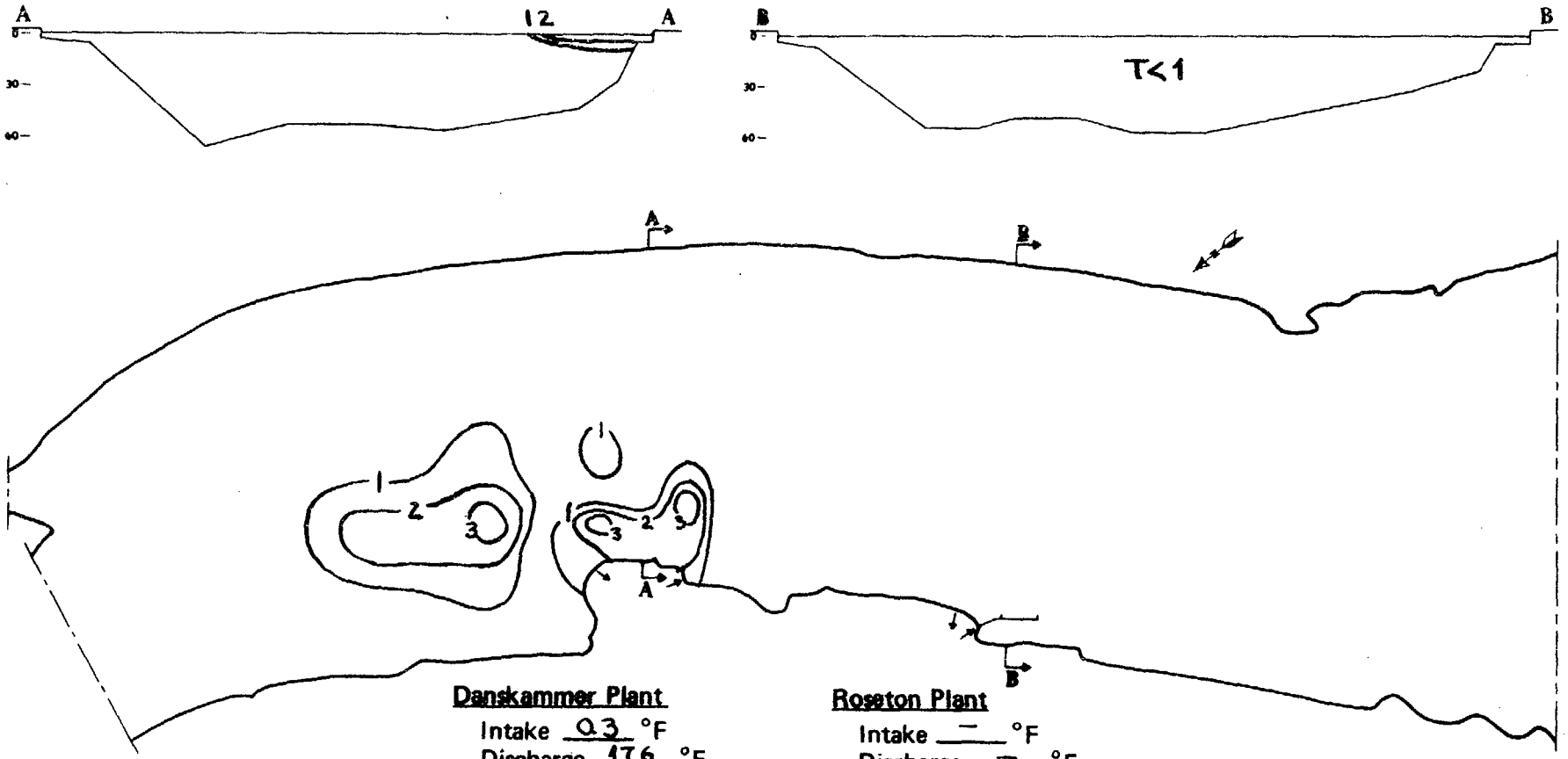


FIGURE A 156

Danskammer Plant

Intake 53 °F
Discharge 176 °F
ΔT 123 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

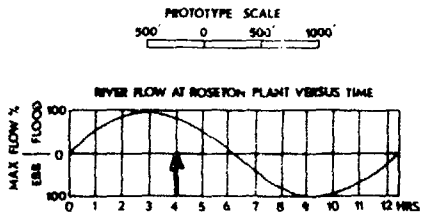
Room Atmosphere

Relative Humidity 93 %
Dry Bulb Temperature 70.7 °F
Thermal Equilibrium Box Temperature -0.7 °F

River

Fresh Water Flow 6000 cfs
Ambient Temperature 69.8 °F

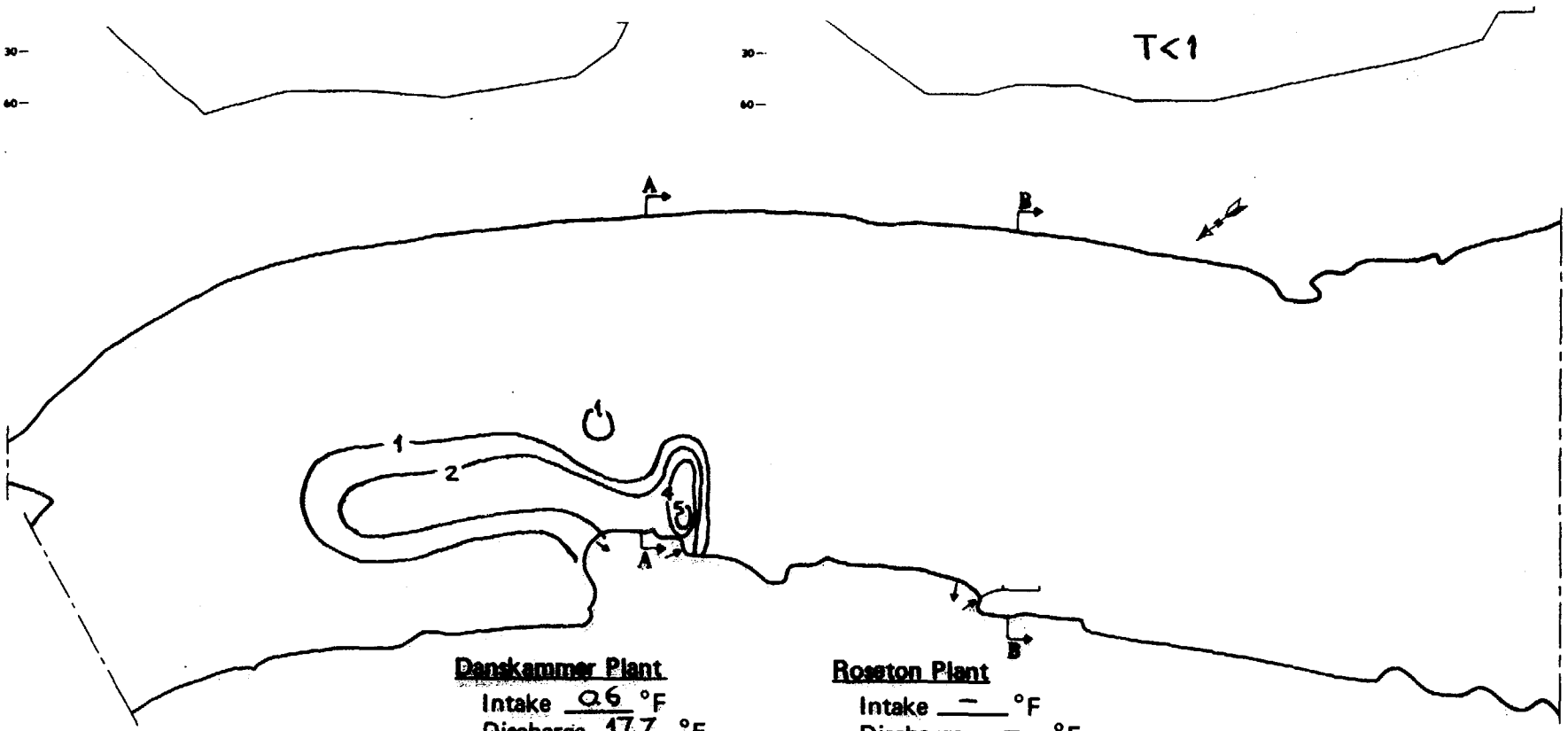
Date 21 SEPT. 72



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL



Danskammer Plant

Intake 96 °F
Discharge 117 °F
ΔT 17.1 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 92 %
Dry Bulb Temperature 70.9 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

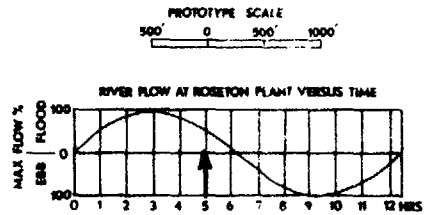
Fresh Water Flow 6000 cfs
Ambient Temperature 69.9 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

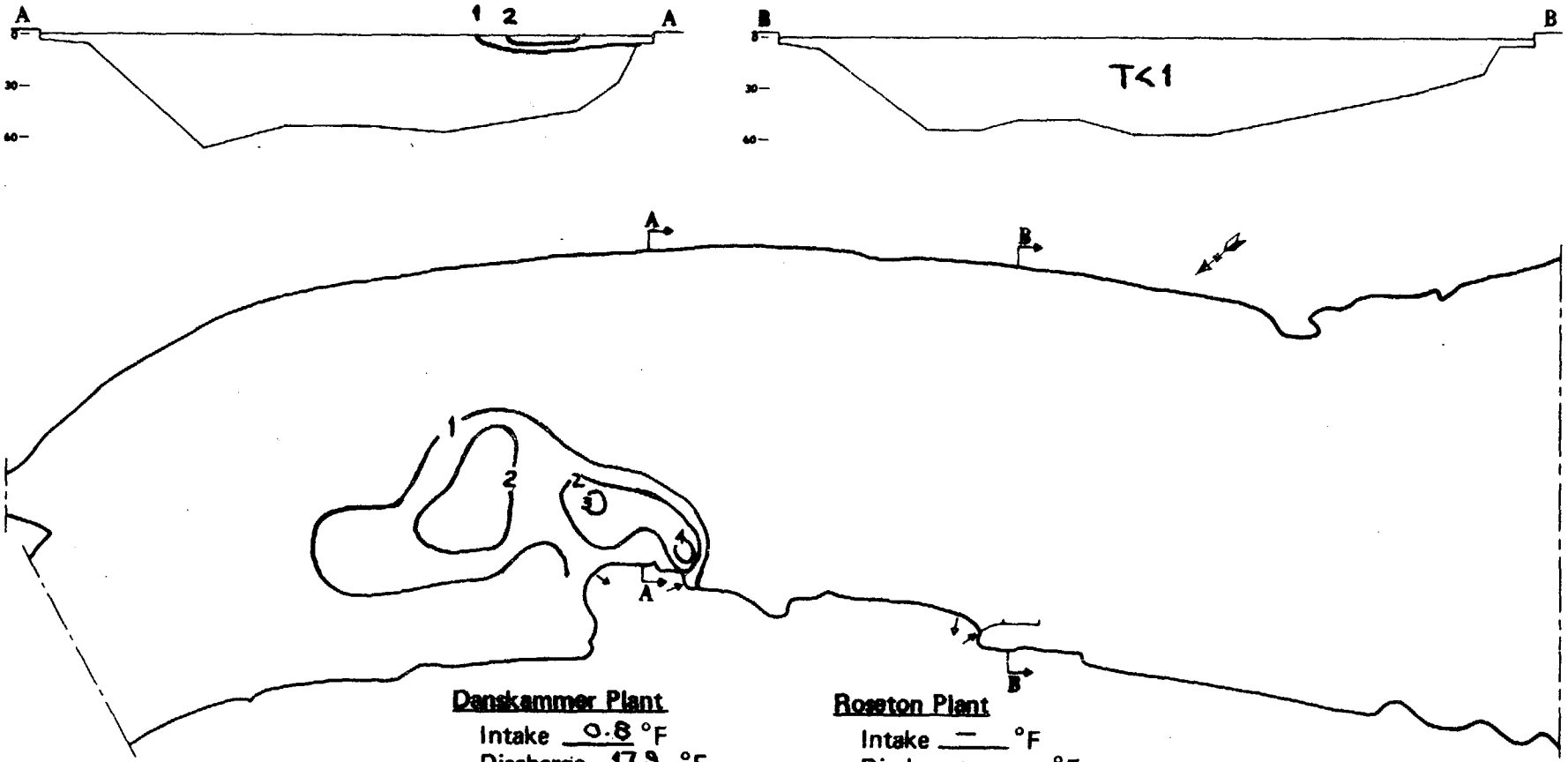


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 157



Danskammer Plant

Intake 0.8 °F
Discharge 17.9 °F
ΔT 17.1 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake — °F
Discharge — °F
ΔT — °F
Flow — cfs
** Outfall Configuration —

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 71.2 °F
Thermal Equilibrium Box Temperature −0.6 °F

River

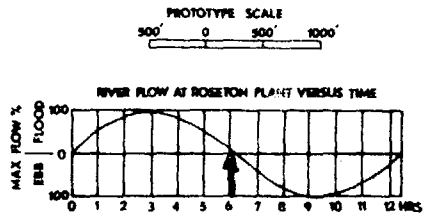
Fresh Water Flow 6000 cfs
Ambient Temperature 69.9 °F

Date 21 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

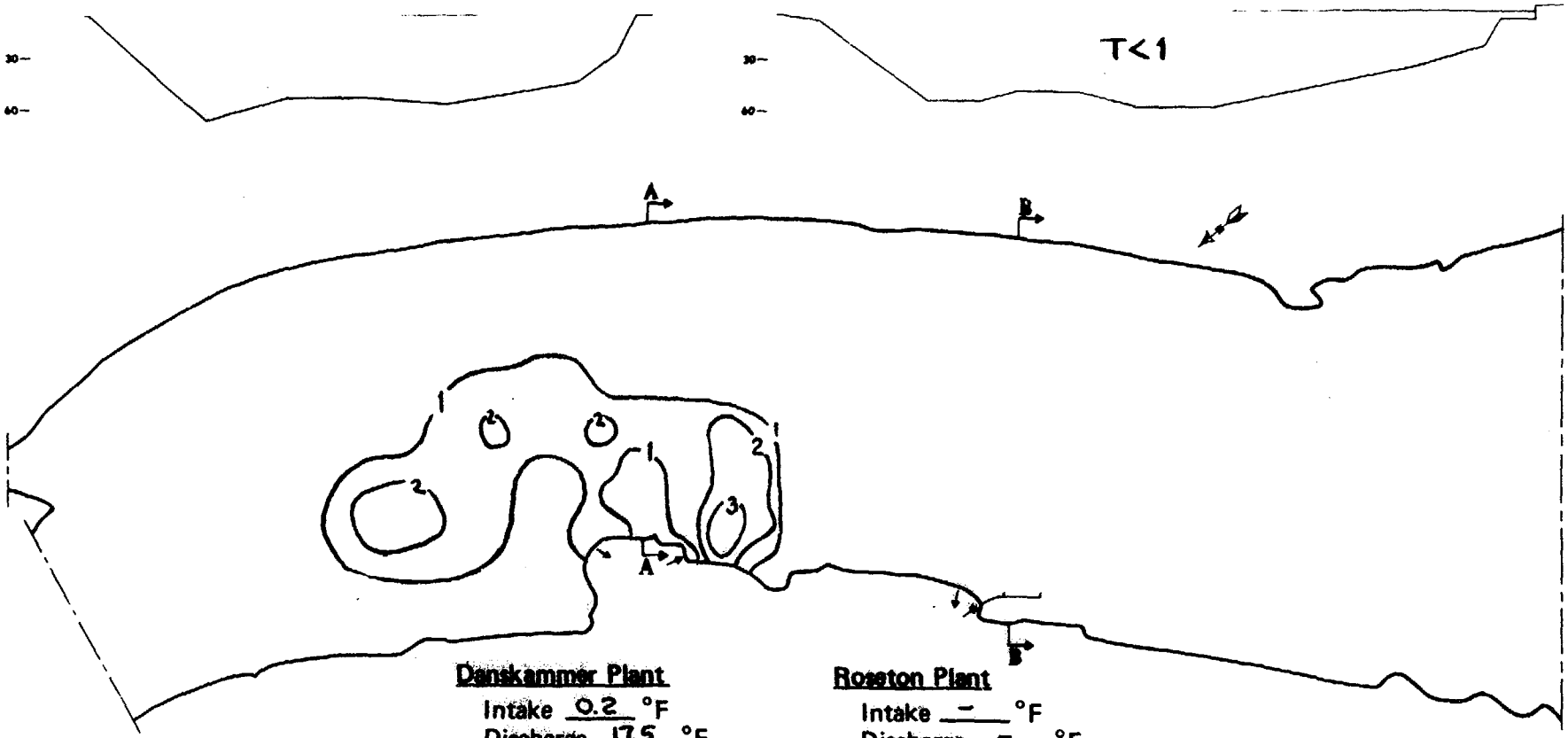


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ANRL

FIGURE A 158



Danskammer Plant

Intake 0.2 °F
Discharge 17.5 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 71.0 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

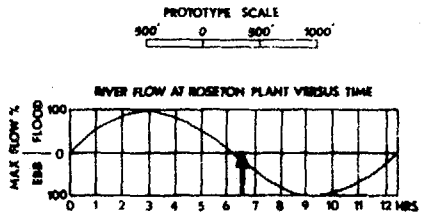
Fresh Water Flow 6000 cfs
Ambient Temperature 69.9 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

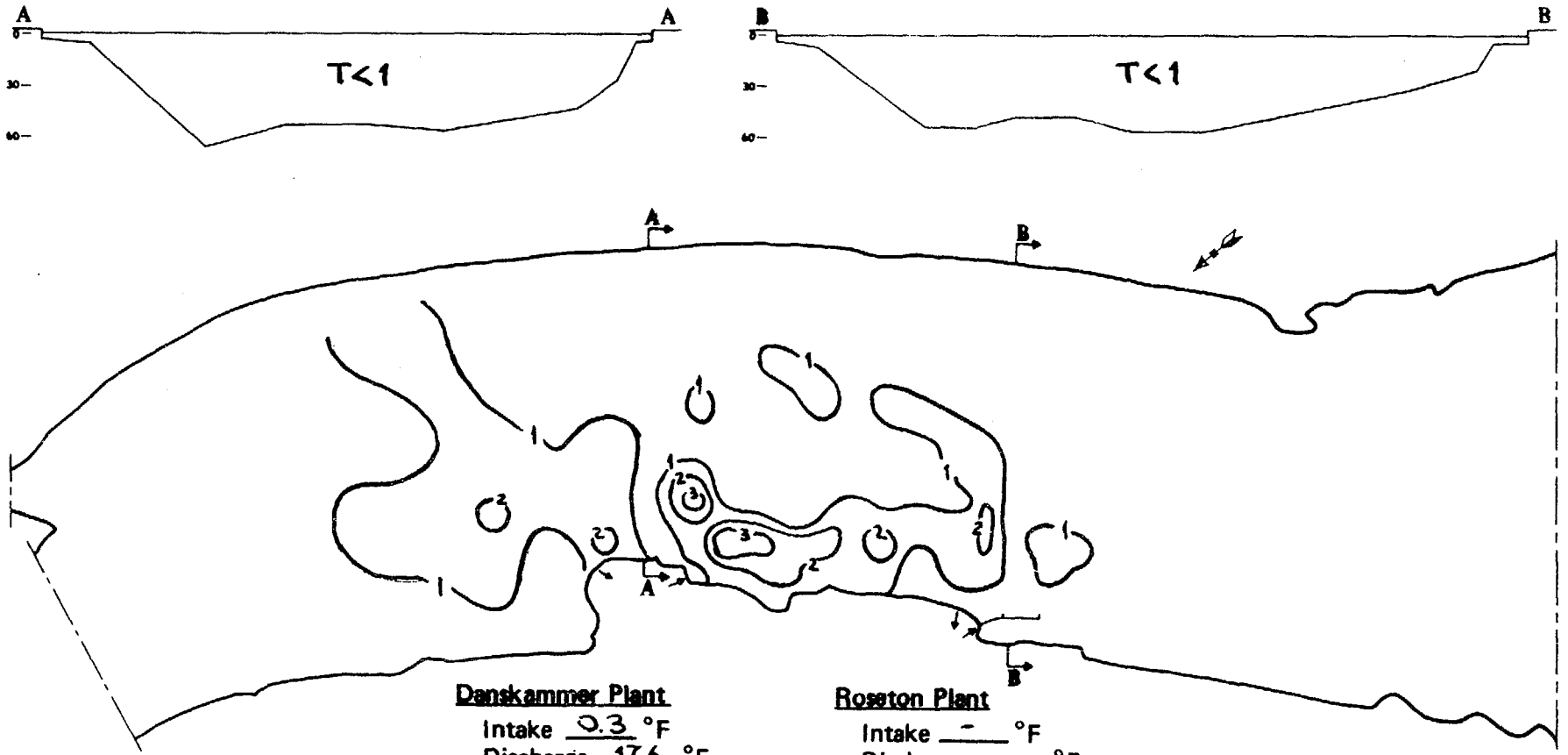


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ARL

FIGURE A 159



Danskammer Plant

Intake 0.3 °F
Discharge 17.6 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 71.1 °F
Thermal Equilibrium Box Temperature -0.6 °F

River

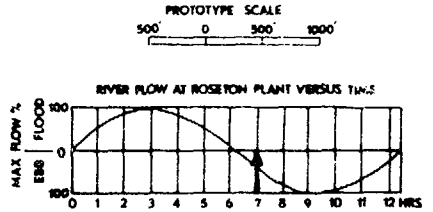
Fresh Water Flow 6000 cfs
Ambient Temperature 70.0 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

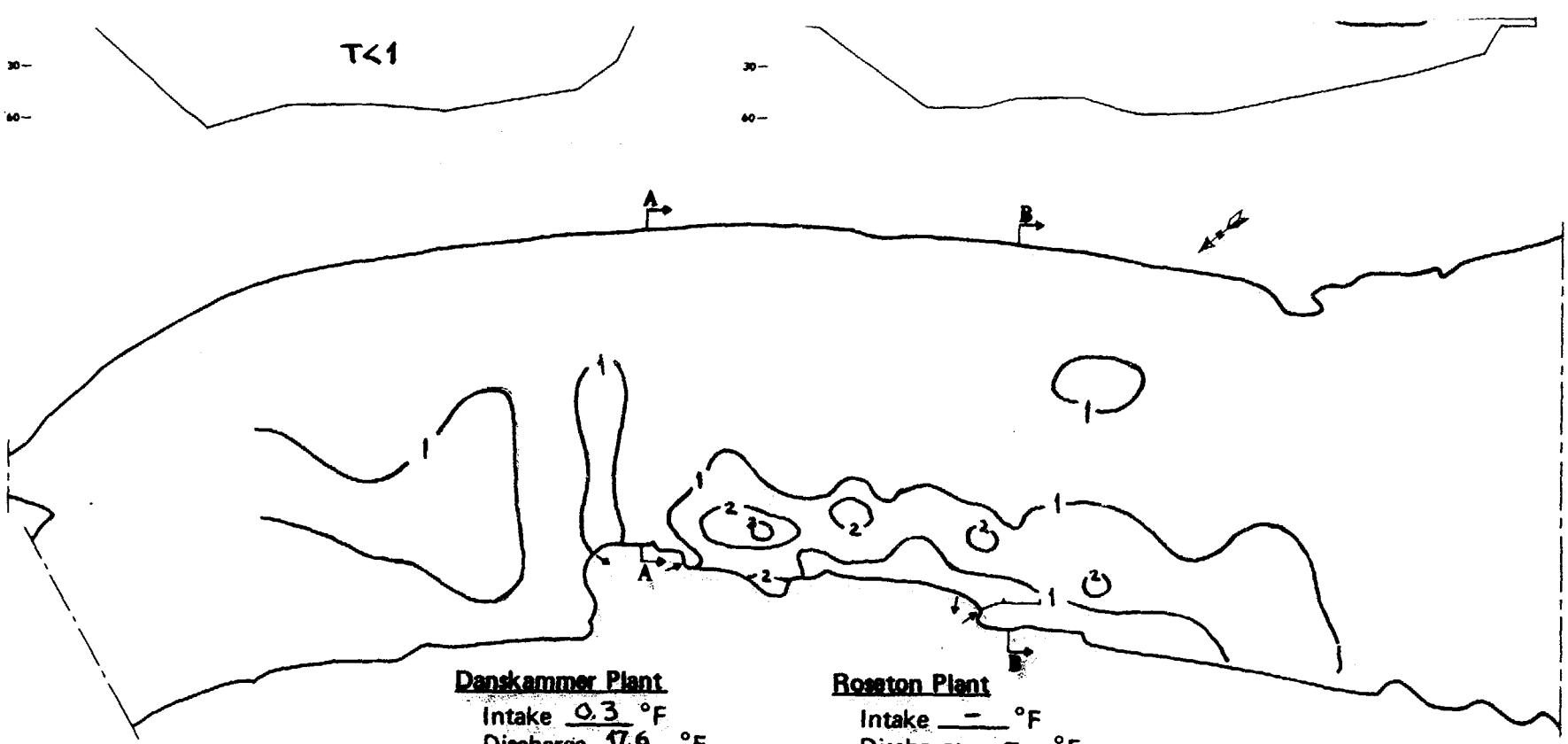


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer—Roseton Power Stations

ANL

FIGURE A 160



Danskammer Plant

Intake 0.3 °F
Discharge 17.6 °F
ΔT 17.3 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake – °F
Discharge – °F
ΔT – °F
Flow – cfs
** Outfall Configuration –

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 71.0 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

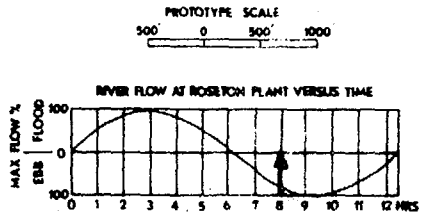
Fresh Water Flow 6000 cfs
Ambient Temperature 70.0 °F

Date 21 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 161

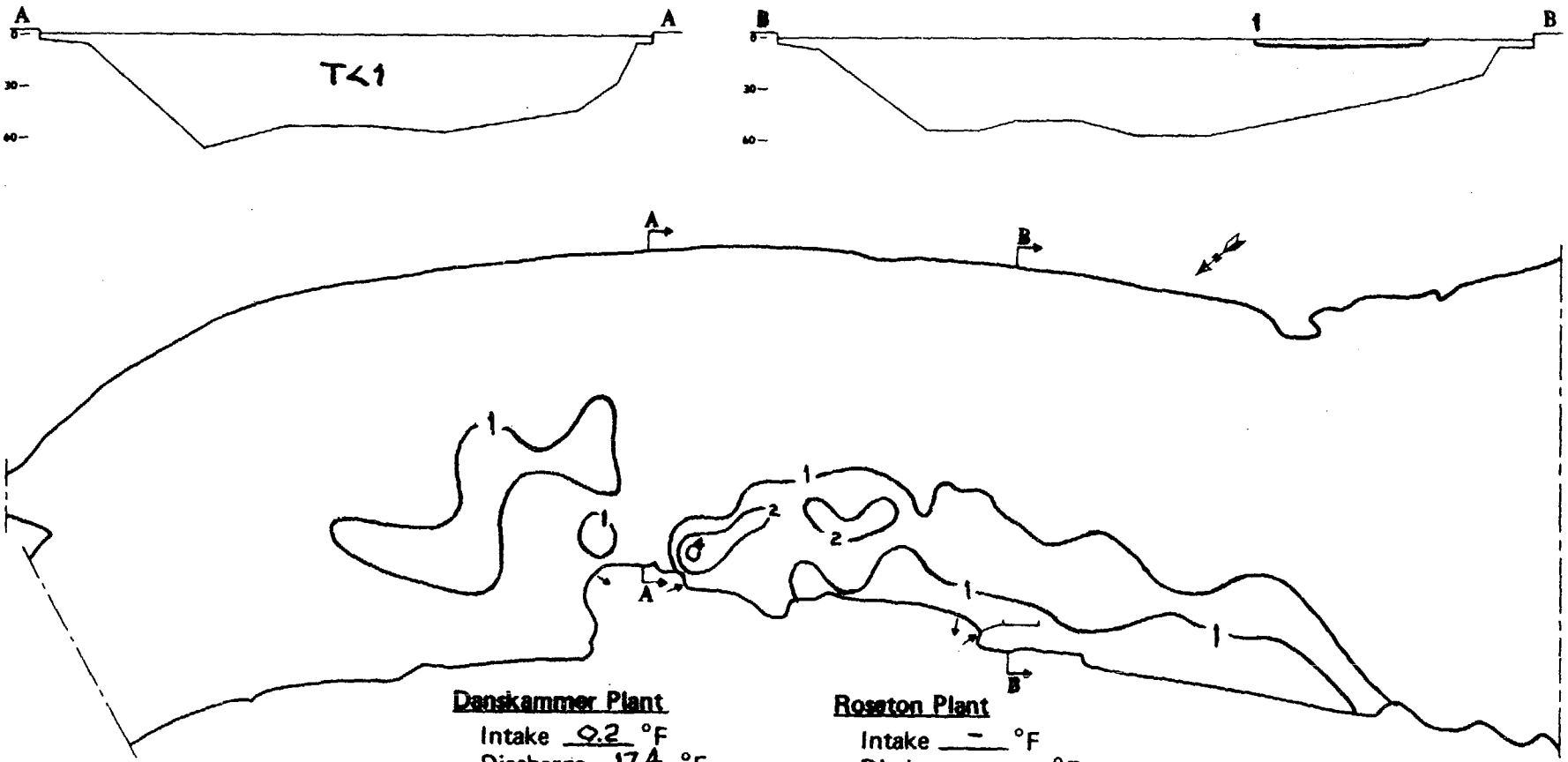


FIGURE A 162

Danskammer Plant

Intake 9.2 °F
Discharge 17.4 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake – °F
Discharge – °F
ΔT – °F
Flow – cfs
** Outfall Configuration –

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 70.8 °F
Thermal Equilibrium Box Temperature 70.5 °F

River

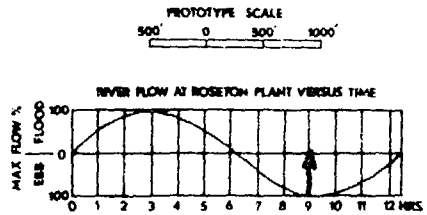
Fresh Water Flow 6000 cfs
Ambient Temperature 70.0 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

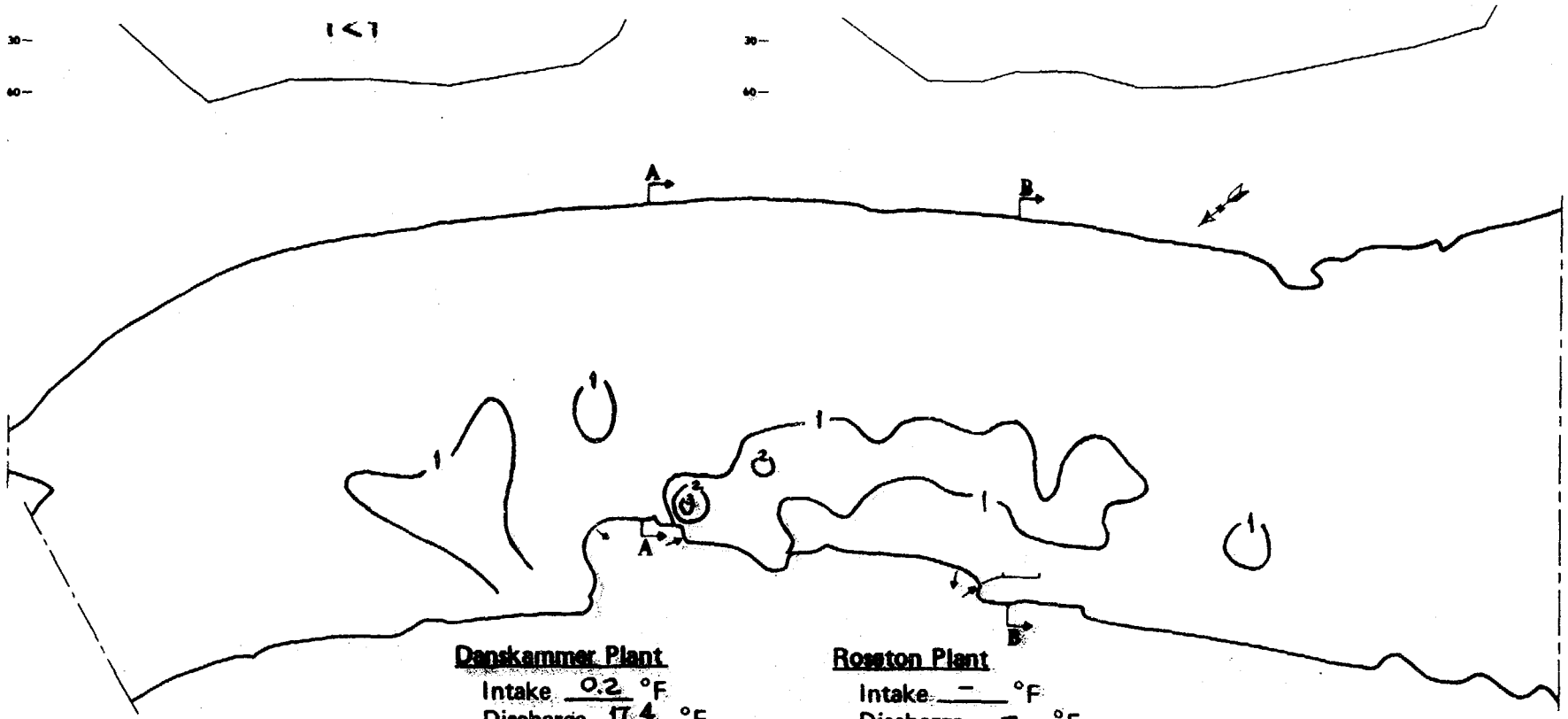
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL



Danskammer Plant

Intake 0.2 °F
Discharge 17.4 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake – °F
Discharge – °F
ΔT – °F
Flow – cfs
** Outfall Configuration –

Room Atmosphere

Relative Humidity 91 %
Dry Bulb Temperature 71.1 °F
Thermal Equilibrium Box Temperature -04 °F

River

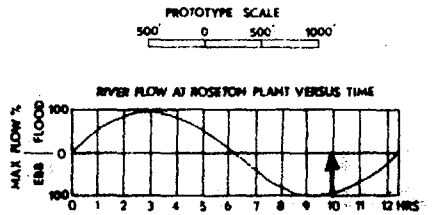
Fresh Water Flow 6000 cfs
Ambient Temperature 70.0°F

Date 21 SEPT 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge

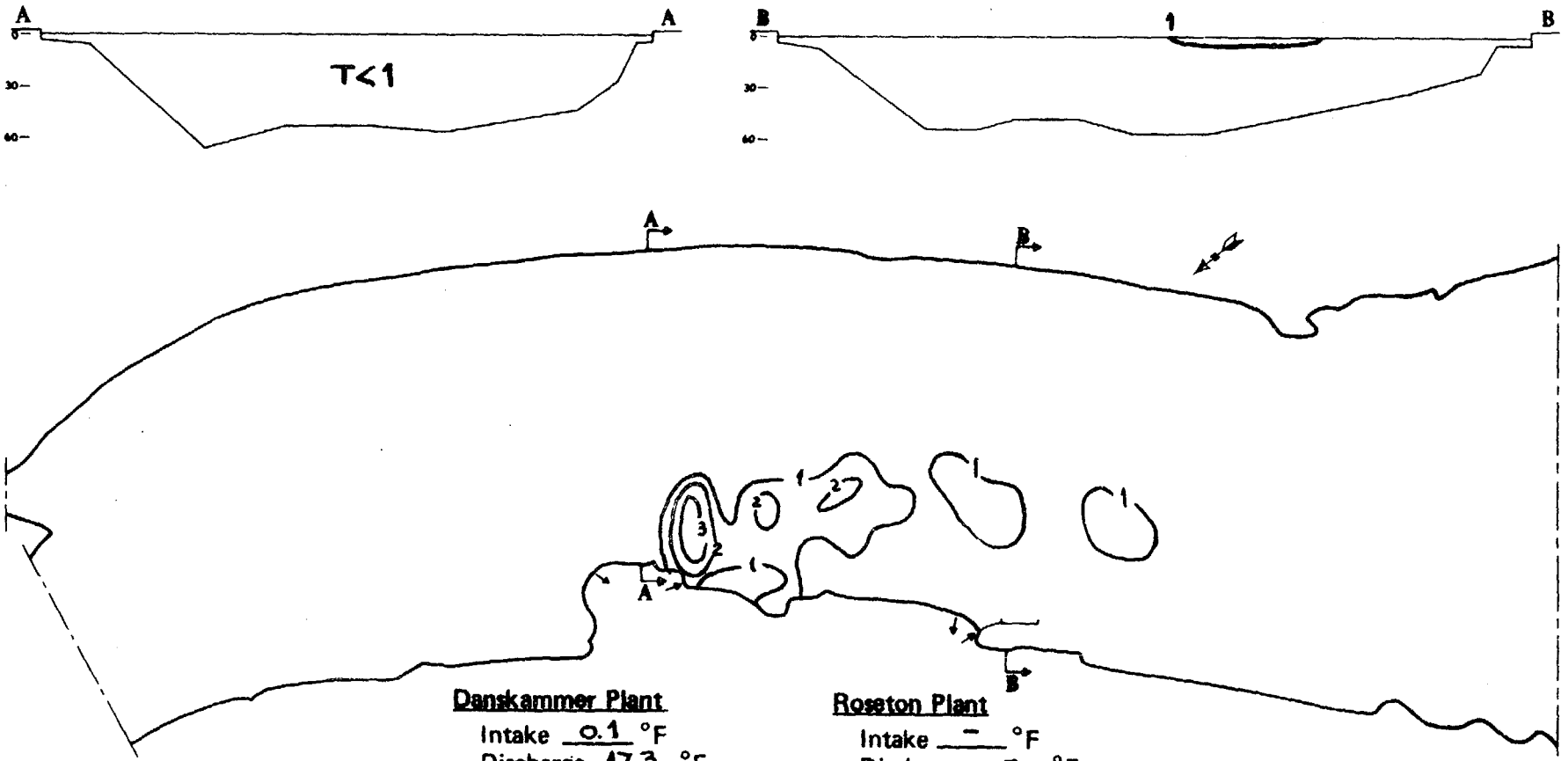


TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 163



Danskammer Plant

Intake 0.1 °F
Discharge 17.3 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 90 %
Dry Bulb Temperature 71.2 °F
Thermal Equilibrium Box Temperature -0.5 °F

River

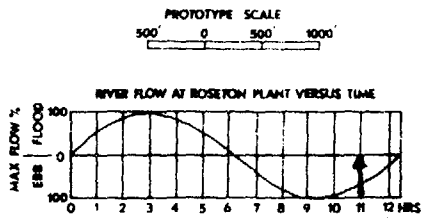
Fresh Water Flow 6000 cfs
Ambient Temperature 70.1° F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

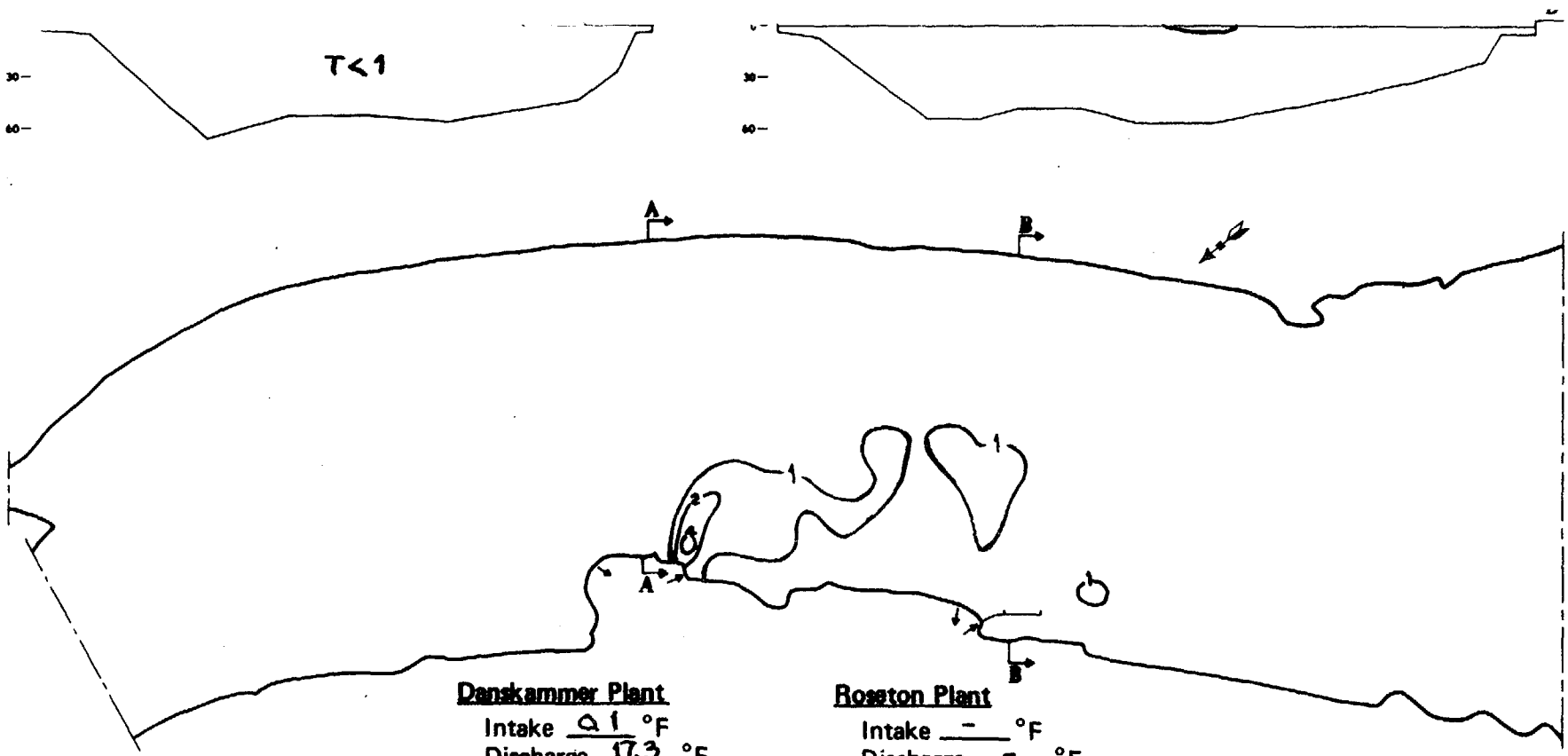
A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

FIGURE A 164



Danskammer Plant

Intake 61 °F
Discharge 77.3 °F
ΔT 17.2 °F
Flow 700 cfs
* Outfall Configuration 3

Roseton Plant

Intake - °F
Discharge - °F
ΔT - °F
Flow - cfs
** Outfall Configuration -

Room Atmosphere

Relative Humidity 89 %
Dry Bulb Temperature 70.8 °F
Thermal Equilibrium Box Temperature -0.4 °F

River

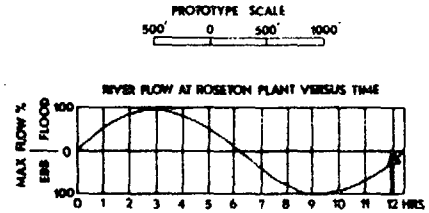
Fresh Water Flow 6000 cfs
Ambient Temperature 70.1 °F

Date 21 SEPT. 72

*1. As Designed
*2. Bulkhead
*3. Diffuser - 10 fps

**1. All 14 Ports

A. With Barge
B. Without Barge



TEMPERATURE RISE ABOVE RIVER AMBIENT

Hydrothermal Model Studies
Danskammer–Roseton Power Stations

ARL

FIGURE A 165