1992 ANNUAL ENVIRONMENTAL REPORT
NON-RADIOLOGICAL
DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
UNITS NO. 1 & 2

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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

APPENDIXES

APPENDIX A

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
TERRESTRIAL MONITORING PROGRAM
1992

APPENDIX B

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
OHIO RIVER
IN-SITU *Corbicula* GROWTH STUDY
1992

LIST OF FIGURES

LIST OF FIGURES
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

I. INTRODUCTION

This report presents a summary of the Non-Radiological Environmental Program conducted by Duquesne Light Company (DLC) during calendar year 1992, for the Beaver Valley Power Station (BVPS) Units 1 and 2, Operating License Numbers DPR-66 and NPF-73. This is primarily an optional program, since the Nuclear Regulatory Commission (NRC) on February 26, 1980, granted DLC's request to delete all of the Aquatic Monitoring Program, with the exception of fish impingement (Amendment No. 25), from the Environmental Technical Specifications (ETS), and in 1983, dropped the fish impingement studies from the ETS program of required sampling along with non-radiological water quality requirements. However, in the interest of providing a non-disruptive data base DLC is continuing the Aquatic Monitoring Program. This report also contains a Terrestrial Monitoring Program (Appendix A) to satisfy the requirements for BVPS Unit 2 Environmental Technical Specifications, Appendix B, Sections 4.2.2 and 4.2.3, and an In-Situ Corbicula Growth Study (Appendix B) performed under the recommendation of the Pennsylvania Department of Environmental Resources.

A. SCOPE AND OBJECTIVES OF THE PROGRAM

The objectives of the 1992 environmental program were:

(1) to assess the possible environmental impact of plant operation (including impingement and entrainment) on the benthos, fish, and ichthyoplankton communities in the Ohio River,

(2) to provide a sampling program for establishing a continuing data base,

(3) to evaluate the presence of Corbicula at the BVPS and to assess the population of Corbicula in the Ohio River,

(4) to study the growth and reproduction of Corbicula in the intake structure and cooling towers of BVPS,

(5) to monitor for the potential infestation of the zebra mussel into the Ohio River near BVPS,

(6) to evaluate vegetation stress in the vicinity of the BVPS cooling towers, and

(7) to evaluate the impact of a chemical additive utilized in the Unit 1 and 2 river water systems on the growth of Corbicula used as environmental monitors in the Ohio River receiving system.

B. SITE DESCRIPTION

BVPS is located on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania, on a 501 acre tract of land. The Shippingport Station once shared the site with BVPS before being decommissioned. Figure I-1 shows an aerial view of BVPS. The site is approximately 1 mile (1.6 km) from Midland, Pennsylvania; 5 miles (8 km) from East Liverpool, Ohio; and 25 miles (40 km) from Pittsburgh, Pennsylvania. Figure I-2 shows the site location in relation to the principal population centers. Population density in the immediate vicinity of the site is relatively low. The population within a 5 mile (8 km) radius of the plant is approximately 18,000 and the only area of concentrated population is the Borough of Midland, Pennsylvania, which has a population of approximately 3,300.

The site lies along the Ohio River in a valley which has a gradual slope extending from the river (elevation 665 ft. (203 m) above sea level) to an elevation of 1,160 ft. (354 m) along a ridge south of BVPS. Plant entrance elevation at the station is approximately 735 ft. (224 m) above sea level.

The station is situated on the Ohio River at river mile 34.8, at a location on the New Cumberland Pool that is 3.3 river miles (5.3 km) downstream from Montgomery Lock and Dam and 19.4 miles (31.2 km) upstream from New Cumberland Lock and Dam. The Pennsylvania-Ohio-West Virginia border is 5.2 river miles (8.4 km) downstream from the site. The river flow is regulated by a series of dams and reservoirs on the Beaver, Allegheny, Monongahela, and Ohio Rivers and their tributaries. Flow generally varies from 5,000 to 100,000 cubic feet per second (cfs). The range of flows in 1992 is shown on Figure I- as well as Table I-1. The maximum flow occurred in December (126,000 cfs).

Ohio River water temperatures generally vary from 32° to 84°F (0° to 29° C). Minimum and maximum temperatures generally occur in January and July/August, respectively. During 1992, minimum temperatures were observed in February and maximum temperatures in July (Figure I-3 and Table I-1).

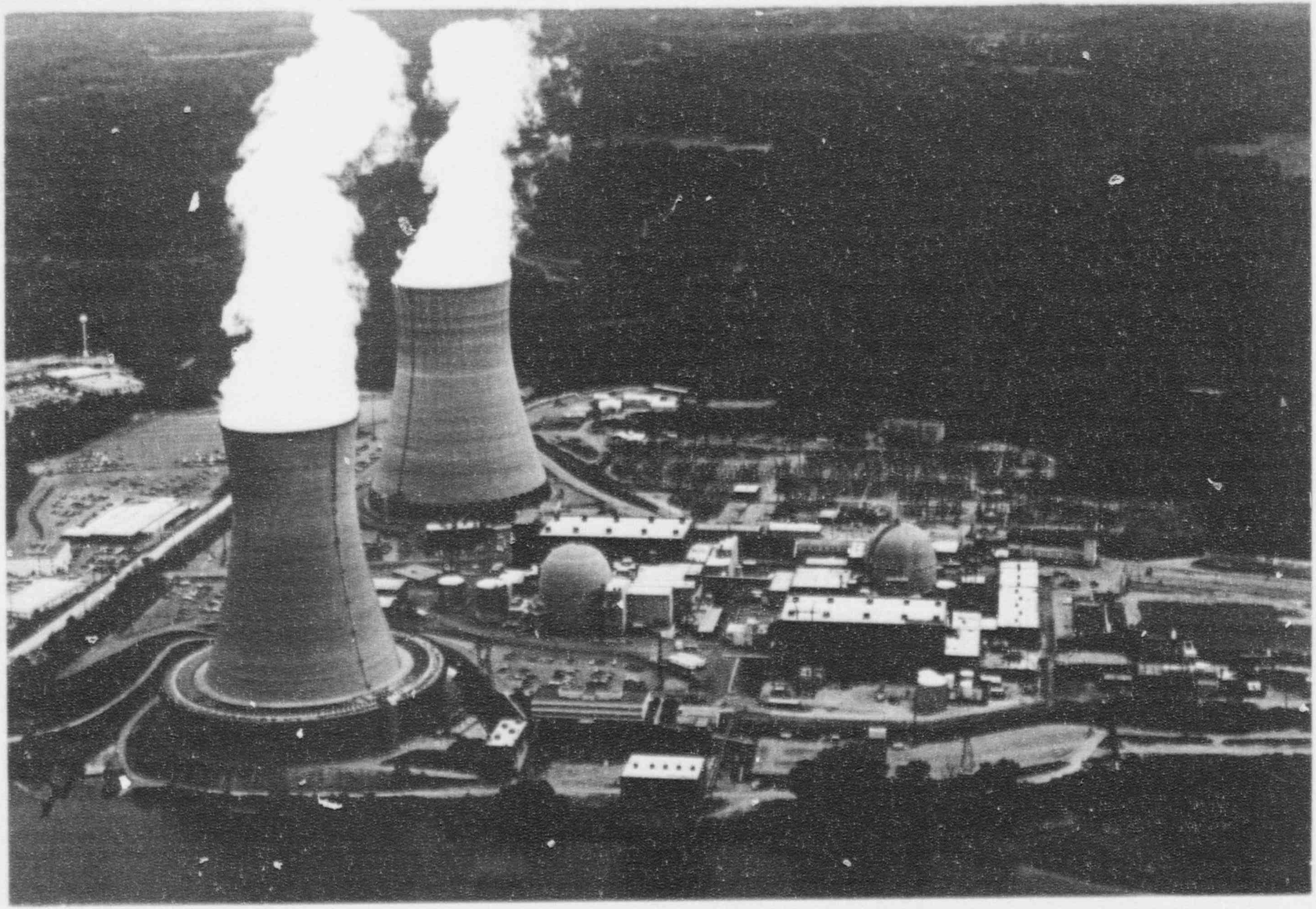

FIGURE I-1

VIEW OF THE BEAVER VALLEY POWER STATION
BVPS

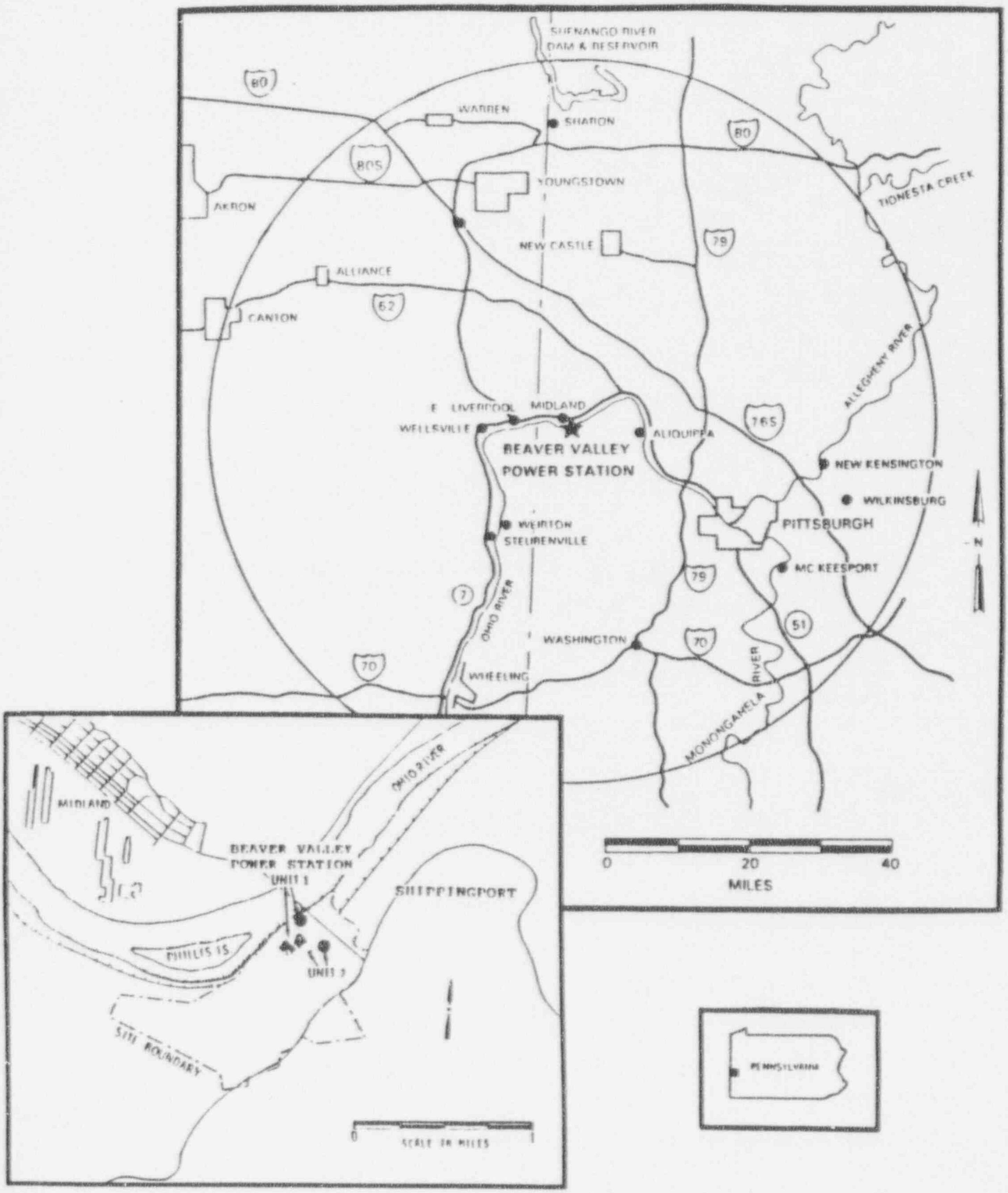

FIGURE I-2

LOCATION OF STUDY AREA, BEAVER VALLEY POWER STATION
SHIPPINGPORT, PENNSYLVANIA
BVPS

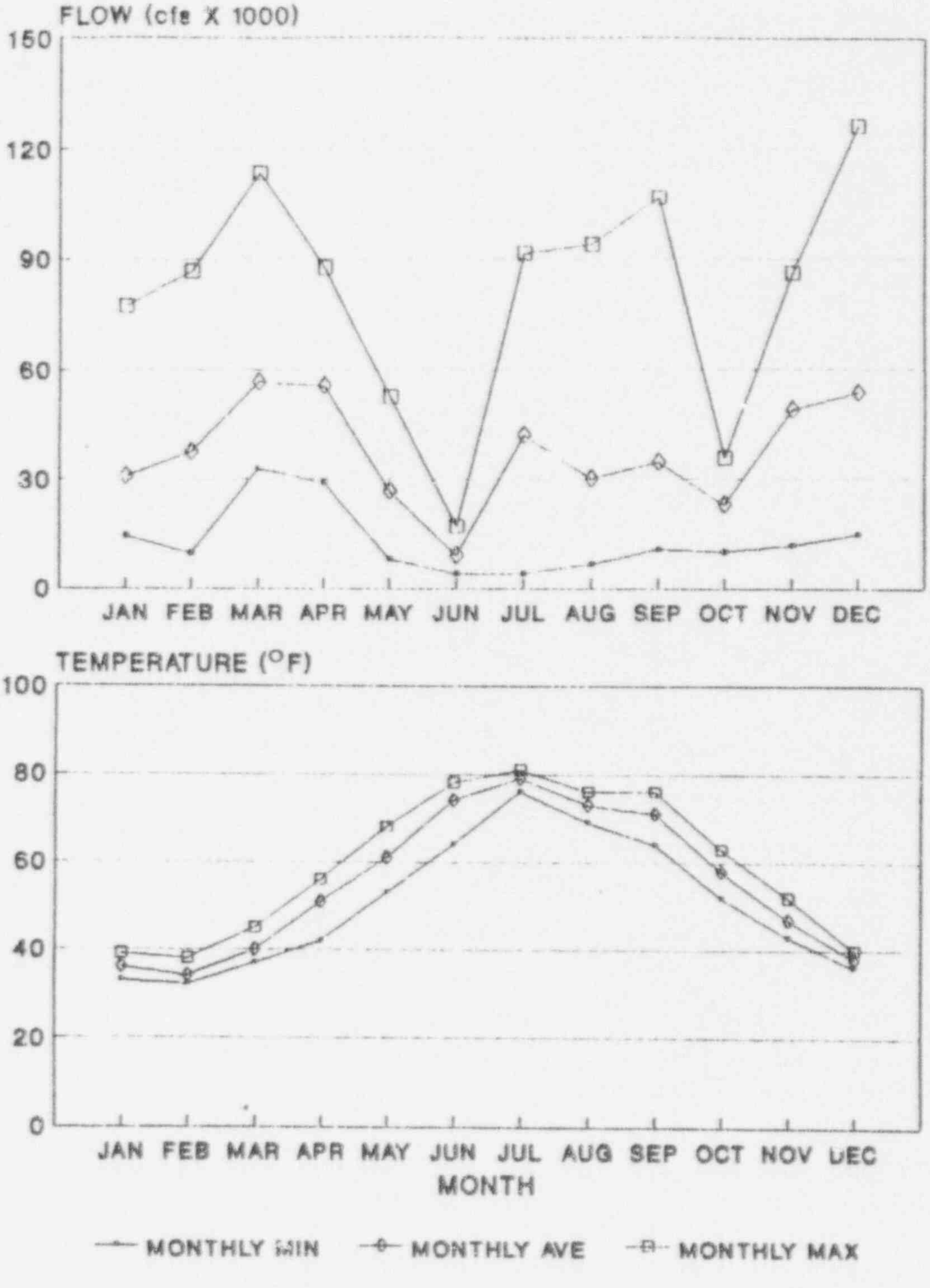

FIGURE I-3

OHIO RIVER FLOW (cfs) AND TEMPERATURE (°F)
RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS
FOR THE NEW CUMBERLAND POOL, 1992
BVPS

TABLE I-1

OHIO RIVER FLOW (cfs) AND TEMPERATURE (^{o}F) RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS FOR THE NEW CUMBERLAND POOL, 1992, BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow (cfs x 10^3)												
Monthly Maximum	77.5	86.7	113.3	87.5	52.4	17.0	91.5	93.8	106.6	35.7	86.1	126.1
Monthly Average	30.9	37.5	56.5	55.5	26.7	9.0	42.0	30.1	34.6	23.0	48.8	53.4
Monthly Minimum	14.5	9.6	32.8	29.1	8.2	4.1	4.1	6.5	10.6	10.1	11.8	14.7
Temperature (^{o}F)												
Monthly Maximum	39	38	45	56	68	78	81	76	76	63	52	40
Monthly Average	36	34	40	51	61	74	79	73	71	58	47	38
Monthly Minimum	33	32	37	42	53	64	76	69	64	52	43	36

BVPS Units 1 and 2 have a thermal rating of 2,660 megawatts (Mw). Units 1 and 2 have a design electrical rating of 835 Mw and 836 Mw, respectively. The circulating water systems are a closed cycle system using a cooling tower to minimize heat released to the Ohio River. Commercial operation of BVPS Unit 1 began in 1976 and Unit 2 began in 1987.

II. SUMMARY AND CONCLUSIONS

The 1992 BVPS Units 1 and 2 Non-Radiological Environmental Monitoring Program included an Aquatic Program (surveillance and field sampling of Ohio River aquatic life), Terrestrial Monitoring Program, and an In-Situ *Corbicula* Growth Study in the Ohio River. The Aquatic Program is an annual program voluntarily conducted by Duquesne Light Company to assess the impact of the operating BVPS on the aquatic ecosystem in the Ohio River, principally the New Cumberland Pool. The Terrestrial Monitoring Program is conducted every other year and is a requirement of the BVPS Unit 2 Technical Specifications to assess the impact of cooling tower drift on vegetation in the vicinity of BVPS. An In-Situ *Corbicula* Growth Study was conducted in 1992 by Duquesne Light Company for the BVPS Units 1 and 2 under the recommendation of the Pennsylvania Department of Environmental Resources. This study investigated the potential impact of a chemical additive on the growth of *Corbicula* (Asiatic clam) used as an environmental monitor in the Ohio River receiving system. This is the seventeenth year of operational environmental monitoring for Unit 1 and the fifth for Unit 2. As in the previous years, no evidence of adverse environmental impact to the aquatic life in the Ohio River or vegetation near BVPS was observed.

AQUATIC MONITORING PROGRAM

The Aquatic Environmental Monitoring Program included studies of: benthos, fish, ichthyoplankton, impingement, plankton entrainment, *Corbicula* and zebra mussel. Sampling was conducted for benthos and fish upstream and downstream of the plant during 1992 to assess potential impacts of BVPS discharges. These data were also compared to preoperational and other operational data to assess long-term trends. Impingement and entrainment data were examined to determine the impact of withdrawing river water for in-plant use. *Corbicula* studies were conducted to determine the presence of these clams in the Ohio River and their growth and reproduction inside the plant. Plant and river sampling was performed in 1992 to monitor for the potential infestation of the zebra mussel into the Ohio River near BVPS. The following paragraphs summarize these findings:

Benthos. Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft muck-type substrates along the shoreline were conducive to worm and midge proliferation, while limiting macroinvertebrates which require a more stable bottom. At the shoreline stations, Oligochaeta accounted for 80% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 17% and 3%, respectively. Community structure has changed little since preoperational years and there was no evidence that BVPS operations were affecting the benthic community of the Ohio River.

Phytoplankton. The phytoplankton community of the Ohio River near BVPS exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. The annual peak of 40,148 cells/ml occurred in June. Total cell densities were low during the colder months. Microflagellates, blue-greens, and chrysophytes were the most abundant groups during 1992. Although blue-green algae were abundant in terms of cell numbers during the summer, the species composition remained similar to that of the previous years. Total cell densities and diversity indices were within the ranges of those previously observed near BVPS.

Zooplankton. Zooplankton densities throughout 1992 were typical of the temperate zooplankton community found in large river habitats. Total densities exceeded the mean range of those reported in preoperational and several operational years. Populations developed highest densities in June and a secondary peak occurred in September. Protozoans and rotifers were always predominant. Common and abundant taxa in 1992 were similar to those reported during preoperational and operational years. Shannon-Weiner diversity indices, number of species, and evenness were within the ranges of preceding years. Based on the data collected during the 17 operating years (1976 through 1992) and the three preoperational years (1973 through 1975), it is concluded that the overall abundance and species composition of the zooplankton in the Ohio River near BVPS has remained stable and possibly improved slightly over the twenty-year period from 1973 to 1992. The data indicate that increased turbidity and current from high water conditions have the strongest effects of delaying the populations' peaks and temporarily decreasing total zooplankton densities in the Ohio River near BVPS.

Fish. The fish community of the Ohio River in the vicinity of BVPS has been sampled from 1970 to present using several types of gear: electrofishing, gill netting, and periodically, minnow traps and seines. The results of these fish surveys show normal community structure based on species composition and relative abundance. In all the surveys since 1970, forage species were collected in the highest numbers. This indicates a normal fish community, since game species (predators) rely on this forage base for their survival. Variations in total annual catch are a natural occurrence and are attributable primarily to fluctuations in the population size of the forage species. Forage species, such as gizzard shad, with high reproductive potentials frequently respond to changes in natural environmental factors (competition, food availability, cover, and water quality) with large changes in population size.

Although variation in total catch has occurred, species composition has remained fairly stable. Since the initiation of studies in 1970, forage fish have dominated the catches. Carp, channel catfish, smallmouth and spotted bass, and walleye have all remained common species. Since 1978, sauger have become a common game species near BVPS.

Differences in the 1992 electrofishing and gill net catches between the Control and Non-Control Transects were similar to previous years (both operational and preoperational) and were probably caused by habitat preferences of individual species. This habitat preference is probably the most influential factor that affects where the different species of fish are collected and in what relative abundance.

Data collected from 1970 through 1992 indicate that fish in the vicinity of the BVPS have not been adversely affected by station operation.

Ichthyoplankton. Gizzard shad and freshwater drum dominated the 1992 ichthyoplankton catch from the back channel of Phillis Island. The peak density occurred in June and consisted mostly of gizzard shad larvae and freshwater drum eggs. The month of April showed no spawning activity. The ichthyoplankton densities for July and August were within the ranges reported for those months in previous survey years.

Fish Impingement. The results of the 1992 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has very little effect on the fish populations. Thirty-six (36) fishes were collected, which was the lowest yearly total since initial operation of BVPS in 1976. Rock bass were the most numerous fish, comprising 16.3% of the total annual catch. The total weight of all fishes collected in 1992 was 0.75 kg (1.6 lbs.). Of the 36 fishes collected, 13 (36.1%) were alive and returned via the discharge pipe to the Ohio River.

Plankton Entrainment. The majority of ichthyoplankton collected in 1992 were larvae and eggs, which comprised 64.5% and 35.4% of the total catch, respectively. Juvenile fishes accounted for the remaining percentage of the catch.

The similarity of species composition and relative abundance of ichthyoplankton taken in 1992 along the river transects to those of 1979-1991, combined with the close correlation between river sampling in front of the intake and actual entrainment sampling established in previous years (DLC 1976, 1977, 1978 and 1979) suggest little change in ichthyoplankton entrainment by BVPS in 1992.

Past results of monthly sampling of phytoplankton in the Ohio River near BVPS and within the intake structure showed little difference in densities (cells/ml) and species composition. During periods of minimum low river flow, approximately 5.0% of the river would be withdrawn into the condenser cooling system. Based on the similar densities of phytoplankton in the river and the BVPS intake structure, and the small amount of water withdrawn from the river, the loss of phytoplankton was very small, even under the worst case low flow conditions.

Past results of monthly sampling of zooplankton in the Ohio River near BVPS and within the intake structure showed little difference in densities (number/liter) and species composition. During periods of minimum, low river flow, approximately 5% of the river would be withdrawn into the condenser cooling system. Based on the similar densities of zooplankton in the river and the BVPS intake structure, and the small amount of water withdrawn from the river, the loss of zooplankton was very small, even under worst case low flow conditions.

Corbicula Monitoring. Corbicula monitoring, consisting of river and plant surveys, was conducted to determine the presence of these clams in the Ohio River and the circulating river water system of the BVPS (intake structure and cooling towers). The Corbicula Monitoring Program was initiated in 1985, and has been expanded in subsequent years.

Sampling of sediments in the Unit 2 cooling tower reservoir was performed on April 5, 1992 during a scheduled outage, in order to estimate the Corbicula population within that structure. The Corbicula population in the reservoir was estimated to be 11.0 million clams (37.1% dead), based upon the ten ponar dredge samples collected. All clams were removed from the Unit 2 cooling tower basin during this outage.

Population surveys of both BVPS cooling tower reservoirs conducted during scheduled outages (1986 through 1992) have resulted in lower estimates of Corbicula in the Unit 2 tower compared to the Unit 1 cooling tower. This can be attributed to differences in cooling tower design and the faster water currents in the Unit 2 cooling tower reservoir, which decrease sediment deposition.

The river surveys conducted in 1992 demonstrate that Corbicula inhabiting the upper Ohio drainage provides a large number of clams to the BVPS. Corbicula densities in 1992 at sampling stations above and below BVPS were either lower or comparable to densities found in the past two years. Cleaning of the intake bays in the spring and fall by divers resulted in removing many live clams from the inner bays; this along with the weekly impingement data show that adult clams move into the plant with the water currents.

Corbicula, which colonized the larval cages housed in the BVPS intake structure during the summer of 1992, exhibited rapid growth during the five-month colonization period. Sixty-nine percent of the live Corbicula removed from the intake structure larval cages in August through December were retained on the 6.3 mm and 9.5 mm mesh size sieves during the size analysis. Only 1.2% were retained on the 12.5 mm mesh sieve and none were retained on the 16.0 mm. Elevated river water temperatures through the summer probably contributed to the rapid growth of these clams, in conjunction with an adequate food source for these filter feeders.

The use of CT-1 molluscicide (1992 DLC Corbicula Control Program) on June 23 and October 6, 1992 in the Unit 1 river water system produced 100% mortality in the larval cages removed from the Unit 1 cooling tower on July 10 and October 23, 1992.

The Corbicula larvae study in the Unit 2 cooling tower was affected by a scheduled outage in April. The larval cage removed in October following the five-month recolonization period contained 76 live Corbicula, most within the 6.3 mm sieve size category.

The use of CT-1 in the Unit 2 river water system on October 28, 1992 produced 100% mortality (133 dead Corbicula) in the larval cage removed approximately one month after dosing (November 20). Recolonization of Unit 2 larval cages exposed to the CT-1 was not observed in the final cage removed in 1992 (December).

Corbicula larvae which colonized the intake structure larval cages during the summer and early fall have shown rapid growth and reached larger sizes than those entering the cages during the winter and early spring. Corbicula removed from the Units 1 and 2 cooling tower larval cages generally have not attained the maximum sizes observed for clams removed from the intake structure cages for the same period. This may be due to chlorination in the cooling towers.

Zebra Mussel Monitoring. The zebra mussel (Dreissena polymorpha) is an exotic freshwater mollusk that is believed to have been introduced into Lake St. Clair in 1987 via ballast water of ocean-going cargo vessels. Since then they have spread rapidly to the other Great Lakes and are infesting riverine systems in the United States.

Due to the proximity of the Ohio River to Lake Erie, BVPS initiated a Zebra Mussel Monitoring Program in January 1990. The Zebra Mussel Monitoring Program in 1992 utilized a new artificial substrate sampler developed by the Pennsylvania Department of Environmental Resources which provides a large surface area for the mussel larvae to attach. In 1992, as the result of plant and river sampling, no zebra mussels have been detected.

TERRESTRIAL MONITORING PROGRAM

During the summer and fall of 1992, vegetation stress was monitored in the vicinity of the Beaver Valley Power Station cooling towers as part of the Terrestrial Monitoring Program. Color infrared aerial photography, photointerpretation of the imagery, and field observations were used to detect stressed or damaged vegetation and to determine probable causes.

Evidence from the aerial photographs and field surveys revealed that the majority of occurrences of vegetation stress were directly due to natural causes or a combination of natural causes and human activities involving intensive land use. The factors included insect infestation (cherry lace bug, gypsy moth, locust leaf miner/locust borer, and elm leaf beetle), decadence (overage/over mature), overgrown woodlot, poor drainage/periodically flooded areas, and wildfire. Human activities resulting in vegetation damage or stress included logging, heavy equipment or construction activity, utility corridor maintenance, and erosion. A few areas of unidentified stress were also delineated (most of which are most likely the result of insect infestations).

Of the 546 identified and delineated occurrences of vegetation stress, 8[illegible]% were directly attributed to natural causal factors. The number of occurrences of stress is lower than in 1990. This decrease is attributed to a lack of a lace bug infestation affecting large numbers of black cherry trees which are prominent in the study area. A decrease in number of occurrences in 1992 was evident, even though gypsy moth affected large areas not previously affected. Approximately 3.1% of the occurrences were caused by a combination of natural factors and human activities involving land use changes, drainage alterations, and fire. The occurrences of stress categorized as unknown total 3.8%; the majority of these can be assumed to be due to natural causes. About 3.8% of the occurrences are directly attributed solely to human activities.

Based on interpretation of the CIR aerial photographs and field verification, there is no evidence to suggest that the BVPS cooling towers are causing vegetation stress. A combination of drift from the BVPS and Bruce Mansfield cooling towers, regional stack emissions, air pollution from other sources such as automobiles, and the local climate may contribute to vegetation stress in the region. The uncertainties of such combinations and resultant synergistic effects would make it difficult, though not impossible, to measure the actual contribution of the BVPS cooling tower drift to these effects.

It is also possible that the BVPS cooling towers are subtly affecting local microclimatic systems with their input of moisture and heat. Damaged vegetation from winter ice buildup would be a diagnostic measure of this effect, but there was not evidence of heavy limb fall or structural damage in the photographs or field observations.

IN-SITU Corbicula GROWTH STUDY

Permission was granted by the Pennsylvania Department of Environmental Resources (DER) to use a chemical additive (Clam-Trol or CT-1) in combination with a detoxification agent (DT-1), a bentonite clay, in the Beaver Valley Power Station (BVPS) Units 1 and 2 river water systems during 1992 for the control of the biofouling clam, Corbicula. An extensively coordinated laboratory to field investigation was undertaken in 1990-91 to determine the efficacy of the additives and their impact on the environment. Results of these studies have been previously forwarded to the DER. As a result of these studies, the DER recommended that an in-situ (river study) be carried out in 1992 using the Asiatic clam, Corbicula, as an environmental monitor of potential growth impairment in the receiving system.

A 1992 in-situ study was conducted where individually marked clams were placed in bioboxes (16) resting at the bottom of the river and attached to shore by individual lines at four river locations or stations (4 bioboxes/station). These stations were at the intake (above the discharge point of the effluent), and at three stations below the effluent release into the back channel of the Ohio River at Phillis Island. These stations (identification in parentheses) were located ~350 (P5), 700 (2B), and 1050 (P10) m downstream.

Clams were evaluated for potential growth impairment in the following ways: 1) mean clam size, 2) growth increment between selected time intervals over 162 days, 3) accumulative growth increment, and 4) trimming the initially measured size class of clams from 20 to the 10 most similar in size and reevaluating trends of 1, 2, 3 above.

Plant dosing occurred on June 23 and October 6, 1992 for Unit 1 and on October 28, 1992 for Unit 2. Clam growth was evaluated at Day 0, 16 days after river acclimation and prior to dosing, followed by selected time intervals when Units 1 and 2 were dosed. Four bioboxes were positioned at each of the four river stations at the start. An organized schedule for biobox rotation was developed to remove potential bias from clam handling. Two of the four bioboxes at each station were removed three days prior to plant dosing and placed in a refugium or "safe place" above the plant at a barge slip. They were returned to their respective stations one day prior to the plant dosing. These bioboxes (except Intake station) would be exposed (the "dosed" group) to CT-1:DT-1 in the river during the dosing of the plant. On the day prior to dosing, the other two bioboxes were removed from each station and placed in the refugium for three days. This was the "nondosed" group. The purpose of the refugium was to serve as an additional control where half of the bioboxes at each station would not be exposed to the CT-1:DT-1 treatment in the plant, but all bioboxes would be involved in the handling/transfer process. This process also addressed the concern about inherent variability in growth between clams.

Of the three parameters evaluated (mean clam size, growth increments at selected time intervals, and accumulative growth increments), the latter was considered to be most important in indicating potential stress to clams on a cumulative basis of three molluscicide dosings over the 162-day study period. This approach provides the most relevant measurement on a continual basis that incorporates the potential of additive stress effects of the three dosings over the duration of the test.

It was concluded that the extent of CT-1:DT-1 interaction during the plant dosings upon Corbicula as an environmental monitor in the Ohio River receiving system was minimal to non-existent at BVPS during the 162-day testing period.

III. ANALYSIS OF SIGNIFICANT ENVIRONMENTAL CHANGE

The BVPS Unit 1 ETS, Appendix B to Operating License No. DPR-66, initially required that significant environmental change analyses be performed on benthos, phytoplankton, and zooplankton data. However, on February 26, 1980, the NRC granted DLC a request to delete all of the Aquatic Monitoring Program, with the exception of fish impingement, from the ETS (Amendment No. 25, License No. DPR-66). Consequently, the requirements for Analysis of Significant Environmental Change was deleted by the NRC, and is not applicable to the present Aquatic Monitoring Program. In 1983, the NRC also deleted the requirement for fish impingement studies. However, in the interest of providing a non-disruptive data base, DLC is continuing the Aquatic Monitoring Program.

IV. MONITORING NON-RADIOLOGICAL EFFLUENTS

A. MONITORING CHEMICAL EFFLUENTS

The Environmental Technical Specifications (ETS) that were developed and included as part of the licensing agreement for the BVPS, required that certain non-radiological chemicals and the temperature of the discharges be monitored and if limits were exceeded they had to be reported to the NRC. During 1983, the NRC (Amendment No. 64, License No. DPR-66) deleted these water quality requirements. The basis for this deletion is that the reporting requirements would be administered under the NPDES permit. However, the NRC requested that if any NPDES permit requirements were exceeded, that a copy of the violation be forwarded to the Director, Office of Nuclear Reactor Regulation.

B. HERBICIDES

Monitoring and reporting of herbicides used for weed control during 1992, is no longer required as stated in Amendment No. 64; thus, this information is not included in this report.

V. AQUATIC MONITORING PROGRAM

A. INTRODUCTION

The environmental study area established to assess potential impacts consisted of three sampling transects (Figure V-A-1). Transect 1 is located at river mile (RM) 34.5, approximately 0.3 mi (0.5 km) upstream of BVPS and is the Control Transect. Transect 2 is located approximately 0.5 mi (0.8 km) downstream of the BVPS discharge structure. Transect 2 is divided by Phillis Island; the main channel is designated Transect 2A and the back channel Transect 2B. Transect 2B is the principal Non-Control Transect because the majority of aqueous discharges from BVPS Units 1 and 2 are released to the back channel. Transect 3 is located approximately 2 mi (3.2 km) downstream of BVPS.

Sampling dates for each of the program elements are presented in Table V-A-1.

The following sections of this report present a summary of findings for each of the program elements.

B. BENTHOS

Objectives

The objectives of the benthic surveys were to characterize the benthos of the Ohio River near BVPS and to determine the impacts, if any, of BVPS operations.

Methods

Benthic surveys were performed in May and September, 1992. Benthos samples were collected at Stations 1, 2A, 2B, and 3 (Figure V-B-1), using a Ponar grab sampler. Duplicate samples were taken off the south shore at Stations 1, 2A, and 3. Sampling at Station 2B in the back

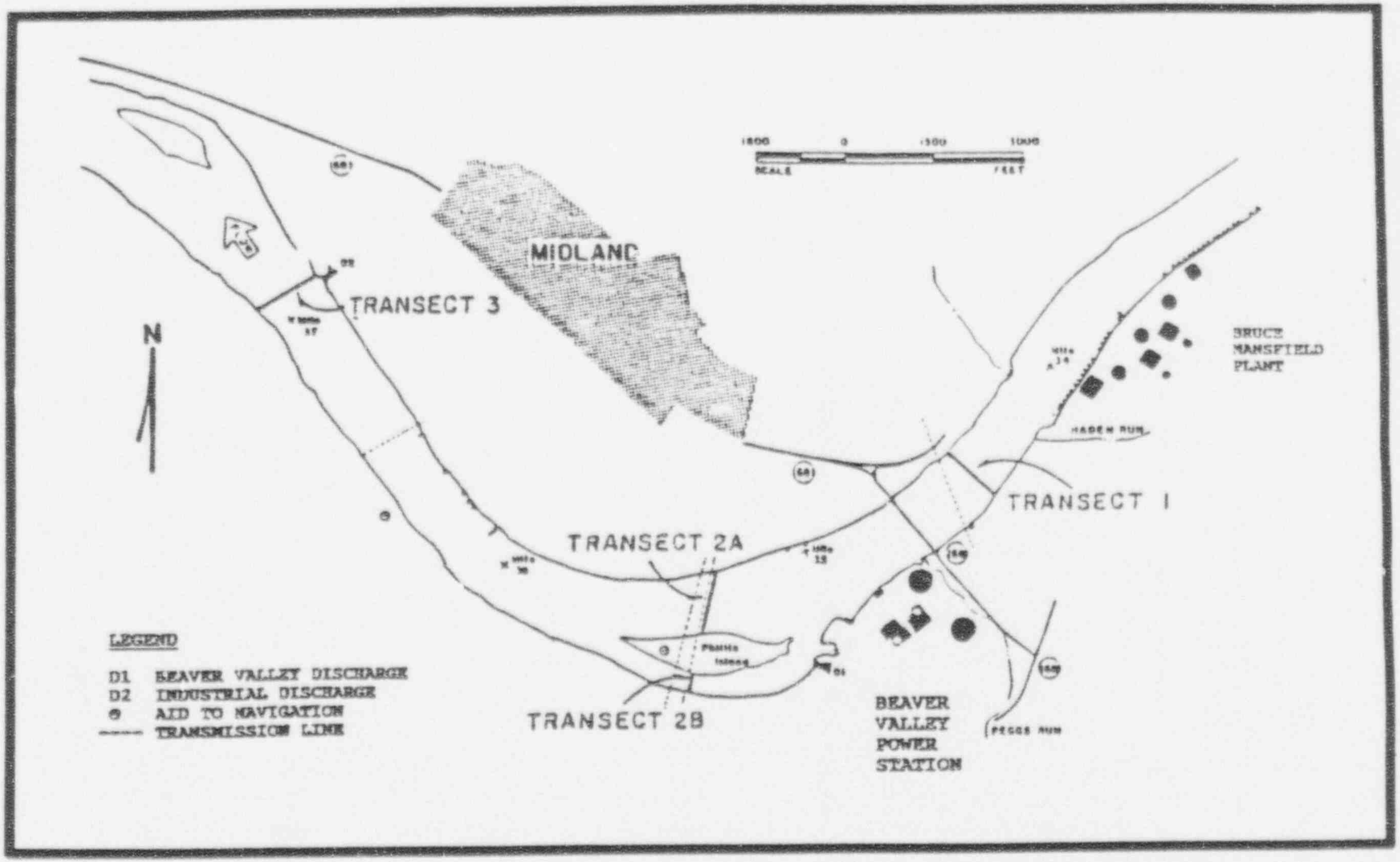

FIGURE V-A-1

SAMPLING TRANSECTS IN THE VICINITY OF THE
BEAVER VALLEY POWER STATION
BVPS

TABLE V-A-1

AQUATIC MONITORING PROGRAM SAMPLING DATES
1992 BVPS

Month	Benthos	Zebra Mussel and *Corbicula* Monitoring[a]	Fish	Impingement	Ichthyoplankton Day	Ichthyoplankton Night	Phyto- and Zooplankton
January		24		3, 10, 31			17
February		17		7, 14, 21, 28			14
March		12		13, 20, 27			13
April		3, 5, 10, 17, 24		3, 10, 17	21		10
May	20	8, 15, 20, 29	18, 19	1, 8, 15	18	19	8
June		12, 26		5, 12, 19, 26	16		12
July		10, 24	8, 9	3, 17, 24, 31	8	9	17
August		13, 27, 28		7, 14, 21, 28	11		14
September	8	8, 18	14, 15	4, 11, 18, 25			10
October		9, 23		2, 9, 16, 30			23
November		6, 20	18, 19	6, 13, 20, 27			20
December		4, 18, 28		4, 11. 31			11

(a) Zebra Mussel and *Corbicula* Monitoring also includes all Impingement dates.

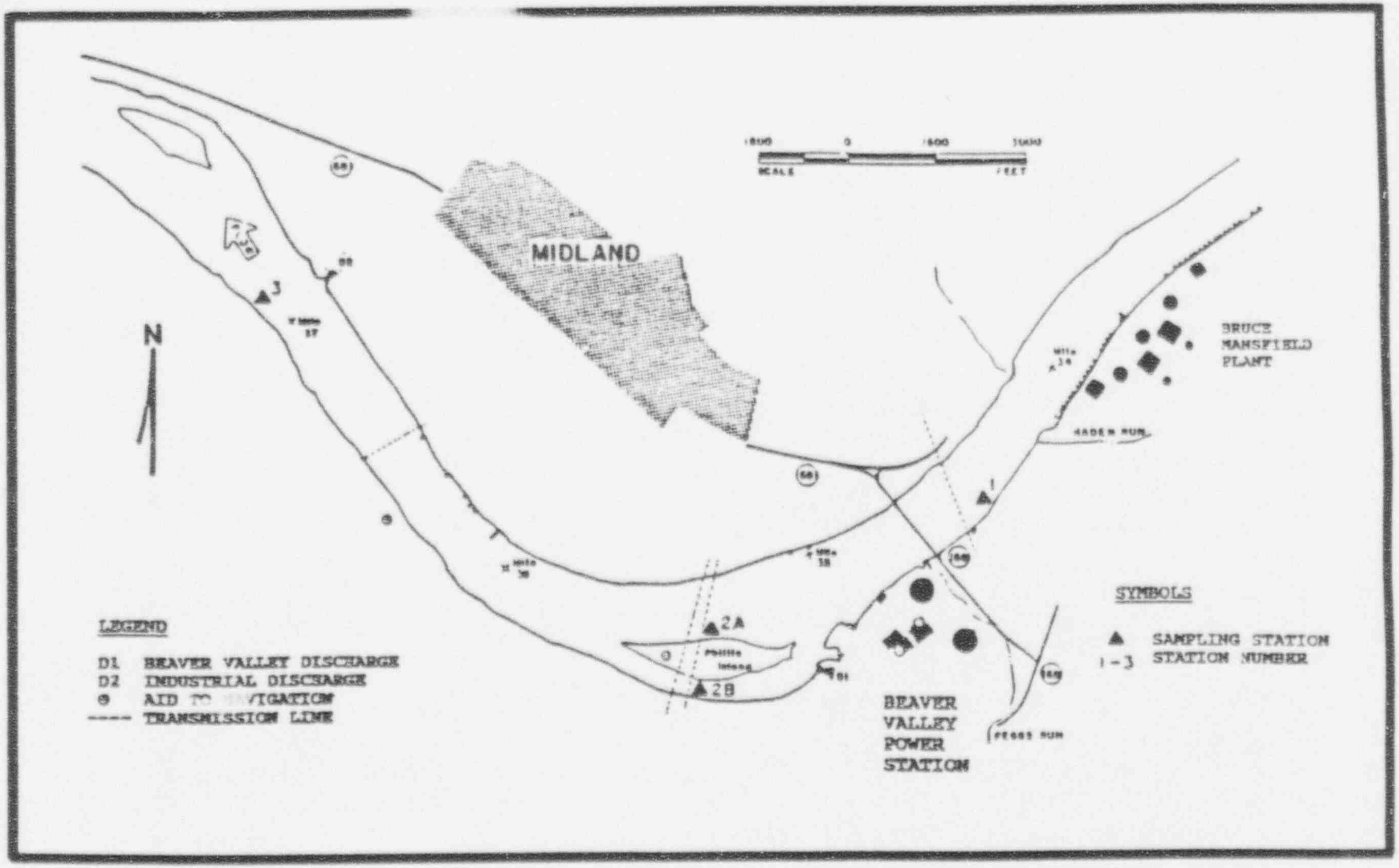

FIGURE V-B-1

BENTHOS SAMPLING STATIONS
BVPS

channel of Phillis Island, consisted of individual Ponar grabs at the south, middle and north side of the channel.

Each grab was washed within a U.S. Standard No. 30 sieve and the remains placed in a bottle and preserved with 10% formalin. In the laboratory, macroinvertebrates were sorted from each sample, identified to the lowest possible taxon and counted. Mean densities (numbers/m^2) for each taxon were calculated for each of the two replicates and three back channel samples. Three species diversity indices were calculated: Shannon-Weiner, evenness indices (Pielou 1969), and the number of species (taxa).

Habitats

Substrate type was an important factor in determining the composition of the benthic community. Two distinct benthic habitats exist in the Ohio River near BVPS. These habitats are the result of damming, channelization, and river traffic. Shoreline habitats were generally soft muck substrates composed of sand, silt, and detritus. An exception occurs along the north shoreline of Phillis Island at Station 2A where clay and sand predominate. The other distinct habitat, hard substrate, is located at midriver. The hard substrate may have been initially caused by channelization and scouring by river currents and turbulence from commercial boat traffic.

Fifty-eight macroinvertebrate taxa were identified during the 1992 monitoring program (Table V-B-1). Species composition during 1992 was similar to that observed during previous preoperational (1973 through 1975) and operational (1976 through 1991) years. The macroinvertebrate assemblage during 1992 was composed primarily of burrowing organisms typical of soft unconsolidated substrates. Oligochaetes (worms) and chironomid (midge) larvae were abundant (Tables V-B-2, V-B-3, and V-B-4). Common genera of oligochaetes were Limnodrilus, Nais, Stylaria, and Paranais. Common genera of chironomids were Procladius, Cryptochironomus, and Polypedilum. The Asiatic clam (Corbicula), which was collected from

TABLE V-B-1

SYSTEMATIC LIST OF MACROINVERTEBRATES COLLECTED IN PREOPERATIONAL AND OPERATIONAL YEARS IN THE OHIO RIVER NEAR BVPS

	operational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Porifera																				
Spongilla fragilis						X														
Cnidaria																				
Hydrozoa																				
Clavidae																				
Cordylophora lacustris		X		X	X	X														X
Hydridae																				
Craspedacusta sowerbyi				X																
Hydra sp.	X		X	X	X	X	X		X					X			X	X		X
Platyhelminthes																				
Tricladida		X		X	X	X				X									X	
Rhabdocoela				X	X	X								X						
Nemertea							X	X	X	X	X		X					X	X	X
Nematoda	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
Entoprocta																				
Urnatella gracilis	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X
Ectoprocta																	X			
Federicella sp.					X	X							X	X				X		
Paludicella articulata					X		X													
Pectinatella sp.	X																			
Plumatella sp.	X																			
Annelida																				
Oligochaeta																				
Aeolosomatidae			X	X	X			X												
Enchytraeidae		X		X	X	X	X	X	X	X	X		X				X		X	X
Naididae																				
Allonais pectinata																		X		
Amphichaeta leydigi								X											X	X
Amphichaeta sp.							X						X							
Arcteonais lomondi					X			X			X				X		X	X		
Aulophorus sp.					X			X												
Chaetogaster diaphanus				X	X	X	X	X				X							X	
C. diastrophus						X		X		X										
Dero digitata	X		X			X														
D. nivea	X					X														
Dero sp.	X	X		X	X	X	X	X	X	X		X		X			X	X		X
Nais barbata						X						X								
N. behningi																	X	X		
N. bretscheri	X	X			X	X				X			X	X				X	X	X
N. communis	X					X						X	X		X	X	X	X	X	X

TABLE V-B-1
(Continued)

	Preoperational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
N. elinguis						X							X	X	X			X	X	X
N. pardalis																		X	X	X
N. simplex																X	X	X	X	
N. variabilis						X							X			X	X	X		X
Nais sp.	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	
Ophidonais serpentina								X		X			X		X	X	X		X	X
Paranais frici	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Paranais sp.							X													
Piguetiella michiganensis																		X		X
Pristina idrensis																		X	X	X
Pristina longiseta																	X			X
P. osborni				X			X					X		X	X			X	X	X
P. sima				X						X	X		X		X		X		X	X
Pristina sp.				X											X					
Ripistes parasita																		X	X	
Slavina appendiculata					X															X
Stephensoniana trivandrana				X	X	X			X	X		X								
Stylaria fossularis																X		X	X	X
S. lacustris				X						X		X	X							
Uncinais uncinata			X																	
Vejdovskyella intermedia											X		X		X		X	X	X	X
Vejdovskyella sp.																X				
Tubificidae																				
Aulodrilus limnobius	X	X	X	X	X	X	X	X	X				X	X			X	X	X	X
A. pigueti	X		X	X	X	X	X	X	X	X	X	X		X	X			X	X	X
A. pluriseta	X			X	X	X	X	X		X	X				X		X	X	X	X
Bothrioneurum vejdovskyanum				X	X	X	X	X		X										
Branchiura sowerbyi		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ilyodrilus templetoni	X	X	X	X	X	X	X	X	X	X		X								X
Limnodrilus cervix	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. cervix (variant)	X	X	X	X		X		X	X	X			X							
L. claparedianus	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X		X
L. hoffmeisteri	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. spiralis		X	X			X														
L. udekemianus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Limnodrilus sp.						X														
Peloscolex multisetosus longidentus		X			X	X	X													
P. m. multisetosus	X	X	X	X	X	X	X	X	X	X	X		X		X					
Potamothrix moldaviensis	X								X	X										
P. vejdovskyi											X	X	X		X	X	X	X		
Psammoryctides curvisetosus		X																		
Tubifex tubifex	X	X			X	X	X	X										X		
Unidentified immature forms:																				
with hair chaetae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
without hair chaetae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lumbriculidae																		X		

TABLE V-B-1
(Continued)

	Preoperational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Hirudinea																				
Glossiphoniidae																	X			
Helobdella elongata										X	X									
H. stagnalis				X																
Helobdella sp.	X																			
Erpobdellidae																				
Erpobdella sp.	X																			
Mooreobdella microstoma		X				X														
Arthropoda																				
Acarina				X		X		X		X	X					X			X	
Ostracoda				X	X	X														
Isopoda																				
Asellus sp.																	X			
Amphipoda																				
Talitridae																				
Hyalella azteca						X	X											X		
Gammaridae																				
Crangonyx pseudogracilis		X																		
Crangonyx sp.		X																		
Gammarus fasciatus						X		X		X										
Gammarus sp.	X	X		X		X	X	X	X	X	X	X	X	X	X		X			X
Decapoda							X													
Collembolla		X																		
Ephemeroptera																				
Heptageniidae	X		X																	
Stenacron sp.				X							X									
Stenonema sp.								X												
Ephemeridae																				
Ephemera sp.							X													
Hexagenia sp.												X		X	X	X	X	X		
Baetidae																	X	X		
Caenidae																				
Caenis sp.				X			X									X				
Tricorythidae																				
Tricorythodes sp.	X																			
Megaloptera																				
Sialis sp.							X													
Odonata																				
Gomphidae																				
Dromogomphus spoliatus		X																		
Dromogomphus sp.							X													
Gomphus sp.		X				X	X	X					X							
Libellulidae																				
Libellula sp.																X				
Trichoptera																				
Hydropsychidae							X													
Cheumatopsyche sp.	X			X																
Hydropsyche sp.						X														

TABLE V-B-1
(Continued)

	Preoperational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Hydroptilidae																				
Hydroptila sp.						X														
Oxyethira sp.	X																			
Leptoceridae																				
Ceraclea sp.																		X	X	
Oecetis sp.		X		X						X	X		X	X			X	X	X	
Polycentropodidae																				
Polycentropus sp.						X											X			
Coleoptera		X														X				
Hydrophilidae						X														
Elmidae																				
Ancyronyx variegatus						X														
Dubiraphia sp.	X	X				X														X
Helichus sp.	X																			
Stenelmis sp.	X				X	X														
Psephenidae																				
Diptera																				
Unidentified Diptera		X		X	X	X	X	X				X	X		X	X				X
Psychodidae				X																
Pericoma sp.						X														
Psychoda sp.						X														
Telmatoscopus sp.		X																		
Unidentified Psychodidae pupae						X														
Chaoboridae																				
Chaoborus sp.	X	X	X	X		X	X		X											
Simulidae																				
Similium sp.				X																
Chironomidae																				
Chironominae							X						X							
Tanytarsini pupa																				X
Chironominae pupa							X			X	X		X		X	X	X	X	X	X
Chironomus sp.		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cladopelma sp.											X		X	X						
Cryptochironomus sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dicrotendipes nervosus	X																			
Dicrotendipes sp.	X	X		X							X				X		X		X	X
Glyptotendipes sp.						X	X				X									X
Harnischia sp.		X	X	X		X	X	X	X	X	X	X		X	X		X	X		X
Microchironomus sp.																				X
Micropsectra sp.				X																
Microtendipes sp.						X														
Parachironomus sp.		X										X								
Phaenopsectra sp.																		X		
Polypedilum (s.s.) convictum type						X														
P. (s.s.) simulans type						X														
Polypedilum sp.	X	X					X			X	X	X	X	X	X	X	X	X	X	X
Rheotanytarsus sp.	X				X	X	X		X		X		X		X	X				X
Stenochironomus sp.		X			X	X		X												
Stictochironomus sp.				X																
Tanytarsus sp.			X			X	X			X	X			X		X			X	X
Xenochironomus sp.												X							X	

TABLE V-B-1
(Continued)

	Preoperational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Tanypodinae																				
Tanypodinae pupae													X		X				X	
Ablabesmyia sp.	X	X		X								X								
Coelotanypus scapularis		X	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X
Djalmabatista pulcher															X			X		
Djalmabatista sp.																			X	
Procladius (*Procladius*)							X	X				X								
Procladius sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tanypus sp.																				X
Thienemannimyia group	X		X		X	X	X													X
Zavrelimyia sp.						X														
Orthocladiinae							X													
Orthocladiinae pupae											X									
Cricotopus bicinctus						X														
C. (s.s.) *trifascia*						X														
Cricotopus (*Isocladius*) *sylvestris* Group							X													
C. (*Isocladius*) sp.						X														
Cricotopus (s.s.) sp.	X	X		X		X					X				X		X	X	X	X
Eukiefferiella sp.					X	X	X													
Hydrobaenus sp.						X														
Limnophyes sp.						X														
Nanocladius (s.s.) *distinctus*			X	X	X	X			X											
Nanocladius sp.							X						X						X	X
Orthocladius sp.	X	X	X	X	X		X			X	X	X					X			
Parametriocnemus sp.		X				X														
Paraphaenocladius sp.						X	X													
Psectrocladius sp.	X	X																		
Pseudorthocladius sp.						X														
Pseudosmittia sp.				X	X															
Smittia sp.		X			X	X	X	X												
Diamesinae																				
Diamesa sp.		X																		
Potthastia sp.	X																			
Ceratopogonidae	X	X		X	X	X				X	X	X		X	X		X	X	X	X
Dolichopodidae					X	X														
Empididae		X		X	X	X				X								X		
Wiedemannia sp.		X																		
Ephydridae						X														
Muscidae				X	X															
Rhagionidae						X														
Tipulidae						X											X			
Stratiomyiidae					X										X		X			
Syrphidae						X														
Lepidoptera				X	X			X												
Mollusca																				
Gastropoda																				
Ancylidae																				
Ferrissia sp.	X	X			X	X														
Planorbidae							X													
Valvatidae																				

TABLE V-B-1
(Continued)

	Preoperational			Operational																
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Valvata perdepressa																				
Pelecypoda							X													
Corbiculidae																				
Corbicula fluminea		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X
Sphaeriidae							X	X	X											
Pisidium sp.	X			X										X			X	X	X	X
Sphaerium sp.	X			X	X	X	X			X	X	X	X	X	X		X			
Unidentified immature Sphaeriidae				X	X	X				X										
Unionidae																				
Anadonta grandis						X														
Anadonta immature																				X
Elliptio sp.						X														
Unidentified immature Unionidae	X				X	X			X	X									X	

TABLE V-B-2

MEAN NUMBER OF MACROINVERTEBRATES (Number/m^2) AND PERCENT COMPOSITION OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA AND OTHER ORGANISMS, 1992
BVPS

	STATION							
	1		2A		2B		3	
	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%
May 20								
Oligochaeta	6,130	84	119	19	7,545	72	5,041	93
Chironomidae	1,026	14	425	67	2,837	27	258	5
Mollusca	59	1	50	8	33	<1	89	2
Others	99	1	40	6	99	1	30	1
Total	7,314	100	634	100	10,514	100	5,418	101
September 8								
Oligochaeta	2,456	90	1,442	79	3,154	67	4,999	94
Chironomidae	148	5	247	14	1,394	30	217	4
Mollusca	99	4	79	4	53	1	39	1
Others	20	1	60	3	106	2	40	1
Total	2,723	100	1,828	100	4,707	100	5,295	100

TABLE V-B-3

BENTHIC MACROINVERTEBRATE DENSITIES (Number/m^2), MEAN OF TRIPLICATE FOR BACK CHANNEL AND DUPLICATE SAMPLES COLLECTED IN THE MAIN CHANNEL OHIO RIVER, MAY 20, 1992

BVPS

Taxa	STATION			
	1	2A	2B	3
Cnidaria				
Hydra sp.			20	
Nemertea		10	13	30
Nematoda	99	30	33	
Entoprocta				
Urnatella gracilis		+	+	
Annelida				
Enchytraeidae			26	
Oligochaeta eggs	+		+	+
Amphichaeta leydigii				20
Dero sp.	40		322	138
Nais bretscheri			7	
Nais communis	99		171	40
Nais elinguis				10
Nais pardalis	99	40	26	680
Nais variabilis	79		269	119
Ophidonais serpentina			53	
Paranais frici	2,285		532	1,350
Piguetiella michiganensis				109
Pristina idrensis	59		302	10
Pristina longiseta	20		26	
Pristina osborni			33	10
Pristina sima	59			
Slavina appendiculata			26	
Stylaria fossularis	1,025		827	512
Vejdovskyella intermedia	118		53	30
Tubificidae				
Aulodrilus limnobius	79		59	188
Aulodrilus pigueti	20		72	40
Aulodrilus pluriseta				10
Branchiura sowerbyi				20
Limnodrilus cervix	59		92	40
Limnodrilus claparedianus				10
Limnodrilus hoffmeisteri	276		72	128
Limnodrilus udekemianus	20			
Immatures w/o capilliform chaeta	1,576	79	3,198	1,488
Immatures w/ capilliform chaeta	217		1,379	89
Amphipoda				
Gammarus sp.			7	
Diptera unidentified	40		26	
Diptera				
Chironominae pupae	119	30	72	30
Cryptochironomus sp.	20	20	118	20
Glyptotendipes sp.			7	
Microchironomus sp.	39	10	282	10
Polypedilum sp.	315	345	2,042	168
Coelotanypus scapularis			46	10
Procladius sp.	473		302	20
Cricotopus sp.	20	10	7	
Tanypus sp.			7	
Tanytarsini pupae		10		
Mollusca				
Corbicula fluminea	59	40	33	89
Pisidium sp.		10		
Total	7,314	634	10,560	5,418

+ Indicates organisms present.

TABLE V-B-4

BENTHIC MACROINVERTEBRATE DENSITIES (Number/m^2), MEAN TRIPLICATE FOR BACK CHANNEL AND DUPLICATE SAMPLES COLLECTED IN THE MAIN CHANNEL OHIO RIVER, SEPTEMBER 8, 1992

BVPS

Taxa	STATION			
	1	2A	2B	3
Cnidaria				
Cordylophora lacustris			7	
Nemertea		30		
Nematoda	20	30	59	40
Entoprocta				
Urnatella gracilis			+	+
Annelida				
Oligochaeta eggs	+	+	+	+
Amphichaeta leydigii	20			
Dero sp.	20	10	92	69
Nais communis	10		46	10
Nais pardalis		10		
Piguetiella michiganensis	39	69	13	10
Pristina idrensis	808	148	158	1,665
Pristina osborni	226	50	158	798
Stylaria fossularis	40		72	10
Vejdovskyella intermedia			20	
Tubificidae				
Aulodrilus limnobius	40	50	70	40
Aulodrilus pigueti	50	20	13	10
Aulodrilus pluriseta				40
Branchiura sowerbyi	69		26	59
Limnodrilus cervix	10		33	69
Limnodrilus hoffmeisteri	217	168	302	178
Limnodrilus udekemianus	20	50	7	40
Ilyodrilus templetoni				20
Immatures w/o capilliform chaeta	818	867	2,049	1,606
Immatures w/ capilliform chaeta	69		145	375
Amphipoda				
Gammarus sp.			26	
Coleoptera				
Dubiraphia sp.			7	
Chironomidae				
Chironominae pupae		10	33	
Chironomus sp.			112	
Cryptochironomus sp.	49	59	79	177
Dicrotendipes sp.			26	10
Harnischia sp.		10	20	10
Microchironomus sp.			59	
Polypedilum sp.	99	148	289	20
Rheotanytarsus sp.			40	
Thienemannimyia group			7	
Tanytarsus sp.		10		
Coelotanypus scapularis			59	
Procladius sp.			650	
Cricotopus sp.		10		
Nanocladius sp.			20	
Ceratopogonidae			7	
Mollusca				
Corbicula fluminea	99	79	46	39
Anadonta immature			7	
Total	2,723	1,828	4,707	5,29

+ Indicates organisms present.

1974 through 1978, has been collected in the 1981 through 1992 surveys. None were collected during 1979 or 1980 surveys.

No ecologically important additions of species were encountered during 1992 nor were any threatened or endangered species collected. Two genera of chironomids, Microchironomus and Tanypus were found to be new additions to the systematic list of macroinvertebrates collected near the BVPS site.

Community Structure and Spatial Distribution

Oligochaetes accounted for the highest percentage of the macroinvertebrates at all sampling stations in both May and September (Figure V-B-2). Among the individual stations, oligochaetes were always the dominant organism except at Station 2A (May 1992), where chironomid larvae were most abundant (Table V-B-2).

Density and species composition variations observed within the BVPS study area were due primarily to habitat differences and the tendency of certain types of macroinvertebrates (e.g., oligochaetes) to cluster. Overall, abundance and species composition throughout the study area were similar.

In general, the mean density of macroinvertebrates during 1992 was lowest at Station 2A in May and September. Highest mean densities occurred at Station 2B in May and Station 3 in September. Higher mean densities usually occur at Stations 1, 2B, and 3 where substrates near the shore were composed of soft mud or various combinations of sand and silt. The lower abundances at Station 2A were probably related to substrate conditions (clay and sand) along the north shoreline of Phillis Island.

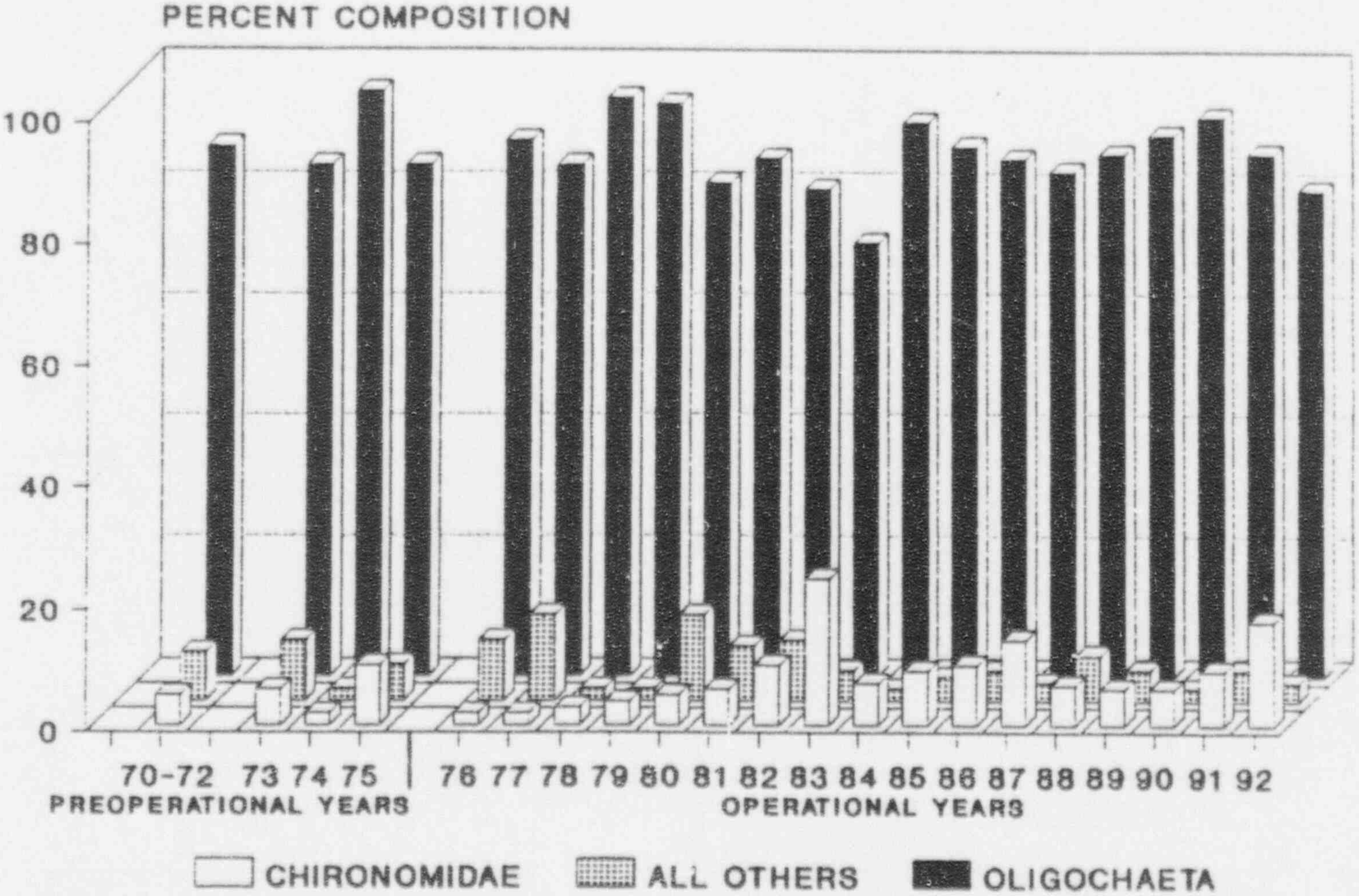

FIGURE V-B-2

MEAN PERCENT COMPOSITION OF THE BENTHOS COMMUNITY
IN THE OHIO RIVER NEAR BVPS DURING
PREOPERATIONAL AND OPERATIONAL YEARS
BVPS

Comparison of Control and Non-Control Station

No adverse impact to the benthic community was observed during 1992. This conclusion is based on a comparison of data collected at Station 1 (Control) and 2B (Non-Control) and on analyses of species composition and densities.

Data indicate that oligochaetes were usually predominant throughout the study area (Figure V-B-2). In May, common taxa at both stations were the oligochaetes, immature without capilliform chaetae, Stylaria fossularis, and Paranais frici, and midges Polypedilum and Procladius (Table V-B-3). In September, the oligochaetes Limnodrilus hoffmeisteri and Pristina spp., and the midge Polypedilum, were the common organisms collected at both stations (Table V-B-4).

In September 1992, a greater mean number of taxa were collected at Non-Control Station 2B than at Control Station 1 (Table V-B-5). This has occurred several times during past surveys. The mean number of taxa and Shannon-Weiner indices for the back channel were within the range of or exceeded the values observed for other stations in the study area. Differences observed between Station 1 (Control) and 2B (Non-Control) and between other stations could be related to differences in habitat. None of the differences were attributed to BVPS operation.

Comparison of Preoperational and Operational Data

Composition, percent occurrence and overall abundance of macroinvertebrates has changed little from preoperational years through the current study year. Oligochaetes have been the predominant macroinvertebrate in the community each year, and they comprised approximately 80% of the individuals collected in 1992 (Figure V-B-2). A similar oligochaete assemblage has been reported each year. Chironomids and mollusks have composed most of the remaining fractions of the community each year. The nuisance clam, Corbicula, increased in abundance from 1974 through 1976, but declined in number during 1977. Since 1981, Corbicula have

TABLE V-B-5

MEAN DIVERSITY VALUES FOR BENTHIC MACROINVERTEBRATES COLLECTED IN THE OHIO RIVER, 1992
BVPS

	STATION			
	1	2A	2B	3
DATE: May 20				
No. of Taxa	22	8	19	24
Shannon-Weiner Index	3.16	2.23	2.82	3.19
Evenness	0.71	0.73	0.76	0.69
DATE: September 8				
No. of Taxa	16	11	20	17
Shannon-Weiner Index	2.86	2.14	2.91	2.64
Evenness	0.72	0.80	0.72	0.65

been collected in the benthic surveys including 1992 when their densities were slightly greater in September as compared to those found in May.

Total macroinvertebrate densities for Station 1 (Control) and 2B (Non-Control) for each year since 1973 are presented in Table V-B-6. Mean densities of macroinvertebrates gradually increased from 1973 through 1976 (BVPS Unit 1 start-up) to 1983. In 1992, densities were greater at Station 2B than those at Station 1. These higher densities at Station 2B in 1992 were well within the range of previous data from preoperational and operational years. Mean densities have frequently been higher in the back channel of Phillis Island (Non-Control 2B) when compared to densities at Station 1 (Control). In years such as 1991, 1990, 1985, 1984, 1983, and 1979, when mean densities were lower at Station 2B than at Station 1, the differences were negligible. These differences could be related to substrate variability and randomness of sample grabs. Higher total densities of macroinvertebrates in the back channel (Station 2B) when compared to Station 1 was probably due to the morphology of the river. The two additional midge taxa encountered in 1992, Microchironomus and Tanypus, were more abundant at Station 2B than at Station 1. Mud, silt, and slow current were predominant at Station 2B creating conditions more favorable for burrowing macroinvertebrates in comparison to Station 1, which has little protection from river currents and turbulence caused by commercial boat traffic.

Summary and Conclusions

Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft muck-type substrates along the shoreline were conducive to worm and midge proliferation, while limiting macroinvertebrates which require a more stable bottom. At the shoreline stations, Oligochaeta accounted for 80% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 17% and 3%, respectively.

TABLE V-B-6

BENTHIC MACROINVERTEBRATE DENSITIES (Number/m^2) FOR STATION 1 (CONTROL) AND STATION 2B (NON-CONTROL) DURING PREOPERATIONAL AND OPERATIONAL YEARS

BVPS

	Preoperational Years						Operational Years									
	1973		1974		1975		1976		1977		1978		1979		1980	
Month	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
January																
February	205	0	703	311			358	200	312	1,100	1,499	2,545			1,029	1,296
March													425	457		
April																
May	248	508	1,116	2,197			927	3,660	674	848	351	126	1,004	840	1,041	747
June	5	40	507	686												
July	653	119	421	410												
August	99	244	143	541	1,017	1,124	851	785	591	3,474	601	1,896	1,185	588		
September			175	92											1,523	448
October	256	239														
November	149	292	318	263	75	617	388	1,295	108	931	386	1,543	812	806		
December																
Mean	231	206	483	643	546	871	631	1,485	421	1,588	709	1,528	857	673	1,198	830

TABLE V-B-6
(Continued)

	Operational Years															
	1981		1982		1983		1984		1985		1986		1987		1988	
Month	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
May	209	456	3,490	3,026	3,590	1,314	2,741	621	2,256	867	601	969	1,971	2,649	1,804	1,775
September	2,185	912	2,956	3,364	4,172	4,213	1,341	828	1,024	913	849	943	2,910	2,780	1,420	1,514
Mean	1,197	684	3,223	3,195	3,881	2,764	2,041	725	1,640	890	725	956	2,440	2,714	1,612	1,645

	Operational Years							
	1989		1990		1991		1992	
Month	1	2B	1	2B	1	2B	1	2B
May	3,459	2,335	15,135	5,796	7,760	6,355	7,314	10,560
September	1,560	4,212	5,550	1,118	3,855	2,605	2,723	4,707
Mean	2,510	3,274	10,343	3,457	5,808	4,480	5,019	7,634

Community structure has changed little since preoperational years and there was no evidence that BVPS operations were affecting the benthic community of the Ohio River.

C. PHYTOPLANKTON

Objectives

Plankton sampling was conducted to determine the condition of the phytoplankton community of the Ohio River in the vicinity of the BVPS.

Methods

One entrainment sample was collected monthly. Each sample was a one-gallon sample taken from below the skimmer wall from one operating intake bay. This one-gallon sample was preserved with Lugol's solution and was used for the analyses of both phytoplankton and zooplankton.

In the laboratory, a measured aliquot of the sample was settled in an inverted microscope chamber. A minimum of 250 cells were identified and counted at 400X magnification. For each collection date, the volume of sample settled and examined was adjusted depending on cell density. A Hyrax diatom slide was also prepared monthly from each sample. This slide was examined at 1000X magnification to make positive identification of the diatoms.

Densities (cells/ml), Shannon-Weiner (log base 2), and evenness diversity indices (Pielou 1969), and richness index (Dahlberg and Odum 1970) were calculated for each monthly sample.

Seasonal Distribution

otal cell densities of phytoplankton from stations on the Ohio River and in the intake samples have been similar during the past years (DLC 1976-1991). Species composition has also been similar in entrainment samples and those from the Ohio River (DLC 1980). Therefore, samples collected from the intake bays should provide an adequate characterization of the phytoplankton community in the Ohio River.

During 1992, the January through May samples had phytoplankton densities of 1,148 to 4,787 cells/ml (Table V-C-1 and Figure V-C-1). Total mean densities peaked in June (40,148 cells/ml). Densities decreased in July through August and developed a small secondary peak in September (13,519 cells/ml). Thereafter phytoplankton displayed a general decreasing trend to end the year at 2,795 cells/ml in December (Table V-C-1 and Figure V-C-1).

Diatoms (Chrysophyta), blue-greens (Cyanophyta), and microflagellates were generally the most abundant groups of phytoplankton during 1992 (Table V-C-1 and Figure V-C-2). Diatoms were an important part of the phytoplankton from March to July. Blue-green algae had the highest percent occurrences in the phytoplankton during August, September, and October. Microflagellates were important components of the phytoplankton during the cold months, while green algae were common during the summer months.

Diversity indices for the phytoplankton during 1992 are presented in Table V-C-2. Shannon-Weiner diversity indices ranged from 1.82 to 3.50, evenness values from 0.43 to 0.69, and richness values from 2.00 to 3.68. High (>2.00) diversity values occurred in 10 of the 12 months. The lowest Shannon-Weiner diversity index (1.82) occurred in January when two colonies of microflagellate algae dominated the cell counts, however, the lowest number of species occurred in April when microflagellates and small centrics were predominant. Highest number of taxa (34) occurred in August and October.

Phytoplankton communities were generally dominated by different taxa each season. The most abundant taxa during coldest months (January to April, November to December) were microflagellates (Table V-C-3). Small centric diatoms were dominant only in May. Microcystis incerta, a colonial blue-green with minute cells, was the dominant taxon based on cell numbers during June, July, September, and October. However, this

TABLE V-C-1

MONTHLY PHYTOPLANKTON GROUP DENSITIES (Number/ml) AND PERCENT COMPOSITION FROM ENTRAINMENT SAMPLES, 1992

BVPS

	Jan		Feb		Mar		Apr		May		Jun	
Group	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%
Chlorophyta	24	1	304	10	86	7	432	15	254	5	6,794	17
Chrysophyta	311	19	245	8	487	42	1,078	36	2,554	53	15,513	39
Cyanophyta	118	7	682	22	0	0	0	0	0	0	13,383	33
Cryptophyta	63	4	2	<1	79	7	150	5	353	7	1,543	4
Microflagellates	1,117	68	1,914	61	495	43	1,307	44	1,622	34	2,915	7
Other Groups	0	0	4	<1	1	<1	0	0	4	<1	0	0
Total	1,633	99	3,151	101	1,148	99	2,967	100	4,787	99	40,148	100

	Jul		Aug		Sep		Oct		Nov		Dec	
Group	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%
Chlorophyta	2,270	21	1,163	11	2,708	20	899	11	187	9	376	13
Chrysophyta	3,327	30	3,177	29	1,585	12	2,379	30	500	24	821	29
Cyanophyta	3,312	30	3,395	31	8,007	59	3,641	46	29	1	99	4
Cryptophyta	665	6	734	7	785	6	53	1	215	10	172	6
Microflagellates	1,435	13	2,401	22	434	3	861	11	1,178	56	1,324	47
Other Groups	8	<1	0	0	0	0	12	<1	3	<1	3	<1
Total	11,017	100	10,870	100	13,519	100	7,845	99	2,112	100	2,795	99

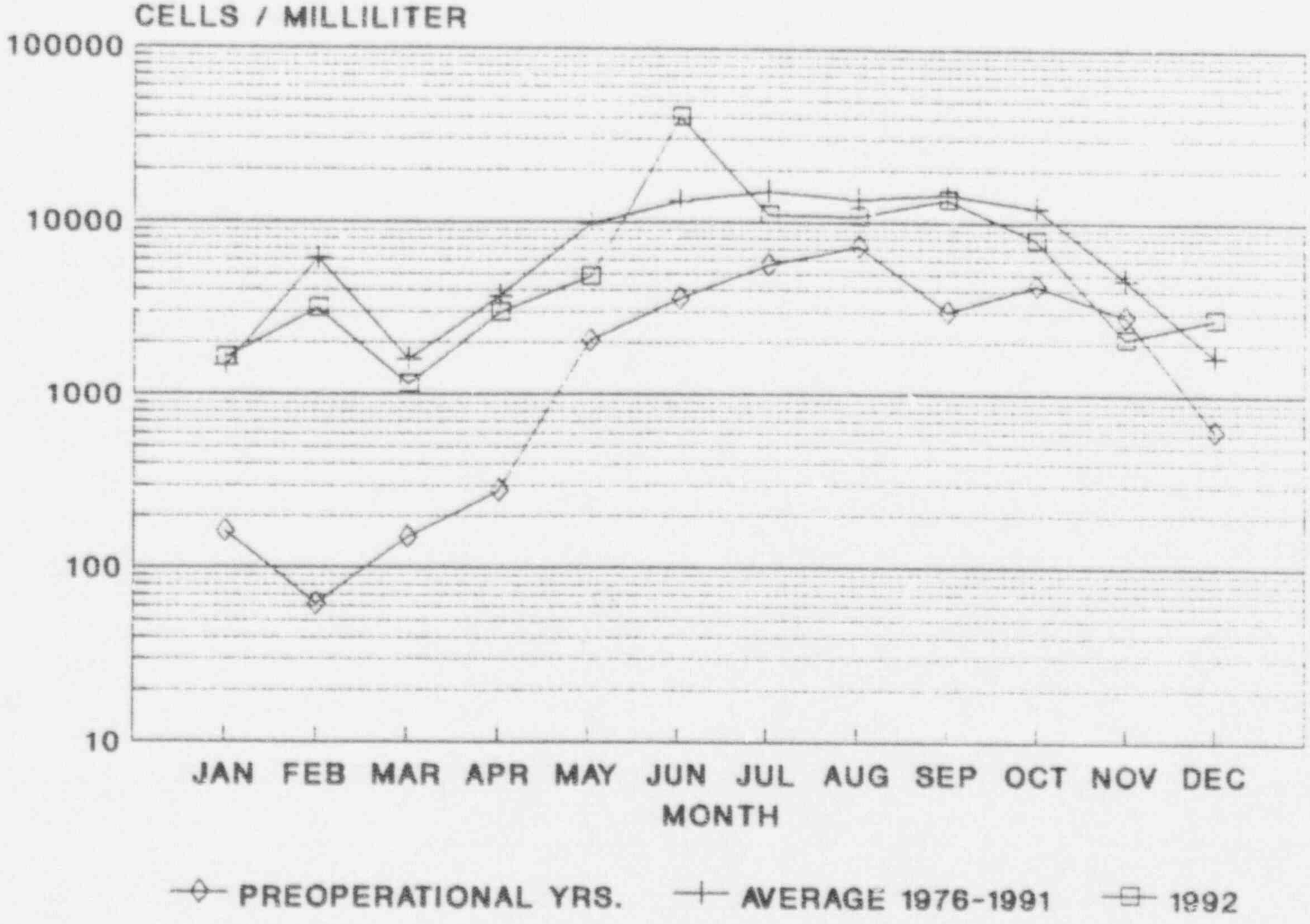

FIGURE V-C-1

MONTHLY PHYTOPLANKTON DENSITIES IN THE OHIO RIVER
DURING PREOPERATIONAL (1974-1975) AND
OPERATIONAL (1976-1992) YEARS
BVPS

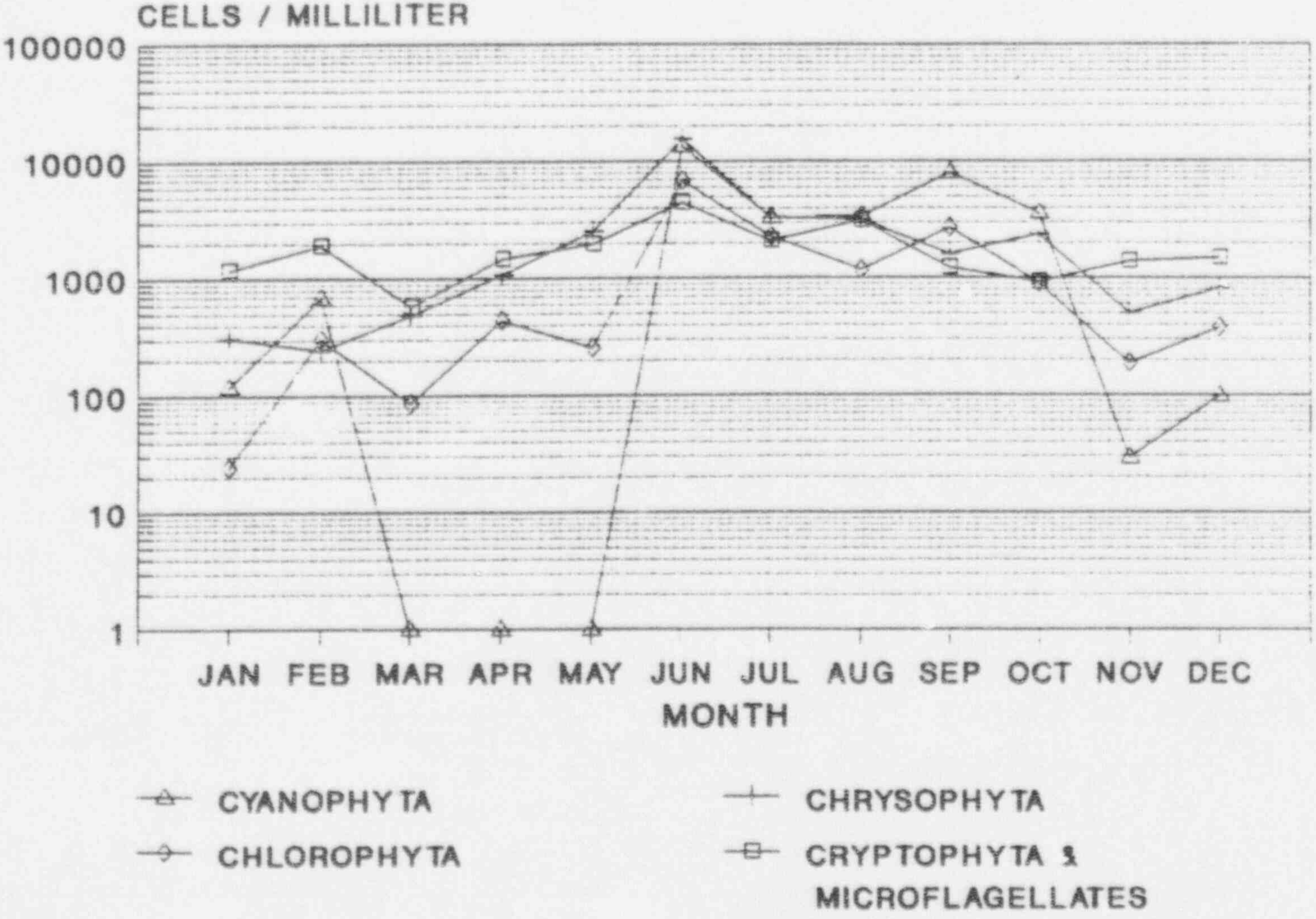

FIGURE V-C-2

PHYTOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1992
BVPS

TABLE V-C-2

PHYTOPLANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1992
BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
No. of Species	18	20	24	17	23	31	28	34	30	34	21	25	25
Shannon-Weiner Index	1.82	1.84	2.93	2.30	2.23	3.21	3.17	3.50	3.22	2.99	2.28	2.71	2.68
Evenness	0.44	0.43	0.64	0.56	0.49	0.65	0.66	0.69	0.66	0.59	0.52	0.58	0.58
Richness	2.30	2.36	3.26	2.00	2.60	2.83	2.90	3.55	3.05	3.68	2.61	3.02	2.85

TABLE V-C-3

DENSITIES (Number/ml) OF MOST ABUNDANT PHYTOPLANKTON TAXA
(Fifteen Most Abundant on Any Date)
COLLECTED FROM ENTRAINMENT SAMPLES
JANUARY THROUGH DECEMBER, 1992
BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CYANOPHYTA												
Lyngbya limnetica										199	9	
Merismopedia tenuissima									1,224			
Microcystis incerta	118	660				11,925	3,312		5,610	2,979		
Oscillatoria limnetica		22				1,458		2,484	1,173	463		99
Oscillatoria subbrevis								911				
CHLOROPHYTA												
Actinastrum hantzschii	6	7	28	117	62	55	63			23		14
Ankistrodesmus convolutus	4	16	4	9	21	228	90	104	701	154	10	44
Ankistrodesmus falcatus	14	31	2	55	74	146	230	99	155	32	10	51
Chlamydomonas spp.				13					51			
Chlorophyta I		242	44	238	33	1,325	1,270	497	994	530	152	132
Dictyosphaerium pulchellum						328	36	126	109	12	9	22
Pediastrum simplex								144				
Pediastrum tetras		7										
Scenedesmus bicellularis						3,975		18	306	66		66
Scenedesmus quadricauda			4		37	264	63	36	109	35		26
Scenedesmus spinosus					18	109	18			6		4

TABLE V-C-3
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHRYSOPHYTA												
Achnanthes minutissima	22		11	13		132					19	
Asterionella formosa	46	52	119	9	168	400		144	228	20	51	76
Cymbella ventrocosa			11	26			55					
Diatoma tenue	15											
Diatoma vulgare	3			26	5				64	12		7
Dinobryon sertularia		3	2	28	39	55		14				
Fragilaria spp.			11									
Fragilaria vaucheriae			55									
Melosira ambigua	5					655		45		23		
Melosira distans									200	296	29	124
Melosira granulata var. angustissima						892	198	279	82	12	36	
Melosira granulata						136	261	27		122	13	13
Navicula cryptocephala	4		8	5	2	9	4		18	9	9	1
Navicula minima			33									
Navicula viridual	15		55	40								
Nitzschia acicularis					33			166		99		
Nitzschia agnita	7	11			99	265	55			33	10	
Nitzschia holsetica						309		18				
Nitzschia palea							110	83				
Skeletonema potamos						2,518	442	497	51	132		
Stephanodiscus niagarae	5	1			5	27	4	4	9	6	1	1
Synedra filiformis		22										
Synedra tenera			22			132		166				
Synura uvella		12	4	14	44			4		3		14
Small centrics	185	143	154	911	2,152	9,938	2,098	1,490	842	1,589	332	563
CRYPTOPHYTA												
Cryptomonas erosa	11	2	2	5	55	218	58	72	155	20	24	40
Rhodomonas minuta	52		77	145	298	1,325	607	662	612	33	190	132
MICROFLAGELLATES	1,117	1,914	495	1,307	1,622	2,915	1,435	2,401	434	861	1,178	1,324
Total Phytoplankton	1,633	3,151	1,148	2,967	4,787	40,148	11,017	10,870	13,519	7,845	2,112	2,795
Total of Most Abundant Taxa	1,629	3,145	1,141	2,961	4,767	39,739	10,409	10,491	13,127	7,769	2,102	2,753
Percent Composition of Most Abundant Phytoplankton	100	100	99	100	100	99	94	97	97	99	100	98

blue-green seldom causes nuisance conditions such as surface scums on the water.

Comparison of Control and Non-Control Transects

Plankton samples were not collected at any river stations after April 1, 1980, due to a reduction in the scope of the aquatic sampling program; therefore, comparison of data was not conducted in 1992.

Comparison of Preoperational and Operational Data

The seasonal succession of phytoplankton varied from year to year, but in general, the phytoplankton taxa have remained consistent. Phytoplankton communities in running waters respond quickly to changes in water temperature, turbidity, nutrients, velocity, and turbulence (Hynes 1970). The phytoplankton from the Ohio River near BVPS generally exhibited a bimodal pattern of annual abundance. During the preoperational year 1974, total densities peaked in August and October, while in operational years 1976 through 1979, mean peak densities occurred in June and September (DLC 1980). Total phytoplankton densities displayed a bimodal pattern in 1992, when peaks occurred in June and September. The increased abundance of blue-greens at several times during the year was not a true reflection of a phytoplankton community structure. The presence of one or two blue-green colonies in an algae count can cause an exaggeration of relative species importance when cell numbers are analyzed.

In general, the phytoplankton community in 1992 was similar to those of preoperational and operational years. No major change in species composition or community structure was observed during 1992. The small differences in the phytoplankton community between 1992 and the previous years were due to natural fluctuations.

Mean diversity indices during 1992 were in the lower to moderate ranges of those reported during previous years. Yearly mean Shannon-Weiner diversity indices from 1973 through 1992 (2.68) were similar ranging from a low of 2.01 in 1990 to a maximum of 4.36 in 1975 (Table V-C-4). Yearly mean evenness in 1992 was 0.58; values from 1974 to 1991 ranged from 0.42 to 0.83. In 1973, the evenness value was the lowest (0.38). The maximum evenness diversity value is 1.0, which occurs when each species is represented by the same number of individuals. The mean number of taxa each year ranged from 19 in 1973 to 49 in 1986 (25 in 1992). The highest number of taxa (68) in phytoplankton samples occurred during November of operational year 1986.

Summary and Conclusions

The phytoplankton community of the Ohio River near BVPS exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. The annual peak of 40,148 cells/ml occurred in June. Total cell densities were low during the colder months. Microflagellates, blue-greens, and chrysophytes were the most abundant groups during 1992. Although blue-green algae were abundant in terms of cell numbers during the summer, the species composition remained similar to that of previous years. Total cell densities and diversity indices were within the ranges of those previously observed near BVPS.

D. ZOOPLANKTON

Objectives

Plankton sampling was conducted to determine the condition of the zooplankton community of the Ohio River in the vicinity of BVPS.

Methods

The zooplankton analysis was performed on one liter aliquots taken from the preserved one-gallon samples obtained from the intake bay (see Phytoplankton methods, in Part C). One liter from each sample was filtered through a 35 micrometer (0.035mm) mesh screen. The portion retained was washed into a graduated cylinder and allowed to settle for

TABLE V-C-4

PHYTOPLANKTON DIVERSITY INDICES (MEAN OF ALL SAMPLES 1973 TO 1992)
NEW CUMBERLAND POOL OF THE OHIO RIVER
BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	x̄
1973													
Number of Species	7	2	(d)	13	24	27	28	30		24	7	16	19
Shannon Index[a]	1.55	0.54		0.63	1.64	2.28	3.55	3.72	No	3.37	3.25	3.27	2.38
Evenness	0.33	0.15		0.11	0.25	0.35	0.55	0.52	Sample	0.50	0.54	0.53	0.38
Richness	1.[illegible]	0.[illegible]		1.50	2.63	3.17	3.61	3.46		3.24	2.89	2.80	2.48
1974													
Number of Species	12	8	17	22	44	46	47	60	34	47			34
Shannon Index	2.96	2.23	3.18	3.50	4.89	4.40	4.03	4.25	3.85	5.02			3.83
Evenness	0.55	0.46	0.57	0.58	0.62	0.62	0.56	0.55	0.54	0.58			0.56
Richness	2.55	1.82	3.05	3.74	5.56	5.45	5.46	6.49	4.77	5.44			4.43
1975													
Number of Species								52	34	43	32	40	40
Shannon Index								4.53	4.22	4.37	4.22	4.48	4.36
Evenness								0.80	0.83	0.81	0.87	0.85	0.83
Richness								5.57	3.96	4.98	3.92	6.19	4.91
1976													
Number of Species	31	35	31	38	47	49	46	43	38	33	35	38	39
Shannon Index	3.98	4.36	3.90	4.25	4.14	4.27	4.28	4.30	3.93	4.16	4.24	4.45	4.19
Evenness	0.80	0.85	0.78	0.81	0.75	0.76	0.78	0.80	0.75	0.83	0.83	0.85	0.80
Richness	5.15	5.89	4.92	4.70	4.68	4.79	4.72	4.34	3.85	4.17	4.95	5.79	4.83
1977													
Number of Species	20	28	31	24	36	30	44	39	37	32	33	27	
Shannon Index	1.96	3.31	3.00	2.78	4.16	3.52	4.36	4.26	4.29	3.92	4.12	4.00	[illegible]
Evenness	0.44	0.70	0.61	0.60	0.80	0.72	0.80	0.81	0.82	0.78	0.82	0.83	0.73
Richness	3.14	4.57	4.44	2.95	3.53	2.77	4.63	4.26	3.87	3.98	4.18	3.72	3.84
1978													
Number of Species	37	29	32	42	28	42	36	37	35	37	34	32	35
Shannon Index	4.08	3.68	3.77	4.67	3.30	4.16	3.95	4.17	3.81	3.99	3.80	4.44	3.99
Evenness	0.78	0.76	0.76	0.87	0.69	0.78	0.77	0.80	0.76	0.77	0.76	0.90	0.78
Richness[b]													
1979													
Number of Species	18	16	19	36	34	27	34	24	29	25	28	38	27
Shannon Index	3.49	3.36	3.79	3.22	3.[illegible]	3.84	4.10	3.88		4.07	3.68	4.32	3.80
Evenness	0.84	0.82	0.88	0.62	0.74	0.81	0.80	0.84		0.88	0.77	0.83	0.81
Richness	2.97	2.64	3.36	4.69	4.08	2.98	3.46	2.72	3.26	3.52	3.57	5.19	3.54
1980 (c)													
Number of Species	28	18	24	25	21	18	30	16	32	24	33	37	24
Shannon Index	3.88	2.64	3.78	3.82	3.28	3.26	3.61	3.45	4.10	3.54	3.73	4.56	3.57
Evenness	0.81	0.64	0.83	0.82	0.75	0.78	0.74	0.86	0.82	0.77	0.74	0.87	0.78
Richness	4.07	2.65	3.49	4.02	2.50	2.38	2.90	1.94	3.33	2.59	4.01	5.40	3.[illegible]

TABLE V-C-4
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
1981													
Number of Species	22	35	37	39	34	33	33	51	35	27	40	32	35
Shannon Index	3.92	4.39	4.39	2.29	3.66	4.56	4.13	4.59	4.07	3.90	4.00	4.32	3.95
Evenness	0.88	0.85	0.84	0.43	0.72	0.90	0.82	0.81	0.79	0.82	0.75	0.86	0.79
Richness	3.91	5.84	6.10	4.58	3.69	4.61	3.73	5.76	3.85	3.56	5.00	4.55	4.60
1982													
Number of Species	51	41	46	22	55	45	66	54	53	35	50	49	47
Shannon Index	4.68	4.80	4.96	1.88	4.79	4.33	4.72	4.54	4.22	3.97	4.09	4.66	4.30
Evenness	0.82	0.90	0.90	0.42	0.83	0.79	0.78	0.79	0.74	0.77	0.72	0.83	0.77
Richness	7.17	6.43	6.88	2.36	6.15	4.96	6.65	5.33	5.23	3.61	5.36	6.23	5.53
1983													
Number of Species	36	42	51	52	25	42	37	40	37	45	37	52	41
Shannon Index	4.27	4.01	4.60	4.74	3.67	4.41	4.16	4.28	3.56	3.51	4.17	4.72	4.18
Evenness	0.82	0.74	0.81	0.83	0.79	0.82	0.80	0.80	0.68	0.64	0.80	0.83	0.78
Richness	5.17	6.45	7.35	6.64	2.98	4.18	3.63	4.17	3.83	4.46	4.38	6.48	4.98
1984													
Number of Species	31	60	36	46	41	51	57	54	51	53	54	44	48
Shannon Index	4.02	4.89	4.30	3.06	4.37	4.48	4.34	4.03	4.38	4.00	4.59	4.10	4.21
Evenness	0.80	0.83	0.82	0.55	0.81	0.79	0.74	0.70	0.77	0.70	0.80	0.75	0.76
Richness	5.05	8.95	6.54	6.98	5.55	6.41	7.29	5.97	5.43	5.70	7.10	6.71	6.47
1985													
Number of Species	41	38	53	39	46	52	53	58	50	61	50	39	48
Shannon Index	3.80	3.31	4.44	3.88	4.24	2.95	4.16	4.28	3.59	2.57	3.15	3.26	3.56
Evenness	0.71	0.63	0.78	0.56	0.77	0.52	0.72	0.73	0.63	0.43	0.55	0.61	0.64
Richness	6.42	5.75	8.48	5.25	4.71	5.12	6.83	6.14	5.40	6.09	6.70	5.88	6.06
1986													
Number of Species	31	39	42	34	45	60	56	48	60	54	68	48	49
Shannon Index	3.79	4.48	3.73	1.50	4.04	3.78	4.04	3.94	4.21	4.01	4.44	4.40	3.86
Evenness	0.77	0.85	0.69	0.29	0.74	0.64	0.69	0.70	0.71	0.70	0.73	0.79	0.69
Richness	4.54	6.40	6.32	3.72	4.54	7.37	6.20	4.75	5.96	6.34	9.58	7.99	6.14
1987													
Number of Species	42	44	29	33	33	36	50	39	33	36	35	31	37
Shannon Index	2.99	2.28	2.51	1.89	3.38	3.56	3.76	3.44	2.12	2.52	2.54	2.41	2.78
Evenness	0.55	0.41	0.52	0.37	0.67	0.69	0.67	0.65	0.42	0.48	0.50	0.48	0.53
Richness	5.24	5.58	3.24	3.71	3.36	3.67	4.80	3.77	3.11	3.93	3.80	3.79	4.00

TABLE V-C-4
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
1988													
Number of Species	31	34	27	40	45	26	42	42	37	37	36	27	35
Shannon Index	3.20	1.90	1.72	2.68	2.83	2.88	3.76	3.13	3.76	2.30	2.61	2.65	2.78
Evenness	0.64	0.37	0.36	0.50	0.51	0.61	0.70	0.58	0.72	0.44	0.50	0.56	0.54
Richness	3.43	4.[illegible]1	3.28	4.65	4.75	2.66	4.20	4.12	3.70	3.25	3.83	3.00	3.76
1989													
Number of Species	27	46	25	45	26	25	37	29	24	30	34	29	31
Shannon Index	1.36	4.32	2.00	3.26	1.81	2.11	2.80	3.01	3.70	3.53	2.16	1.95	2.6[illegible]
Evenness	0.29	0.78	0.43	0.60	0.38	0.45	0.54	0.62	0.81	0.72	0.42	0.40	0.54
Richness	2.96	6.12	3.16	5.74	3.33	2.85	3.73	3.11	2.85	3.34	4.07	3.53	3.73
1990													
Number of Species	27	22	20	25	32	29	26	33	30	25	21	34	27
Shannon Index	1.58	1.22	2.49	1.69	1.99	2.64	1.71	2.41	2.70	1.50	1.99	2.22	2.01
Evenness	0.33	0.27	0.58	0.36	0.40	0.54	0.36	0.48	0.55	0.32	0.45	0.44	0.42
Richness	3.45	2.67	2.11	2.80	3.32	3.00	2.69	3.32	3.52	2.94	2.52	4.16	3.04
1991													
Number of Species	16	15	20	18	28	23	29	32	35	24	29	25	25
Shannon Index	2.21	1.71	1.94	1.43	3.52	1.44	2.31	2.89	2.70	2.68	3.45	3.27	2.46
Evenness	0.55	0.44	0.45	0.34	0.73	0.32	0.48	0.58	0.53	0.58	0.71	0.70	0.53
Richness	2.29	2.13	2.64	1.82	2.78	2.06	2.56	2.96	3.22	2.26	2.88	3.36	2.58
1992													
Number of Species	18	20	24	17	23	31	28	34	30	34	21	25	25
Shannon Index	1.82	1.84	2.93	2.30	2.23	3.21	3.17	3.50	3.22	2.99	2.28	2.71	2.68
Evenness	0.44	0.43	0.64	0.56	0.49	0.65	0.66	0.69	0.66	0.59	0.52	0.58	0.58
Richness	2.30	2.36	3.26	2.00	2.60	2.83	2.90	3.55	3.05	3.68	2.61	3.02	2.85

(a) Shannon-Weiner Index
(b) No data
(c) Data for period April 1980-December 1992 represents single entrainment samples collected monthly.
(d) Blanks represent periods when no collections were made.

a minimum of 24 hours. The supernatant was withdrawn to obtain a concentrated sample. One ml of this thoroughly mixed, measured concentrate was placed in an inverted microscope cell and examined at 100X magnification. All zooplankters within the cell were identified to the lowest practicable taxon and counted. Total density (individuals/liter), Shannon-Weiner and evenness diversity indices (Pielou 1969), and richness index (Dahlberg and Odum 1970) were calculated based upon one sample per month, which was collected below the skimmer wall from one operating intake bay.

Seasonal Distribution

The zooplankton community of a river system is typically composed of protozoans and rotifers (Hynes 1970, Winner 1975). The zooplankton community of the Ohio River near BVPS during preoperational and operational monitoring years was composed primarily of protozoans and rotifers.

Total organism density and species composition of zooplankton from the Ohio River and entrainment samples were similar during 1976, 1977, 1978, and 1979 (DLC 1980). Samples collected from intake bays were usually representative of the zooplankton populations of the Ohio River near BVPS.

During 1992, protozoans and rotifers accounted for 98% or more of all zooplankton on all sample dates (Table V-D-1). Total organism densities during the winter and spring (January through May) were less than 1,300/liter (Figures V-D-1, Table V-D-1). Total organism densities peaked in June (12,720/liter). A secondary peak occurred in September when 8,150 organisms/liter were observed; thereafter densities decreased gradually through December. The maximum zooplankton density in the Ohio River near BVPS frequently occurs in the spring, although it is sometimes delayed until summer or early fall (Table V-D-2, Figure V-D-1).

The seasonal pattern of zooplankton densities observed in the Ohio River near BVPS is typical of those in temperate climates (Hutchinson 1967). Zooplankton densities in winter are low due primarily to low water temp-

TABLE V-D-1

MONTHLY ZOOPLANKTON GROUP DENSITIES (Number/liter) AND PERCENT COMPOSITION
FROM ENTRAINMENT SAMPLES, 1992
BVPS

	Jan		Feb		Mar		Apr		May		June	
Group	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%
Protozoa	740	82	690	97	1,250	97	980	96	890	88	6,600	52
Rotifera	140	16	20	3	40	3	40	4	110	11	6,120	48
Crustacea	20	2	0	0	0	0	0	0	10	1	0	0
Total	900	100	710	100	1,290	100	1,020	100	1,010	100	12,720	100

	Jul		Aug		Sep		Oct		Nov		Dec	
Group	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%
Protozoa	6,540	81	2,750	81	7,350	90	4,550	98	3,300	94	1,440	94
Rotifera	1,560	19	600	18	800	10	100	2	200	6	100	6
Crustacea	0	0	50	1	0	0	0	0	0	0	0	0
Total	8,100	100	3,400	100	8,150	100	4,650	100	3,500	100	1,540	100

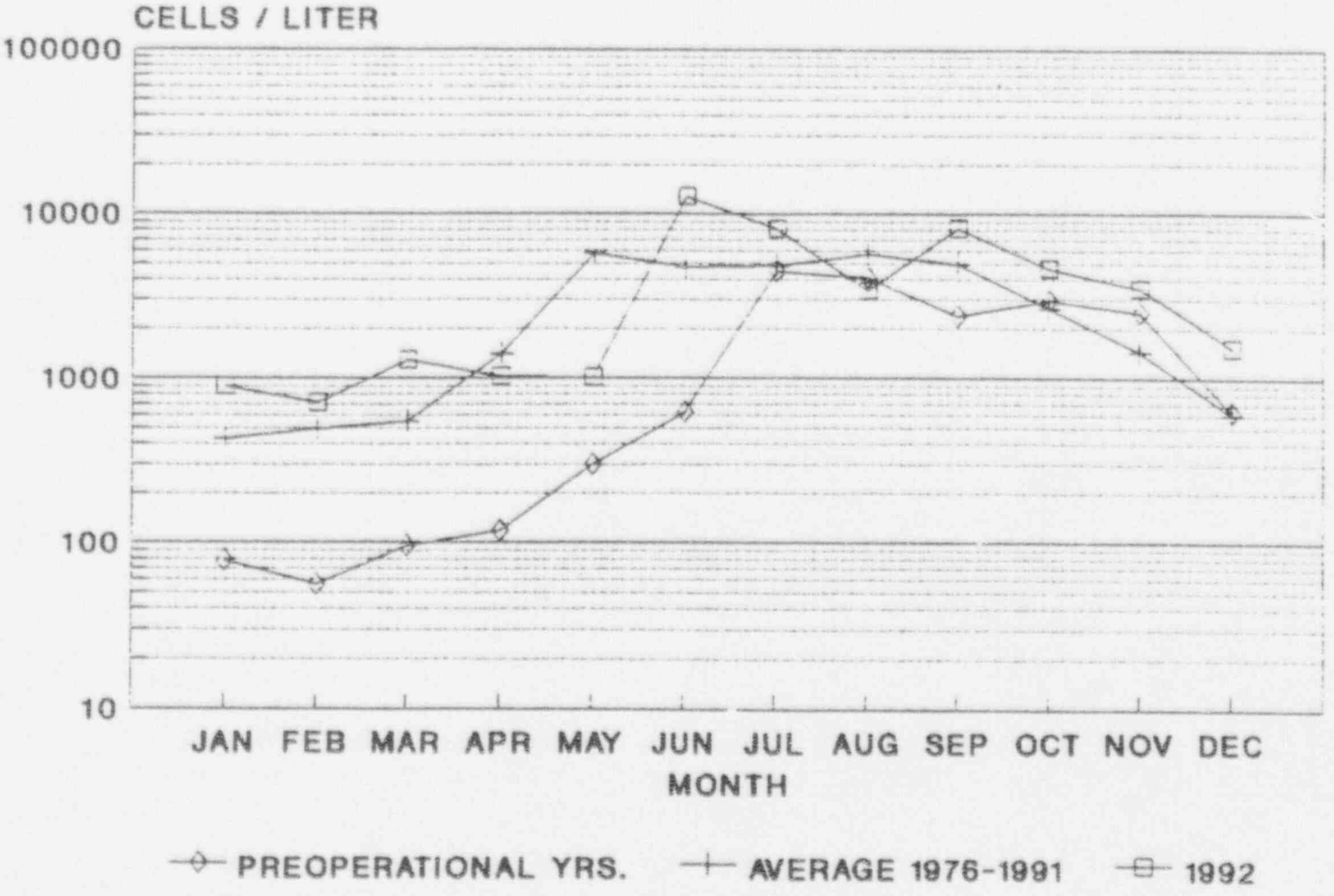

FIGURE V-D-1

MONTHLY ZOOPLANKTON DENSITIES IN THE OHIO RIVER
DURING PREOPERATIONAL (1974-1975) AND
OPERATIONAL (1976-1992) YEARS
BVPS

TABLE V-D-2

MEAN ZOOPLANKTON DENSITIES (Number/liter) BY MONTH FROM 1973 THROUGH 1992, OHIO RIVER AND BVPS

Total Zooplankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	(a)	50	-	90	154	588	945	1,341	-	425	180	87
1974	78	56	96	118	299	625	4,487	3,740	1,120	4,321	-	-
1975	-	-	-	-	-	-	-	4,426	3,621	1,591	2,491	623
1976	327	311	347	10,948	2,516	5,711	3,344	3,296	3,521	518	446	577
1977	147	396	264	393	5,153	4,128	1,143	1,503	3,601	553	934	486
1978	31	30	20	35	403	1,861	1,526	800	1,003	435	297	60
1979	357	96	228	534	2,226	599	2,672	4,238	950	370	542	550
1980	320	265	389	270	530	420	3,110	490	2,020	3,820	1,030	700
1981	190	360	220	580	840	310	3,800	1,940	4,490	1,850	760	370
1982	400	320	340	880	4,650	1,020	5,630	5,170	5,520	6,410	2,300	1,030
1983	285	330	1,415	540	480	8,220	4,780	6,010	3,280	2,880	950	560
1984	270	290	295	290	560	1,520	610	1,380	6,700	6,080	570	390
1985	410	485	255	365	6,520	6,280	1,920	10,000	4,680	4,760	740	570
1986	350	350	360	860	14,280	1,650	6,390	11,040	14,760	1,815	590	350
1987	550	1,330	1,850	600	36,000	14,080	11,550	7,800	3,920	1,400	4,640	900
1988	1,120	400	370	2,520	4,440	18,420	15,040	8,160	6,320	6,020	2,160	770
1989	710	855	825	885	735	2,340	3,330	1,800	5,420	1,995	960	470
1990	825	539	900	800	2,325	1,215	990	19,280	2,054	1,716	1,183	512
1991	570	1,570	670	2,010	11,920	4,200	11,600	8,200	10,760	4,340	4,920	1,400
1992	900	710	1,290	1,020	1,010	12,720	8,100	3,400	8,150	4,650	3,500	1,540
Protozoa												
1973	-	45	-	63	82	188	56	331	-	346	135	58
1974	50	42	72	91	138	409	1,690	716	1,006	4,[illegible]	-	-
1975	-	-	-	-	-	-	-	835	3,295	1,141	2,239	452
1976	278	274	305	10,774	1,698	6	1,903	1,676	808	425	396	492
1977	135	365	236	312	4,509	2,048	808	947	2,529	401	825	344
1978	18	14	14	27	332	1,360	407	315	256	222	227	26
1979	312	64	188	380	2,052	459	340	712	609	326	454	328
1980	244	250	354	190	390	370	1,620	380	1,180	3,010	760	640
1981	130	310	180	510	480	230	730	1,250	4,020	1,580	550	330
1982	350	310	310	820	1,300	870	2,360	1,560	1,590	4,850	2,060	980
1983	250	320	315	500	390	6,940	1,320	5,030	1,100	1,670	890	490
1984	225	280	285	260	500	1,190	530	1,210	5,000	5,300	530	360
1985	365	455	230	355	3,280	4,440	1,340	6,680	1,860	4,080	670	520
1986	330	330	300	760	11,220	1,290	5,970	7,520	9,780	1,680	490	305
1987	500	1,260	1,725	480	36,000	9,360	10,080	6,750	3,520	1,030	4,320	725
1988	1,080	345	330	2,360	4,020	8,580	10,720	7,000	5,000	5,720	2,040	710
1989	680	795	780	780	705	2,200	2,910	400	3,000	1,575	900	430
1990	750	525	800	710	2,085	1,140	960	15,520	1,911	1,560	1,178	432
1991	540	1,300	570	1,980	10,840	2,640	9,920	6,240	10,080	3,940	4,720	1,350
1992	740	690	1,250	980	890	6,600	6,540	2,750	7,350	4,550	3,300	1,440

TABLE V-D-2
(Continued)

Rotifera	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	-	5	-	25	64	388	859	1.001	-	75	43	27
1974	26	12	22	24	155	213	2,783	2,939	115	120	-	-
1975	-	-	-	-	-	-	-	3,339	313	444	250	164
1976	48	36	38	169	808	4,864	1,398	1,597	2,643	89	48	78
1977	12	31	26	76	631	1,984	328	539	1,022	147	108	136
1978	29	33	15	14	16	24	72	61	67	47	22	48
1979	44	33	37	151	172	135	2,255	3,482	324	42	86	220
1980	72	14	33	80	140	50	1,470	110	790	780	260	50
1981	40	50	40	70	340	80	2,800	630	470	260	210	40
1982	50	10	30	50	3,340	130	3,250	1,550	3,840	1,520	240	40
1983	30	10	1,100	40	90	1,270	3,440	880	1,930	1,190	60	70
1984	45	10	10	30	40	330	80	160	1,700	780	40	30
1985	40	30	25	10	3,240	1,820	580	2,880	2,740	660	70	40
1986	20	20	60	100	3,060	300	330	3,280	4,560	120	100	45
1987	40	70	125	120	0	4,720	1,400	950	280	370	320	175
1988	40	45	40	160	420	9,540	4,240	1,000	1,320	260	120	60
1989	30	60	45	90	30	140	420	920	2,360	390	60	40
1990	60	14	90	80	225	75	30	3,680	143	156	65	72
1991	30	70	100	30	1,040	1,560	1,680	1,880	480	380	160	50
1992	140	20	40	40	110	6,120	1,560	600	800	100	200	100
Crustacea												
1973	-	1	-	1	3	12	29	9	-	3	2	2
1974	2	2	3	3	6	3	14	85	7	6	-	-
1975	-	-	-	-	-	-	-	51	12	6	3	6
1976	2	1	5	4	10	141	43	23	69	3	2	8
1977	-	-	2	5	13	96	7	17	50	5	1	6
1978	4	6	3	2	6	48	12	27	75	9	5	5
1979	1	0	3	3	2	4	78	44	17	2	2	2
1980	3	1	1	0	0	0	20	0	50	30	10	10
1981	20	0	0	0	20	0	270	60	0	10	0	0
1982	0	0	0	10	10	20	20	60	90	40	0	10
1983	5	0	0	0	0	10	20	100	250	20	0	0
1984	0	0	0	0	20	0	0	10	0	0	0	0
1985	5	0	0	0	0	20	0	440	80	20	0	10
1986	0	0	0	0	0	60	90	240	420	15	0	0
1987	10	0	0	0	0	0	70	100	120	0	0	0
1988	0	10	0	0	0	300	80	160	0	40	0	0
1989	0	0	0	15	0	0	0	480	60	30	0	0
1990	15	0	10	10	15	0	0	40	0	0	0	8
1991	0	0	0	0	40	0	0	80	200	20	40	0
1992	20	0	0	0	10	0	0	50	0	0	0	0

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[a] No sample collected.

erature and limited food availability (Winner 1975). In the spring, food availability and water temperatures increase, which stimulate growth and reproduction. Zooplankton populations decrease during the fall and winter from the summer maximum because optimum conditions for growth and reproduction decrease during the cooler periods.

Densities of protozoans from January through May of 1992 were between 690 and 1,250/liter (Table V-D-1). Protozoans peaked in June (6,660/liter) and September (7,350/liter). Thereafter, populations progressively decreased until December when densities of 1,440/liter were observed. Vorticella sp., Strombidium sp., and Tintinnidium fluvitale were the common protozoans throughout the year. Vorticella sp. or Tintinnidium sp. dominated the protozoan assemblage during nine months (Table V-D-3). The most abundant protozoan in the other months were Difflugia, Arcella, and Strombidium (March, April, and October). These taxa have been a main part of the protozoan assemblage of the Ohio River near BVPS since environmental studies were initiated in 1973.

The rotifer assemblage in 1992 (Figure V-D-2) displayed a typical pattern of rotifer populations in temperate inland waters (Hutchinson 1967). Rotifer densities increased from a minimum of 20/liter in February to a maximum of 6,120/liter in June; a small secondary peak (800/liter) occurred in September (Table V-D-2). Rotifer populations generally decreased after September to densities of 100/liter in December. Rotifers were the second most abundant group during 1992. Keratella cochlearis, Synchaeta sp., and Polyarthra dolichoptera were the most abundant rotifers during most of the year (Table V-D-3).

Crustacean densities were low (0 to 50/liter) throughout 1992 (Table V-D-1). Most crustaceans were collected during summer; the peak density of 50/liter occurred in August (Figure V-D-2). Crustacean densities never exceeded protozoan or rotifer densities and constituted from 0 to 2% of the total zooplankton density each month (Table V-D-1). Copepod nauplii and Bosmina were the most numerous crustaceans collected during 1992. Despite relatively good river conditions in 1992, crustacean populations did not develop high densities due primarily to unfavorable

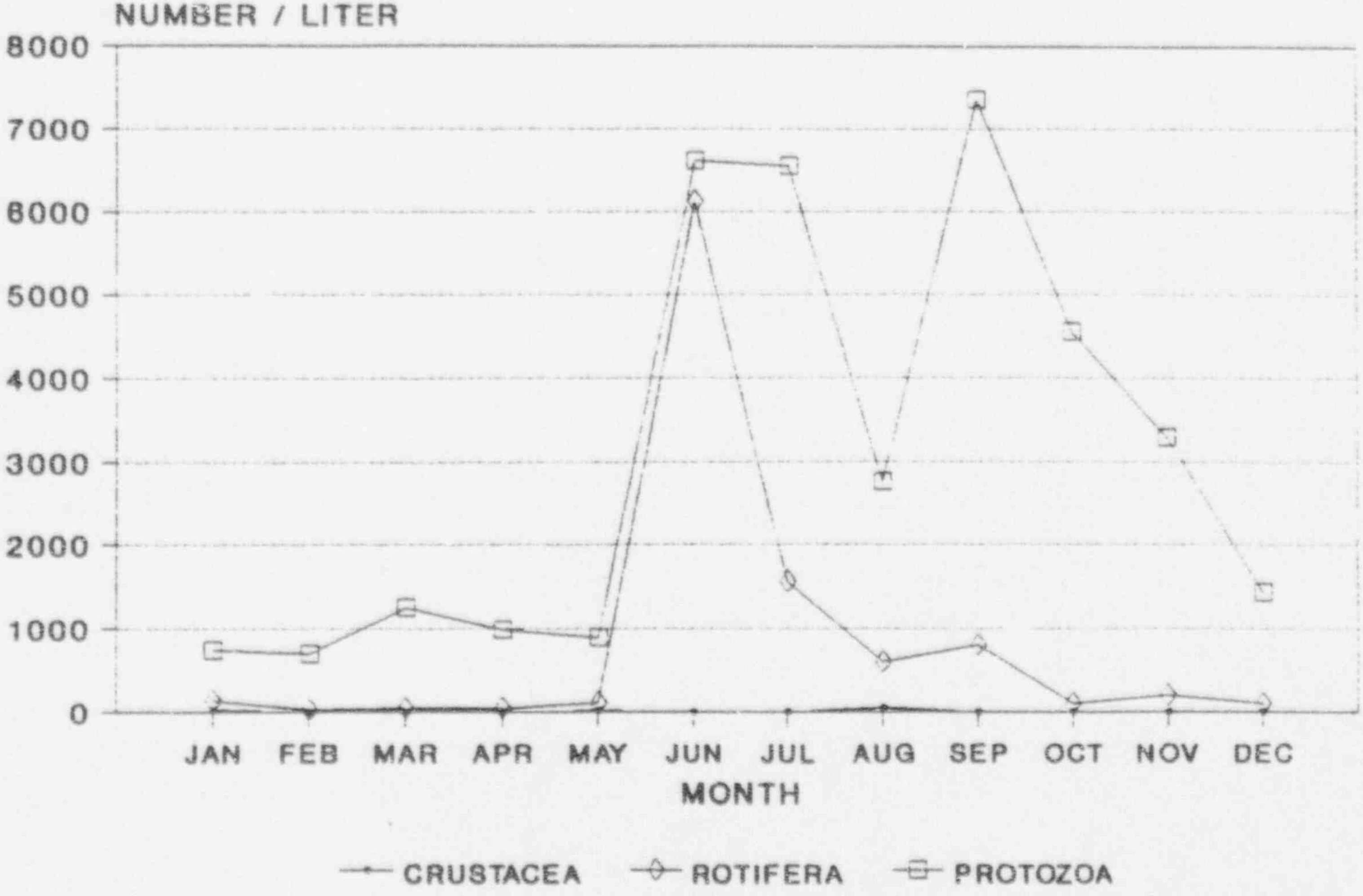

FIGURE V-D-2

ZOOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1992
BVPS

TABLE V-D-3

DENSITIES (Number/liter) OF MOST ABUNDANT ZOOPLANKTON TAXA
(Greater than 2% on any date)
COLLECTED FROM ENTRAINMENT SAMPLES
JANUARY THROUGH DECEMBER, 1992
BVPS

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PROTOZOA												
Arcella sp.	40	80	200	360	140	40	540		50	100	200	140
Bursaria sp.			20		10	520	180		100	50		
Centropyxis sp.			30									
Ciliate #4								100		50	150	20
Codonella cratera	30	90	60	40	60	80			350	50	250	20
Colpodium sp.	20	10	20	10						50		
Difflugia sp.	60	30	380	240	240		1,320	100	700	300	900	180
Epistylis sp.									400			20
Nuclearia simplex								150				40
Opercularia sp.	80											
Paramecium sp.			70									
Phascolodon vorticella		10				440			150			
Strobilidium gyrans	40	40	20	40	40	440		300	1,250	1,300	150	60
Strombidium sp.	30	30	50		80	720	180	450	900	1,050	300	160
Suctorian ciliate								100		50		
Tintinnidium fluvitale	30	90	90	120	150	2,880	3,240	550	1 950	800	700	160
Tintinnopsis cylindrica										100		
Trachelius sp.	20		10			40		50	50			
Uronema sp.	50	10	20		20	40	60	250	50	100	100	40
Urotricha sp.		10		10					50	100	50	
Vorticella sp.	310	290	260	150	110	960	780	600	1,250	400	350	560
Ciliate unidentified	10		20	10	10			50			100	
ROTIFERA												
Anuraeopsis fissa		10						100				
Brachionus calcyfloris						600						
Cephalodella sp.	20		10			40						
Keratella cochlearis	40				20	3,120	240	50	200			
Keratella cochlearis f. tecta						240		100				
Lecane sp.								50				40
Polyarthra dolichoptera	20		10	10	10	960	900	150	300		50	20
Synchaeta sp.	30			30	70	1,000	300	50			100	20
Trichocerca pusilla						160		50	200	50		
CRUSTACEA												
Nauplii	20				10							
Total ZOOPLANKTON	900	710	1,290	1,020	1,010	12,720	8,100	3,400	8,150	4,650	3,500	1,540
Total of Most Abundant Taxa	850	700	1,270	1,020	970	12,280	7,740	3,250	7,950	4,550	3,400	1,480
Percentage Composition of												

current conditions that are ever present in the river. Crustaceans are rarely numerous in the open waters of rivers and many are eliminated by silt and turbulent water (Hynes 1970).

The highest Shannon-Weiner diversity index of 3.79 occurred in August while the maximum number of species (22) occurred in January and June (Table V-D-4). Evenness ranged from 0.72 in July to 0.86 in August. Richness varied from a low of 1.44 in April to a high of 3.09 in January. The number of species ranged from 11 in April to 22 in January and June. Lowest Shannon-Weiner diversity index of 2.57 occurred during April.

Comparison of Control and Non-Control Transects

Zooplankton samples were not collected from stations on the Ohio River after April 1, 1980; therefore, comparison of Control and Non-Control transects was not conducted.

Comparison of Preoperational and Operational Data

Population dynamics of the zooplankton community during the seasons of preoperational and operational years are displayed in Figure V-D-1. Total zooplankton densities were lowest in winter, usually greatest in summer, and transitional in spring and autumn. This pattern in the Ohio River sometimes varies from year to year which is normal for zooplankton populations in other river habitats. Hynes (1970) concluded that the zooplankton community of rivers is inherently unstable and subject to constant change due to variations of temperature, flow, current, turbidity, and food source. Total densities of zooplankton during nine months of 1992 exceeded the average range established during the preoperational years (1973 through 1975) and operational years (1976 through 1991) (Figure V-D-1). In 1992, peak zooplankton densities occurred in June and September.

The species composition of zooplankton in the Ohio River near BVPS has remained stable during preoperational and operational years. The common

TABLE V-D-4

ANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1992
BVPS

	Jan	Feb	Mar	Apr	May	Jun
No. of Species	22	13	18	11	17	22
Shannon-Weiner Index	3.63	2.78	3.15	2.57	3.36	3.37
Evenness	0.81	0.75	0.76	0.74	0.82	0.76
Richness	3.09	1.83	2.37	1.44	2.31	2.22

	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
No. of Species	15	21	18	17	15	17	17
Shannon-Weiner Index	2.82	3.79	3.35	3.03	3.29	3.13	3.19
Evenness	0.72	0.86	0.80	0.74	0.84	0.77	0.78
Richness	1.56	2.50	1.89	1.89	1.72	2.18	2.08

or abundant protozoans since 1973 have been Vorticella, Codonella, Difflugia, Strobilidium, Cyclotrichium, Arcella, and Centropyxis. The most numerous and frequently occurring rotifers have been Keratella, Polyarthra, Synchaeta, Branchionus, and Trichocerca. Copepod nauplii have been the only crustacean taxon found consistently.

Community structure, as compared by diversity indices, has been similar since 1973 (Table V-D-5). In previous years, low diversity indices and number of species occurred in winter; high diversities and number of species usually occurred in late spring and summer.

In 1992, the diversity indices and species numbers were moderately low in February and April which was typical for months of winter and early spring. Shannon-Weiner diversity indices in 1992 ranged from 2.57 to 3.79 and were at the upper range of 1.80 to 3.28 that occurred during preoperational years from 1973 to 1975. The variation in evenness during 1992 (0.72 to 0.86) was usually at the upper portion of the range reported from 1973 to 1991 (0.21 to 0.93).

Summary and Conclusions

Zooplankton densities throughout 1992 were typical of the temperate zooplankton community found in large river habitats. Total densities frequently exceeded the mean range of those reported in preoperational and several operational years. Populations developed highest densities in June and a secondary peak occurred in September. Protozoans and rotifers were always predominant. Common and abundant taxa in 1992 were similar to those reported during preoperational and operational years. Shannon-Weiner diversity indices, number of species, and evenness were within the ranges of preceding years. Based on the data collected during the 17 operating years (1976 through 1992) and the three preoperational years (1973 through 1975), it is concluded that the overall abundance and species composition of the zooplankton in the Ohio River near BVPS has remained stable and possibly improved slightly over the twenty-year period from 1973 to 1992. The data indicate that increased turbidity and current from high water conditions have the strongest

TABLE V-D-5

MEAN ZOOPLANKTON DIVERSITY INDICES BY MONTH FROM 1973 THROUGH 1992 IN THE OHIO RIVER NEAR BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	(a)											
Number of Species		8.44		15.29	21.28	25.07	21.96	22.86		16.33	14.40	14.30
Shannon Index (b)		1.80		3.06	3.08	2.79	2.25	2.20		2.21	2.31	3.10
Evenness		0.37		0.63	0.58	0.46	0.39	0.36		0.37	0.44	0.61
1974												
Number of Species	14.64	9.18	14.92	17.75	23.25	15.56	21.14	18.89	9.56	14.47		
Shannon Index	3.18	2.53	2.91	3.06	3.25	2.32	3.28	2.24	2.15	1.84		
Evenness	0.62	0.56	0.57	0.58	0.55	0.41	0.60	0.41	0.42	0.30		
1975												
Number of Species								24.75	18.75	14.38	17.44	15.38
Shannon Index								3.20	1.86	2.90	2.01	3.20
Evenness								0.69	0.44	0.77	0.49	0.82
1976												
Number of Species	7.00	9.13	8.69	17.56	19.19	23.56	28.06	23.50	23.56	11.19	8.75	11.75
Shannon Index	1.67	2.64	2.24	0.89	3.06	2.33	3.36	3.63	2.76	2.73	1.60	2.64
Evenness	0.60	0.84	0.73	0.21	0.72	0.51	0.70	0.80	0.61	0.79	0.51	0.75
1977												
Number of Species	4.00	10.00	12.00	13.31	21.00	25.62	22.88	25.50	36.75	16.88	20.31	15.31
Shannon Index	1.53	2.59	3.01	2.98	3.15	3.45	3.32	3.60	3.71	3.35	3.42	3.42
Evenness	0.78	0.79	0.87	0.81	0.72	0.74	0.73	0.77	0.71	0.82	0.79	0.86
1978												
Number of Species	0.12	7.12	4.31	5.12	7.62	6.25	10.25	11.25	12.50	0.25	10.88	10.38
Shannon Index	2.48	2.41	1.53	1.70	1.53	1.33	2.50	2.44	2.53	2.28	2.15	2.00
Evenness	0.83	0.85	0.74	0.71	0.52	0.50	0.76	0.70	0.70	0.73	0.62	0.83
1979												
Number of Species	10.62	6.00	10.25	15.88	17.25	14.25	16.88	21.50	18.12	12.00	14.62	14.00
Shannon Index	2.51	2.52	3.05	3.42	2.36	3.02	2.42	3.30	3.36	2.99	2.84	3.10
Evenness	0.74	0.93	0.90	0.86	0.58	0.80	0.60	0.74	0.80	0.84	0.74	0.83

TABLE V-D-5
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1980[c]												
Number of Species	11.62	11.00	12.50	10.00	8.00	15.00	21.00	15.00	18.00	22.00	18.00	18.00
Shannon Index	2.51	2.70	3.03	2.41	2.00	2.91	3.63	2.79	3.23	2.88	3.26	3.36
Evenness	0.70	0.78	0.84	0.72	0.66	0.74	0.82	0.71	0.77	0.64	0.78	0.80
1981												
Number of Species	8.00	12.00	7.00	11.00	19.00	12.00	23.00	24.00	20.00	21.00	17.00	10.00
Shannon Index	2.14	3.02	2.28	2.32	3.44	2.73	2.96	3.55	2.62	3.05	2.66	2.47
Evenness	0.71	0.84	0.81	0.67	0.81	0.76	0.65	0.77	0.60	0.69	0.65	0.74
1982												
Number of Species	10.00	9.00	11.00	22.00	27.00	20.00	37.00	36.00	40.00	34.00	19.00	17.00
Shannon Index	2.99	2.22	2.89	3.59	2.46	3.20	3.82	4.28	3.86	3.09	3.54	3.14
Evenness	0.90	0.70	0.83	0.80	0.52	0.74	0.73	0.83	0.72	0.61	0.83	0.77
1983												
Number of Species	18.00	10.00	23.00	14.00	17.00	24.00	34.00	30.00	37.00	33.00	17.00	18.00
Shannon Index	3.20	2.39	2.41	3.09	3.54	2.36	3.56	2.65	3.92	3.43	3.28	3.54
Evenness	0.76	0.71	0.53	0.81	0.86	0.51	0.70	0.54	0.75	0.68	0.80	0.85
1984												
Number of Species	17.00	10.00	7.00	10.00	13.00	18.00	12.00	18.00	23.00	19.00	14.00	11.00
Shannon Index	3.29	2.67	0.82	2.10	2.26	2.63	2.40	2.28	3.62	2.84	2.89	2.52
Evenness	0.80	0.79	0.28	0.63	0.61	0.63	0.67	0.54	0.80	0.67	0.74	0.72
1985												
Number of Species	13.00	12.00	9.00	10.00	16.00	19.00	18.00	32.00	27.00	20.00	19.00	13.00
Shannon Index	2.32	1.98	1.72	1.64	2.90	2.91	3.35	3.60	3.72	3.27	3.25	1.97
Evenness	0.62	0.55	0.53	0.49	0.72	0.68	0.80	0.72	0.78	0.76	0.76	0.53
1986												
Number of Species	12.00	13.00	15.00	19.00	21.00	22.00	13.00	26.00	32.00	17.00	15.00	21.00
Shannon Index	2.97	2.84	3.13	3.15	2.26	3.74	2.94	3.69	4.19	2.90	2.83	3.10
Evenness	0.83	0.76	0.80	0.74	0.74	0.84	0.65	0.78	0.84	0.71	0.72	0.70

TABLE V-D-5
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987												
Number of Species	13.00	14.00	16.00	14.00	9.00	20.00	28.00	25.00	20.00	20.00	16.00	16.00
Shannon Index	2.64	1.76	3.40	3.54	0.89	3.15	3.53	3.50	3.29	3.37	2.32	3.48
Evenness	0.71	0.46	0.85	0.93	0.28	0.73	0.73	0.75	0.76	0.78	0.58	0.87
1988												
Number of Species	8.00	17.00	17.00	13.00	13.00	24.00	14.00	24.00	26.00	22.00	16.00	21.00
Shannon Index	2.45	2.57	2.70	2.30	2.60	3.30	2.29	3.20	3.48	2.35	2.97	2.68
Evenness	0.82	0.62	0.65	0.62	0.70	0.72	0.60	0.70	0.74	0.53	0.74	0.61
1989												
Number of Species	14.00	11.00	15.00	15.00	12.00	18.00	18.00	21.00	22.00	14.00	14.00	15.00
Shannon Index	2.37	2.68	3.02	3.22	2.91	3.21	3.43	3.46	3.35	3.20	3.49	2.82
Evenness	0.62	0.77	0.77	0.82	0.81	0.77	0.82	0.79	0.75	0.84	0.92	0.72
1990												
Number of Species	16.00	13.00	19.00	16.00	18.00	12.00	11.00	21.00	19.00	17.00	12.00	13.00
Shannon Index	3.02	2.46	3.53	2.95	2.73	2.52	2.54	3.09	3.07	3.35	2.87	2.40
Evenness	0.76	0.67	0.83	0.74	0.66	0.70	0.73	0.70	0.72	0.82	0.80	0.65
1991												
Number of Species	15.00	20.00	20.00	24.00	22.00	19.00	26.00	24.00	20.00	19.00	14.00	19.00
Shannon Index	2.73	2.05	2.64	3.19	3.17	3.32	2.97	3.42	2.07	2.75	2.21	1.86
Evenness	0.70	0.47	0.61	0.70	0.71	0.78	0.63	0.75	0.48	0.65	0.58	0.44
1992												
Number of Species	22.00	13.00	18.00	11.00	17.00	22.00	15.00	21.00	18.00	17.00	15.00	17.00
Shannon Index	3.63	2.78	3.15	2.57	3.36	3.37	2.82	3.79	3.35	3.03	3.29	3.13
Evenness	0.81	0.75	0.76	0.74	0.82	0.76	0.72	0.86	0.80	0.74	0.84	0.77

(a) Blanks represent periods when no collections were made.
(b) Shannon-Weiner Index
(c) Data for period April 1980-December 1992 represents single entrainment samples collected monthly.

effects of delaying the populations' peaks and temporarily decreasing total zooplankton densities in the Ohio River near BVPS.

E. FISH

Objective

Fish sampling was conducted in order to detect any changes which might occur in fish populations in the Ohio River near BVPS.

Methods

Adult fish surveys were performed in May, July, September, and November 1992. During each survey, fish were collected at the three study transects (Figure V-E-1) using gill nets, electrofishing and minnow traps.

The gill nets consisted of five 25 ft. panels of 1.0, 2.0, 2.5, 3.0, and 3.5 inch square mesh. Two nets were positioned at each transect, one angled along each shoreline, with the small mesh positioned inshore. At Transect 2 the river is divided by Phillis Island into two separate channels, the main channel (2A) and the back channel (2B). Two gill nets were set in each of these channels, resulting in a total of eight gill nets set per sampling date.

Electrofishing was conducted with a boat-mounted boom electroshocker. Direct current of 220 volts at one to two amperes was generally used. The shoreline areas of each transect were shocked for ten minutes during each survey.

Minnow traps were baited with bread, cheese and sucrose then placed next to the inshore side of each gill net on each sampling date. These traps were painted black and brown with a camouflage design and were set for 24 hours before they were removed and checked for fish.

Fishes collected using gill nets, electrofishing and minnow traps were processed according to the following procedures. All game fishes were

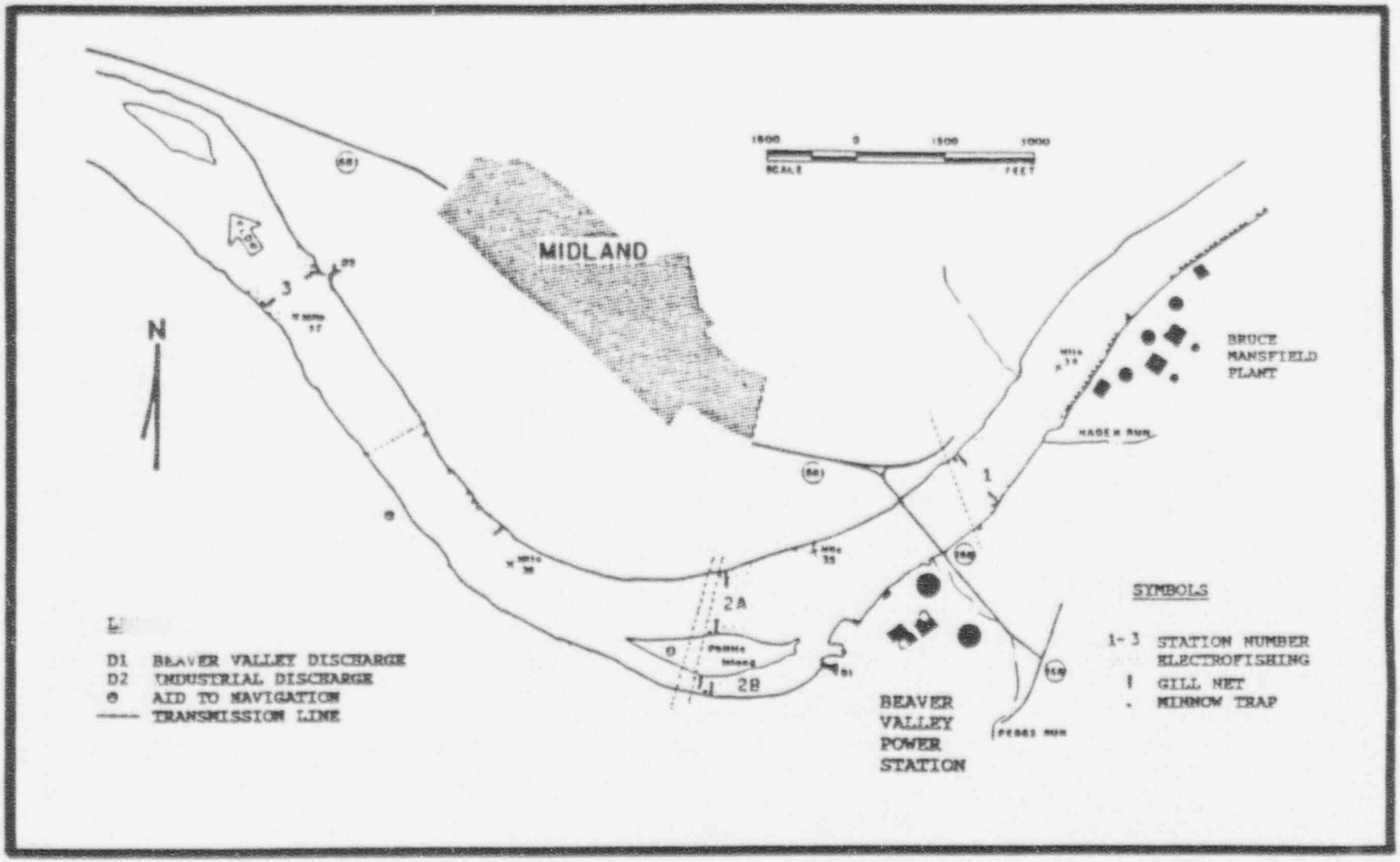

FIGURE V-E-1

FISH SAMPLING STATIONS
BVPS

identified, counted, measured for total length (mm), and weighed (g) individually. For all non-game fish taxa samples comprised of 30 specimens or less, the total length (mm) was measured for each specimen. Large non-game fishes were weighed individually. Smaller non-game fishes (e.g., shiner sp.) were separated by species and batch weighed. Subsampling was performed when more than 30 specimens were obtained for a non-game taxa according to methodologies stated in the DLC BVPS Environmental Procedures Manual, Chapter 5, Aquatic Ecological Monitoring Procedures, Section 7.1-4. Live fish were returned to the river immediately after the processing was completed. All fish which were unidentifiable or of questionable identification were placed in plastic sample bottles, preserved with 10% formalin, labeled and returned to the laboratory. Any fish species which was not previously collected at BVPS was retained for the voucher collection.

Results

Fish population surveys have been conducted in the Ohio River near BVPS from 1970 through 1992. These surveys have collected 67 fish species and four hybrids (Table V-E-1). In 1992, 30 fish species, represented by 464 individuals were collected near BVPS by gill netting, electrofishing and minnow traps (Table V-E-2). The spotted sucker, Minytrema melanops and saugeye (sauger x walleye) not collected in previous BVPS surveys, were collected for the first time in 1992.

Various agencies have conducted fishery surveys in the New Cumberland Pool of the Ohio River in recent years resulting in the identification of fish species not collected during BVPS surveys. The Ohio River Valley Sanitation Commission collected an alewife during their 1992 New Cumberland Pool fish study. This additional fish species has been added to Table V-E-1, bringing the total taxa of fish to 76 for the New Cumberland Pool of the Ohio River.

A total of 227 fishes, representing 19 species were collected during 1992 BVPS surveys by electrofishing (Table V-E-3). Gizzard shad accounted for 53.3% of the total electrofishing catch in 1992. Collec-

TABLE V-E-1

(SCIENTIFIC AND COMMON NAME)[1]
FAMILIES AND SPECIES OF FISH COLLECTED IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1970-1992
BVPS

Family and Scientific Name	Common Name
Lepisosteidae (gars)	
Lepisosteus osseus	Longnose gar
Clupeidae (herrings)	
Alosa chrysochloris	Skipjack herring
A. pseudoharengus	Alewife
Dorosoma cepedianum	Gizzard shad
Hiodontidae (mooneyes)	
Hiodon alosoides	Goldeye
H. tergisus	Mooneye
Salmonidae (salmon and trouts)	
Salmo gairdneri	Rainbow trout
Esocidae (pikes)	
Esox lucius	Northern pike
E. masquinongy	Muskellunge
E. lucius x *E. masquinongy*	Tiger muskellunge
Cyprinidae (minnows and carps)	
Campostoma anomalum	Central stoneroller
Carassius auratus	Goldfish
Ctenopharyngodon idella	Grass carp
Cyprinus carpio	Common carp
C. carpio x *C. auratus*	Carp-goldfish hybrid
Ericymba buccata	Silverjaw minnow
Hybopsis storeriana	Silver chub
Nocomis micropogon	River chub
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald shiner
N. chrysocephalus[2]	Striped shiner[2]
N. hudsonius	Spottail shiner
N. rubellus	Rosyface shiner
N. spilopterus	Spotfin shiner
N. stramineus	Sand shiner
N. volucellus	Mimic shiner
Pimephales notatus	Bluntnose minnow
P. promelas	Fathead minnow
Rhinichthys atratulus	Blacknose dace
Semotilus atromaculatus	Creek chub

TABLE V-E-1
(Continued)

Family and Scientific Name	Common Name
Catostomidae (suckers)	
Carpiodes carpio	River carpsucker
C. cyprinus	Quillback
C. velifer	Highfin carpsucker
Catostomus commersoni	White sucker
Hypentelium nigricans	Northern hog sucker
Minytrema melanops	Spotted sucker
Ictiobus bubalus	Smallmouth buffalo
I. niger	Black buffalo
Moxostoma anisurum	Silver redhorse
M. carinatum	River redhorse
M. duquesnei	Black redhorse
M. erythrurum	Golden redhorse
M. macrolepidotum	Shorthead redhorse
Ictaluridae (bullhead and catfishes)	
Ictalurus catus	White catfish
I. melas	Black bullhead
I. natalis	Yellow bullhead
I. nebulosus	Brown bullhead
I. punctatus	Channel catfish
Noturus flavus	Stonecat
Pylodictis olivaris	Flathead catfish
Percopsidae (trout-perches)	
Percopsis omiscomaycus	Trout-perch
Cyprinodontidae (killifishes)	
Fundulus diaphanus	Banded killifish
Atherinidae (silversides)	
Labidesthes sicculus	Brook silverside
Percichthyidae (temperate basses)	
Morone chrysops	White bass
M. chrysops x *M. saxatilis*	Striped bass hybrid
Centrarchidae (sunfishes)	
Ambloplites rupestris	Rock bass
Lepomis cyanellus	Green sunfish
L. gibbosus	Pumpkinseed
L. macrochirus	Bluegill
L. microlophus	Redear sunfish
L. gibbosus x *L. microlophus*	Pumpkinseed-redear sunfish hybrid
Micropterus dolomieui	Smallmouth bass
M. punctulatus	Spotted bass
M. salmoides	Largemouth bass
Pomoxis annularis	White crappie
P. nigromaculatus	Black crappie

TABLE V-E-1
(Continued)

Family and Scientific Name	Common Name
Percidae (perches)	
Etheostoma blennioides	Greenside darter
E. nigrum	Johnny darter
E. zonale	Banded darter
Perca flavescens	Yellow perch
Percina caprodes	Logperch
P. copelandi	Channel darter
Stizostedion canadense	Sauger
S. vitreum vitreum	Walleye
S. canadense x *S. vitreum*	Saugeye
Sciaenidae (drums)	
Aplodinotus grunniens	Freshwater drum

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[1] Nomenclature follows Robins, *et al*. (1980).
[2] A former subspecies of *N. cornutus* (Gilbert, 1964) and previously reported as common shiner.

TABLE V-E-2

NUMBER OF FISH COLLECTED AT VARIOUS TRANSECTS BY GILL NET (G), ELECTROFISHING (E) AND MINNOW TRAP (M) IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1992
BVPS

Taxa	1			2A			2B			3			Grand Total			Annual Total	Percent Annual Total
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M		
Longnose gar		1					1			1			2	1		3	0.6
Gizzard shad	2	52		3	35		1	13		10	21		16	121		137	29.5
Tiger muskellunge	1			1			1			2			5			5	1.1
Common carp	14	9		9	5		8	1		11	4		42	19		61	13.1
Emerald shiner												1			1	1	0.2
River carpsucker										4			4			4	0.9
Quillback	4			2				1		4			10	1		11	2.4
Highfin carpsucker							1						1			1	0.2
Northern hog sucker		3			1			1						5		5	1.1
Spotted sucker										1			1			1	0.2
Silver redhorse				2			2			6			10			10	2.2
Golden redhorse	3	10		4	9		1	2		2	1		10	22		32	6.9
Shorthead redhorse	1	3		1	3		1			1	4		4	10		14	3.0
Redhorse sp.		4			7						1			12		12	2.6
Channel catfish	19			10			28			14			71			71	15.3
Flathead catfish				1			1			7			9			9	1.9
White bass				1						3			4			4	0.9
Striped bass hybrid	4	1		2	2		1			4			11	3		14	3.0
Rock bass		1				2								1	2	3	0.6
Green sunfish										1			1			1	0.2
Bluegill											1			1		1	0.2
Smallmouth bass		7		1	5		2	2		2	4		5	18		23	5.0
Spotted bass	3			1			7	2		3			14	2		16	3.4
White crappie											1			1		1	0.2
Bass sp.								2			1			3		3	0.6
Logperch					4									4		4	0.9
Sauger	2	1		2			1			4			9	1		10	2.2
Walleye				1				1		2			3	1		4	0.9
Saugeye	1												1			1	0.2
Freshwater drum		1								1			1	1		2	0.4
Total	54	93		41	71	2	56	25		83	38	1	234	227	3	464	

TABLE V-E-3

NUMBER OF FISH COLLECTED BY MONTH BY GILL NET (G), ELECTROFISHING (E), AND MINNOW TRAP (M) IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1992
BVPS

Taxa	May			Jul			Sep			Nov			Grand Total			Annual Total	Percent Annual Total
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M		
Longnose gar				1			1	1					2	1		3	0.6
Gizzard shad	3	59		10	3			59		3			16	121		137	29.5
Tiger muskellunge	1			2						2			5			5	1.1
Common carp	24	5		15	4		2	1		1	9		42	19		61	13.1
Emerald shiner			1												1	1	0.2
River carpsucker	2			2									4			4	0.9
Quillback	3			3	1		4						10	1		11	2.4
Highfin carpsucker				1									1			1	0.2
Northern hog sucker					5									5		5	1.1
Spotted sucker							1						1			1	0.2
Silver redhorse	4			1			4			1			10			10	2.2
River redhorse	2	11		3	6		3	3		2	2		10	22		32	6.9
Shorthead redhorse					9		2	1		2			4	10		14	3.0
Redhorse sp.		1			8			3						12		12	2.6
Channel catfish	49			9			9			4			71			71	15.3
Flathead catfish	1			5			3						9			9	1.9
White bass				3			1						4			4	0.9
Striped bass hybrid	3			8							3		11	3		14	3.0
Rock bass		1	2											1	2	3	0.6
Green sunfish	1												1			1	0.2
Bluegill											1			1		1	0.2
Smallmouth bass	1	6		4	6			4			2		5	18		23	5.0
Spotted bass	10				1		4				1		14	2		16	3.4
White crappie											1			1		1	0.2
Bass sp.		1			2									3		3	0.6
Logperch					4									4		4	0.9
Sauger	1			3	1		1			4			9	1		10	2.2
Walleye				3							1		3	1		4	0.9
Saugeye							1						1			1	0.2
Freshwater drum				1							1		1	1		2	0.4
Total	105	84	3	74	50		36	72		19	21		234	227	3	464	

tively, redhorse species represented 19.4% of the catch. Common carp and smallmouth bass accounted for 8.4% and 7.9% of the total electrofishing catch, respectively. Each remaining taxa accounted for 3% or less of the total catch. Most of the fishes sampled by electrofishing were collected in May (37.0%). The fewest fish were collected in November (9.3%).

It should be noted that "observed" fishes are typically included in the electrofishing catch-per-unit-effort. This is sometimes necessary because of the turbidity and swiftness of the water, although these conditions were minimal in 1992. When these conditions do exist, it is often not physically possible for the collectors to net these stunned fishes and they are identified to the genus level and recorded as "observed."

The gill net results varied by month with the highest catch in May (105 fish). July was the next highest month with 74 fish, and September and November totals were 36 and 19 fish, respectively (Table V-E-4). The most common species collected by gill nets in 1992 were channel catfish (30.3%), common carp (17.9%), gizzard shad (6.8%) and spotted bass (6.0%).

Three fishes were captured using minnow traps in 1992 (Table V-E-2). One emerald shiner and two rock bass specimens were collected in the minnow traps in May.

The most common species (i.e., those which contributed more than 5% to the annual total catch) collected through the use of gill nets, electrofishing and minnow traps included the following: gizzard shad (29.5%), channel catfish (15.3%), common carp (13.1%) and golden redhorse (6.9%). The remaining species each accounted for 5% or less of the total.

TABLE [illegible]-4

NUMBER OF FISH COLLECTED BY GILL NET, ELECTROFISHING AND MINNOW TRAP AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1992

BVPS

	Transect					
Gill Net	1	2A	2B	3	Total	Average
May	30	6	34	35	105	26.3
July	13	23	9	29	74	18.5
September	5	6	10	15	36	9.0
November	6	6	3	4	19	4.8
Total	54	41	56	83	234	
Average	13.5	10.3	14.0	20.8		
Electrofishing						
May	46	19	6	13	84	21.0
July	15	22	5	8	50	12.5
September	21	27	11	13	72	18.0
November	11	3	3	4	21	5.3
Total	93	71	25	38	227	
Average	23.3	17.8	6.3	9.5		
Minnow Trap						
May	0	2	0	1	3	0.8
July	0	0	0	0	0	0
September	0	0	0	0	0	0
November	0	0	0	0	0	0
Total	0	2	0	1	3	
Average	0	0.5	0	0.3		

Comparison of Control and Non-Control Transects

The electrofishing data compiled since 1974 (Table V-E-5) reflects relatively minor differences in catch-per-unit-effort between the Control Transect (1) and the Non-Control Transects, when examined on a year-by-year basis. The fluctuations in fish catches are more pronounced when making comparisons between the years, however. These fluctuations are often the result of natural variables functioning within the river ecosystem. Fluctuations in catches occur with changes in the physical and chemical properties of the river's ambient water quality. Since electrofishing efficiency depends on the water's conductivity, any sampling conducted during extremes in this parameter will affect catch-per-unit-effort. In addition, turbidity and current affect the collectors' ability to observe and catch the stunned fish. Direct sunlight also influences where fishes congregate, thus determining their susceptibility to being shocked.

Electrofishing collects mostly small forage species (minnows and gizzard shad) and their highly fluctuating annual populations were reflected in differences in catch-per-unit effort from year to year and station to station. In 1992, the population of gizzard shad in the Ohio River near BVPS was greatly reduced compared to the 1991 population which had produced the highest catch-per-unit-effort for electrofishing for the eighteen-year period (1974-1991).

Gill nets catch mostly game species and are more indicative of changes in fish abundance. When comparing gill net data for 1974 through 1990 (Table V-E-6) little change is noted between Control and Non-Control Transects or between preoperational and operational years. However, the 1991 gill net catch-per-unit-effort totals were the highest recorded for the eighteen-year period, at 17.3 and 12.9-13.7 for the Control and Non-Control Transects, respectively. The 1992 gill net catch-per-unit-effort totals were lower than 1991 results, however they were at the upper end of the ranges recorded over the nineteen-year period (Control 7.0, Non-Control 7.5-8.0). Channel catfish and common carp contributed the most to the 1992 gill net catch-per-unit-effort totals. In both

TABLE V-E-5

ELECTROFISHING CATCH (FISH/HOUR) MEANS ($\bar{X}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1974-1992

BVPS

	Transect 1																		
Species	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]	1990[d]	1991[d]	1992[d]
Longnose gar	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	1.5
Gizzard shad	-	2.1	1.2	2.0	-	-	3.1	3.0	0.8	69.0	31.5	27.0	36.0	76.5	175.5	93.0	-	964.5	78.0
Tiger muskellunge	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-
Muskellunge	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern pike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pike sp.	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	1.5	-	-	-
Goldfish	-	-	0.7	-	-	-	2.3	-	0.8	-	-	-	-	-	-	-	-	-	-
Carp	5.9	-	-	1.0	12.5	-	20.8	15.8	1.5	30.0	66.0	13.5	9.0	15.0	18.0	7.5	13.5	7.5	13.5
Silver chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	-
River chub	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Golden shiner	-	-	-	-		-	-	0.8	-	-	1.5	-	-	-	-	-	-	-	-
Emerald shiner	42.0	441.7	18.7	57.0	22.8	58.4	51.5	151.5	114.8	279.0	12.0	6.0	46.5	58.5	40.5	9.0	10.5	7.5	-
Striped shiner	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-
Spottail shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	3.0	1.5	-	-	-
Spotfin shiner	0.9	-	4.8	7.0	0.5	-	-	-	3.0	4.5	1.5	-	-	-	-	-	-	-	-
Sand shiner	57.6	129.1	52.5	95.9	8.8	93.6	32.3	23.2	19.5	6.0	3.0	-	4.5	9.0	-	-	-	-	-
Mimic shiner	-	-	3.5	7.0	0.5	1.6	6.2	3.0	6.0	-	-	-	19.5	1.5	-	-	-	1.5	-
Bluntnose minnow	33.3	72.3	53.2	57.8	12.8	89.4	15.4	18.0	21.8	9.0	4.5	1.5	4.5	-	1.5	-	-	-	-
Creek chub	0.9	-	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	1.5	-
Blacknose dace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shiner sp.	-	-	-	-	-	-	-	-	-	-	78.0	3.0	528.0	114.0	78.0	21.0	15.0	-	-
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	1.5	-
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-
White sucker	-	-	-	-	0.3	-	-	-	-	-	1.5	1.5	3.0	-	-	-	-	-	-
Northern hog sucker	0.7	-	-	1.0	0.3	-	-	-	-	1.5	-	-	-	1.5	-	-	-	1.5	4.5
Redhorse sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	-	-	6.0
Silver redhorse	-	-	-	-	-	-	-	-	0.0	1.5	-	3.0	-	-	-	-	3.0	-	-
Black redhorse	-	-	-	-	0.8	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden redhorse	-	-	-	-	-	-	1.5	1.5	-	1.5	6.0	1.5	-	-	-	7.5	1.5	4.5	15.0
Shorthead redhorse	-	-	-	-	-	-	-	0.8	0.0	-	1.5	-	-	3.0	3.0	-	-	-	4.5
Yellow bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	-	-	-	-	0.3	-	-	0.8	-	-	-	-	-	1.5	-	1.5	1.5	-	-
Flathead catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-
Catfish sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	1.5	-	0.8	-	1.5	-	-	-	-	-	-	-	-
Banded killifish	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-

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[a] MAY-JUL

[b] AUG, NOV

[c] MAY-SEP, NOV

[d] MAY, JUL, SEP AND NOV

[e] MAY, JULY, SEP AND DEC

TABLE V-E-5
(Continued)

Species	Transect 1																		
	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]	1990[d]	1991[d]	1992[d]
Brook silverside	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	4.5	3.0	1.5	-	-
Striped bass hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Rock bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Sunfish (*Lepomis*) hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green sunfish	-	-	-	-	0.3	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	-	-	0.3	0.5	-	-	-	1.5	-	-	-	-	-	1.5	-	-	-
Bluegill	6.6	-	1.5	-	3.0	0.5	-	1.5	0.8	1.5	1.5	-	1.5	-	3.0	-	1.5	-	-
Sunfish sp.	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	1.5	1.5	-	-
Smallmouth bass	0.9	-	2.3	3.0	0.3	0.5	4.6	3.0	3.8	4.5	9.0	3.0	1.5	6.0	3.0	3.0	-	3.0	10.5
Spotted bass	0.9	-	-	2.7	-	2.6	4.6	1.5	-	4.5	9.0	1.5	3.0	7.5	4.5	-	-	-	-
Largemouth bass	1.1	-	-	1.0	1.0	-	0.8	-	0.9	-	-	-	3.0	-	1.5	-	-	1.5	-
Bass sp.	-	-	-	-	-	-	-	-	-	-	4.5	3.0	3.0	4.5	18.0	-	-	1.5	-
White crappie	-	-	-	-	-	-	1.5	-	-	-	-	-	1.5	-	-	-	-	-	-
Black crappie	-	-	-	-	-	-	-	-	-	1.5	-	1.5	-	-	-	-	-	-	-
Johnny darter	-	-	-	-		0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Banded darter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-
Yellow perch	-	-	-	-	0.3	0.5	-	0.8	-	-	3.0	-	-	-	-	-	-	-	-
Logperch	-	-	-	-	0.3	0.5	-	-	-	-	-	-	1.5	-	3.0	-	-	1.5	-
Sauger	-	-	-	-	-	-	-	-	-	-	-	1.5	1.5	1.5	-	1.5	6.0	-	1.5
Walleye	-	-	0.5	-	-	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-
Freshwater drum	-	-	-	-	-	-	-	-	-	-	-	-	3.0	3.0	1.5	1.5	3.0	-	1.5
Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	150.8	645.2	139.4	235.9	65.6	250.6	146.9	225.2	176.0	418.5	241.5	67.5	670.5	304.5	361.5	162.0	60.0	1,002.0	139.5

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[a] MAY- JUL
[b] AUG, NOV
[c] MAY- SEP, NOV
[d] MAY, JUL, SEP AND NOV
[e] MAY, JULY, SEP AND DEC

TABLE V-E-5
(Continued)

Species	Transect 2A, 2B, 3																		
	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]	1990[d]	1991[d]	1992[d]
Longnose gar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	0.5	-	-
Skipjack herring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-
Gizzard shad	0.9	1.0	1.4	0.7	0.3	2.1	2.5	21.5	19.2	19.5	76.5	33.0	57.5	116.0	315.0	80.0	35.0	1119.0	34.5
Rainbow trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
Tiger muskellunge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	-	0.5	-
Muskellunge	-	-	-	-	-	-	0.3	-	-	-	0.5	-	-	-	-	-	0.5	-	-
Northern pike	-	-	-	-	0.3	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Pike sp.	-	-	-	-	-	-	-	-	-	-	1.0	1.0	0.5	-	-	0.5	-	-	-
Goldfish	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	-
Carp	3.3	0.5	0.7	1.2	6.6	1.2	4.2	6.0	4.8	3.0	20.2	10.0	9.5	5.0	6.0	5.5	3.0	9.0	5.0
Silver chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-
River chub	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-
Golden shiner	-	-	-	-	-	-	-	-	0.2	0.5	-	-	0.5	-	-	0.5	-	-	-
Emerald shiner	67.7	239.5	[illegible]	33.8	23.9	53.7	37.0	163.5	21.8	493.5	22.5	21.5	36.5	31.0	10.0	7.0	7.0	11.5	-
Striped shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail shiner	-	-	-	-	-	-	-	-	-	-	-	-	0.5	3.5	-	1.0	-	-	-
Spotfin shiner	4.3	2.0	[illegible]	4.9	0.5	0.5	1.0	0.8	1.0	4.0	1.5	-	2.0	0.5	0.5	-	1.0	-	-
Sand shiner	17.4	81.0	52.6	26.2	13.3	45.2	25.8	10.2	22.8	26.0	-	-	0.5	1.5	0.5	-	-	-	-
Mimic shiner	-	-	1.8	1.1	0.3	2.2	1.0	3.2	4.8	7.0	-	-	1.5	0.5	-	-	-	-	-
Bluntnose minnow	6.1	31.2	45.3	44.9	21.4	40.8	10.2	5.2	14.2	38.5	0.5	1.0	0.5	0.5	0.5	-	-	-	-
Creek chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Blacknose dace	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Shiner sp.	-	-	-	-	-	-	-	-	-	-	40.0	42.5	566.5	299.5	12.5	174.0	18.0	17.5	-
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	0.5
White sucker	-	0.5	-	0.3	0.1	0.3	-	-	-	0.5	-	-	-	-	-	-	-	-	-
Northern hog sucker	-	-	-	0.3	0.3	0.3	0.2	0.8	-	-	-	0.5	-	-	-	-	-	0.5	1.0
Smallmouth buffalo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
Redhorse sp.	-	-	-	0.3	-	-	-	-	-	-	0.5	1.5	0.5	-	0.5	-	-	1.5	4.0
Silver redhorse	-	-	-	-	0.3	-	-	0.2	0.2	-	1.0	-	-	-	-	0.5	-	-	-
River redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
Black redhorse	-	-	-	0.3	0.3	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-
Golden redhorse	-	-	-	-	-	-	0.8	0.2	1.5	1.5	-	1.0	2.0	0.5	0.5	2.0	1.0	3.5	6.0
Shorthead redhorse	-	-	-	-	0.4	-	-	0.2	1.5	0.5	-	-	-	0.5	-	-	0.5	0.5	3.5
Yellow bullhead	0.4	-	0.2	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	0.4	-	0.2	-	0.1	-	-	0.1	-	-	-	0.5	-	-	-	-	-	-	-
Channel catfish	-	1.0	0.2	1.1	0.3	0.7	0.5	1.2	1.0	0.5	0.5	-	1.5	1.0	-	-	-	0.5	-
Flathead catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-
Catfish sp.	-	-	-	-	-	-	-	-	-	-	0.5	1.0	-	-	-	-	-	-	-
Trout- perch	-	-	-	-	0.1	0.5	0.2	-	0.2	5.0	-	-	-	-	-	-	-	-	-

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[a] MAY- JUL
[b] AUG, NOV
[c] MAY- SEP, NOV
[d] MAY, JUL, SEP AND NOV
[e] MAY, JULY, SEP AND DEC

TABLE V-E-5
(Continued)

	Transect 2A, 2B, 3																		
Species	1974^a	1975^b	1976^c	1977^c	1978^c	1979^c	1980^d	1981^d	1982^d	1983^d	1984^d	1985^e	1986^d	1987^d	1988^d	1989^d	1990^d	1991^d	1992^d
Banded killifish	-	-	-	-	0.1	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-
Brook silverside	-	-	-	-	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	0.1	-	0.5	-	-	-	-	-	-	-	15.0	10.5	0.5	-	-
Rock bass	-	-	0.4	-	0.1	-	-	0.5	-	-	-	-	0.5	0.5	0.5	-	-	-	-
Sunfish (*Lepomis*) hybrid	-	-	-	0.3	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Green sunfish	-	-	-	1.4	0.3	0.5	0.2	0.2	0.8	-	1.0	0.5	0.5	-	-	-	0.5	0.5	-
Pumpkinseed	-	0.5	0.7	1.0	0.5	-	-	0.2	0.2	-	1.0	-	-	-	0.5	-	-	-	-
Bluegill	1.9	0.6	0.2	0.3	1.4	0.2	-	0.8	0.2	1.5	1.0	0.5	0.5	1.5	1.0	0.5	0.5	1.0	0.5
Sunfish sp.	-	-	-	-	-	-	-	-	-	-	0.5	0.5	-	-	0.5	-	0.5	-	-
Smallmouth bass	0.8	-	0.6	1.0	0.3	0.9	2.8	6.5	5.8	4.0	6.0	2.0	3.5	4.0	4.5	5.0	6.5	6.0	5.5
Spotted bass	0.4	-	-	2.7	-	2.1	1.5	0.5	0.8	2.5	9.5	1.0	2.5	7.5	5.5	4.0	0.5	-	1.0
Largemouth bass	1.4	-	1.1	0.7	0.7	0.3	0.2	0.8	0.5	2.5	-	-	0.5	-	-	-	-	0.5	-
Bass sp.	-	-	-	-	-	-	-	-	-	-	11.0	1.5	2.5	1.0	1.0	4.0	2.0	1.5	1.5
White crappie	-	-	-	-	0.1	-	0.8	-	-	-	0.5	-	0.5	-	-	-	-	-	0.5
Black crappie	0.5	-	0.3	-	-	0.2	-	-	-	-	1.0	0.5	-	-	-	-	-	0.5	-
Johnny darter	1.0	1.0	0.4	-	0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Banded darter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-
Yellow perch	-	-	-	-	0.1	0.2	0.2	-	-	-	0.5	-	-	-	-	-	-	-	-
Logperch	-	-	-	0.3	-	0.7	0.2	0.8	0.8	1.0	0.5	-	1.0	-	1.0	-	0.5	1.0	2.0
Sauger	-	-	-	-	-	-	0.5	0.2	-	-	-	1.0	0.5	1.5	-	0.5	4.5	-	-
Walleye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	1.0
Freshwater drum	-	-	-	-	-	-	0.2	-	-	-	-	3.0	-	1.0	0.5	1.0	2.0	-	-
Unidentified	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-
Total	106.5	359.2	125.3	122.8	72.5	153.6	91.3	224.0	102.3	614.5	219.5	126.0	692.5	477.5	377.5	299.0	87.5	1,178.0	66.5

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[a] MAY- JUL
[b] AUG, NOV
[c] MAY- SEP, NOV
[d] MAY, JUL, SEP AND NOV
[e] MAY, JULY, SEP AND DEC

TABLE V-E-6

GILL NET CATCH (FISH/24 HOUR) MEANS ($\bar{X}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1974-1992
BVPS

	Transect 1																		
Species	1974[a]	1975[b]	1976[c]	1977[d]	1978[d]	1979[d]	1980[e]	1981[e]	1982[e]	1983[e]	1984[e]	1985[f]	1986[e]	1987[e]	1988[e]	1989[e]	1990[e]	1991[e]	1992[e]
Longnose gar	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-
Gizzard shad	-	-	-	-	-	-	0.1	-	0.4	0.1	-	0.1	-	0.1	0.1	-	-	0.4	0.3
Mooneye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rainbow trout	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
Northern pike	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muskellunge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tiger muskellunge	-	-	-	0.1	0.1	-	-	-	-	0.1	-	0.1	-	-	0.3	0.1	-	0.3	0.1
Goldfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grass carp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-
Carp	0.8	1.2	0.1	0.4	0.6	0.1	-	0.4	-	0.8	0.2	0.8	0.4	0.4	2.4	1.0	0.8	2.8	1.8
Goldfish x Carp hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
River carpsucker	-	-	-	-	-	-	-	-	-	0.1	-	-	0.1	-	-	-	-	0.3	-
Quillback	-	-	0.1	0.2	-	-	-	0.1	0.1	-	-	-	-	-	-	-	-	0.4	0.5
Highfin carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
White sucker	-	0.3	-	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Silver redhorse	-	-	-	-	-	0.1	-	-	0.1	-	-	-	-	-	-	-	0.3	0.6	-
Golden redhorse	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.3	0.3	0.1	0.9	0.4
Shorthead redhorse	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	0.3	-	-	0.1	0.1
Redhorse sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	0.4	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow bullhead	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
White catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	-	0.8	-	0.7	0.7	0.2	0.2	0.2	0.4	0.2	-	0.4	0.6	0.4	0.4	0.1	0.5	1.8	2.4
Flathead catfish	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	0.1	-
White bass	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	0.5	0.1	-	4.0	-
Striped bass hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	0.5
Rock bass	-	0.3	-	0.2	0.1	0.2	-	-	-	-	-	-	0.1	-	-	-	-	-	-
Green sunfish	-	-	0.1	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
Bluegill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smallmouth bass	-	-	-	-	0.1	0.1	-	-	-	-	-	-	-	-	0.1	-	-	0.5	-
Largemouth bass	-	-	0.2	-	-	0.1	-	-	0.1	0.1	-	-	-	-	-	-	-	-	-
Spotted bass	-	0.2	0.7	0.1	-	0.1	-	-	0.5	1.6	-	1.0	0.4	0.1	1.3	0.9	-	1.4	0.3
White crappie	-	-	-	-	0.1	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
Black crappie	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
Yellow perch	0.4	0.6	0.5	0.8	0.3	0.2	-	-	-	-	-	-	-	0.1	-	-	-	0.1	-
Sauger	-	-	-	-	0.2	-	0.1	-	0.2	0.1	-	-	0.3	-	0.3	0.1	0.4	1.4	0.5
Walleye	0.2	-	0.3	0.3	0.3	0.2	-	0.1	0.4	0.5	-	-	-	0.1	-	0.1	-	0.1	-
Saugeye	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.1
Freshwater drum	-	-	-	-	-	-	-	-	0.2	0.2	0.1	-	-	-	-	-	-	-	-
Total	1.8	3.4	2.2	3.2	2.9	0.8-1.3	0.4	0.8	2.4	4.2	0.6	2.7	2.0	1.5	6.0	3.1	2.1	17.3	7.0

TABLE V-E-6
(Continued)

	Transect 2A, 2B, 3																		
Species	1974[a]	1975[b]	1976[c]	1977[d]	1978[d]	1979[d]	1980[e]	1981[e]	1982[e]	1983[e]	1984[e]	1985[f]	1986[e]	1987[e]	1988[e]	1989[e]	1990[e]	1991[e]	1992[e]
Longnose gar	-	-	-	-	-	-	-	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	0.1	-	0.2	<0.1
Gizzard shad	0.2	0.1	-	0.1	-	<0.1	-	<0.1	0.7	0.1	-	0.4	0.8	0.1	0.3	-	0.1	0.8	0.6
Mooneye	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	0.1	-
Rainbow trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern pike	-	-	-	0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-
Muskellunge	-	-	-	-	<0.1	-	-	-	<0.1	0.1	-	<0.1	0.2	-	-	0.1	-	-	-
Tiger muskellunge	-	-	-	-	<0.1	-	<0.1	-	-	<0.1	-	<0.1	-	-	0.2	0.3	-	<0.1	0.2
Goldfish	-	-	<0.1	0.1	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	0.1	-
Carp	0.9	0.3	0.2	0.6	0.3	0.3	0.2	0.3	0.9	0.9	0.3	0.5	1.0	0.4	2.1	1.3	0.5	1.8	1.2
Goldfish x Carp hybrid	-	0.1	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	<0.1	0.1	0.1	0.2	<0.1	<0.1	0.2	0.2
Quillback	-	-	<0.1	0.2	0.1	<0.1	<0.1	-	<0.1	0.2	-	0.1	-	-	0.1	<0.1	0.1	0.5	0.3
Highfin carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1
White sucker	0.1	-	-	<0.1	-	<0.1	<0.1	-	-	0.1	<0.1	-	<0.1	-	-	<0.1	-	-	-
Spotted sucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
Smallmouth buffalo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-
Black redhorse	-	-	-	<0.1	0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver redhorse	-	-	-	-	-	<0.1	-	-	<0.1	-	0.2	0.1	-	-	<0.1	<0.1	<0.1	0.2	0.4
River redhorse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-
Golden redhorse	-	-	-	-	-	-	-	-	<0.1	-	<0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.4	0.3
Shorthead redhorse	-	-	-	-	-	-	-	-	<0.1	<0.1	0.1	-	-	<0.1	0.1	0.1	-	-	0.1
Redhorse sp.	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	0.1	-	-	-	-	-	-
Black bullhead	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	0.2	-	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow bullhead	0.1	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
White catfish	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	0.3	1.3	0.4	1.0	0.4	0.5	0.4	0.6	0.7	0.5	0.3	0.8	1.1	0.6	0.7	1.2	0.5	2.7	2.2
Flathead catfish	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	0.1	-	0.1	0.1	0.2	0.2	0.4
White bass	-	-	-	-	-	-	-	-	-	0.1	-	-	<0.1	0.1	0.8	0.3	<0.1	0.3	0.2
Striped bass hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.3	0.3
Rock bass	-	0.1	-	<0.1	<0.1	<0.1	-	-	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	-
Green sunfish	-	-	-	0.1	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1
Pumpkinseed	-	-	-	0.1	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-
Bluegill	-	-	-	0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	-	<0.1	-
Smallmouth bass	-	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	0.2	0.2
Largemouth bass	0.2	0.1	0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	-	-	-	-	<0.1	-	-	0.1	-
Spotted bass	-	-	0.2	0.1	<0.1	<0.1	0.1	<0.1	0.3	1.8	0.2	0.5	0.1	0.7	2.2	1.0	0.1	1.9	0.5
White crappie	-	-	<0.1	<0.1	-	0.1	0.1	-	<0.1	0.2	-	0.2	-	0.1	<0.1	<0.1	-	<0.1	-
Black crappie	-	-	<0.1	0.1	-	<0.1	-	-	-	0.1	<0.1	-	-	0.1	<0.1	<0.1	-	<0.1	-
Yellow perch	-	0.7	0.5	0.7	0.1	0.1	-	<0.1	-	<0.1	<0.1	-	<0.1	-	-	-	-	-	-
Sauger	-	0.1	-	<0.1	0.2	0.3	<0.1	0.2	0.3	0.5	0.4	0.2	0.3	0.2	0.7	0.2	0.5	0.6	0.3
Walleye	0.2	0.2	0.1	0.2	0.1	<0.1	0.2	0.1	0.7	0.1	0.1	0.1	<0.1	-	0.2	0.1	<0.1	0.1	0.1
Freshwater drum	-	-	-	-	-	-	-	0.1	0.3	0.2	-	-	<0.1	-	0.2	0.1	0.1	0.2	<0.1
Total	2.2	3.1	1.5- 2.2	3.6- 4.3	1.3 1.9	1.3- 1.9	1.2- 1.6	1.5	4.4	5.2	2.0	3.3- 4.0	3.8- 4.8	2.6- 3.1	8.1- 8.7	5.1- 5.9	2.2- 2.7	12.9- 13.7	7.5- 8.0

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[a] MAY, SEP, NOV
[b] AUG, SEP, NOV
[c] MAY- SEP
[d] MAY- SEP, NOV
[e] MAY, JUL, SEP, NOV
[f] MAY, JUL, SEP, DEC

1991 and 1992 the river conditions were favorable (low flow and limited debris) during all of the gill net surveys, which may have contributed to the high catches.

Comparison of Preoperational and Operational Data

Electrofishing and gill net data, expressed as catch-per-unit-effort, for the years 1974 through 1992 are presented in Tables V-E-5 and V-E-6. These nineteen years represent two preoperational years (1974 and 1975) and seventeen operational years (1976 through 1992). Fish data for Transect 1 (Control Transect) and the averages of Transects 2A, 2B, and 3 (Non-Control Transects) are tabulated separately. These data indicate that new species are continuing to move into the study area and that, in general, the water quality of the Ohio River has steadily improved.

Summary and Conclusions

The fish community of the Ohio River in the vicinity of BVPS has been sampled from 1970 to present, using several types of gear: electrofishing, gill netting, and periodically, minnow traps and seines. The results of these fish surveys show normal community structure based on species composition and relative abundance. In all the surveys since 1970, forage species were collected in the highest numbers. This indicates a normal fish community, since game species (predators) rely on this forage base for their survival. Variations in total annual catch are a natural occurrence and are attributable primarily to fluctuations in the population size of the forage species. Forage species, such as gizzard shad, with high reproductive potentials frequently respond to changes in natural environmental factors (competition, food availability, cover, and water quality) with large changes in population size.

Although variation in total catch has occurred, species composition has remained fairly stable. Since the initiation of studies in 1970, forage fish have dominated the catches. Carp, channel catfish, smallmouth and spotted bass, and walleye have all remained common species. Since 1978, sauger have become a common game species near BVPS.

Differences in the 1992 electrofishing and gill net catches, between the Control and Non-Control Transects were similar to previous years (both operational and preoperational) and were probably caused by habitat preferences of individual species. This habitat preference is probably the most influential factor that affects where the different species of fish are collected and in what relative abundance.

Data collected from 1970 through 1992 indicate that fish in the vicinity of BVPS have not been adversely affected by station operation.

F. ICHTHYOPLANKTON

Objective

Ichthyoplankton sampling was performed in order to monitor the extent fishes utilize the back channel of Phillis Island as spawning and nursery grounds.

Methods

The 1992 program had five day surveys (April 21, May 18, June 16, July 8 and August 11) and two night surveys (May 19, and July 9) conducted during the spring and summer, which is the primary spawning season for most resident fish species. One surface and one bottom collection were taken at Transect 2B (back channel of Phillis Island) during each survey (Figure V-F-1). Tows were made in a zig-zag fashion across the channel utilizing a conical 505 micron mesh plankton net with a 0.5 m mouth diameter.

A General Oceanics Model 2030 digital flowmeter, mounted centrically in the net mouth, was used to determine the volume of water filtered. Samples were preserved in the field using 5% buffered formalin containing rose bengal dye.

In the laboratory, ichthyoplankton was sorted from the sample and enumerated. Each specimen was identified as to its stage of development

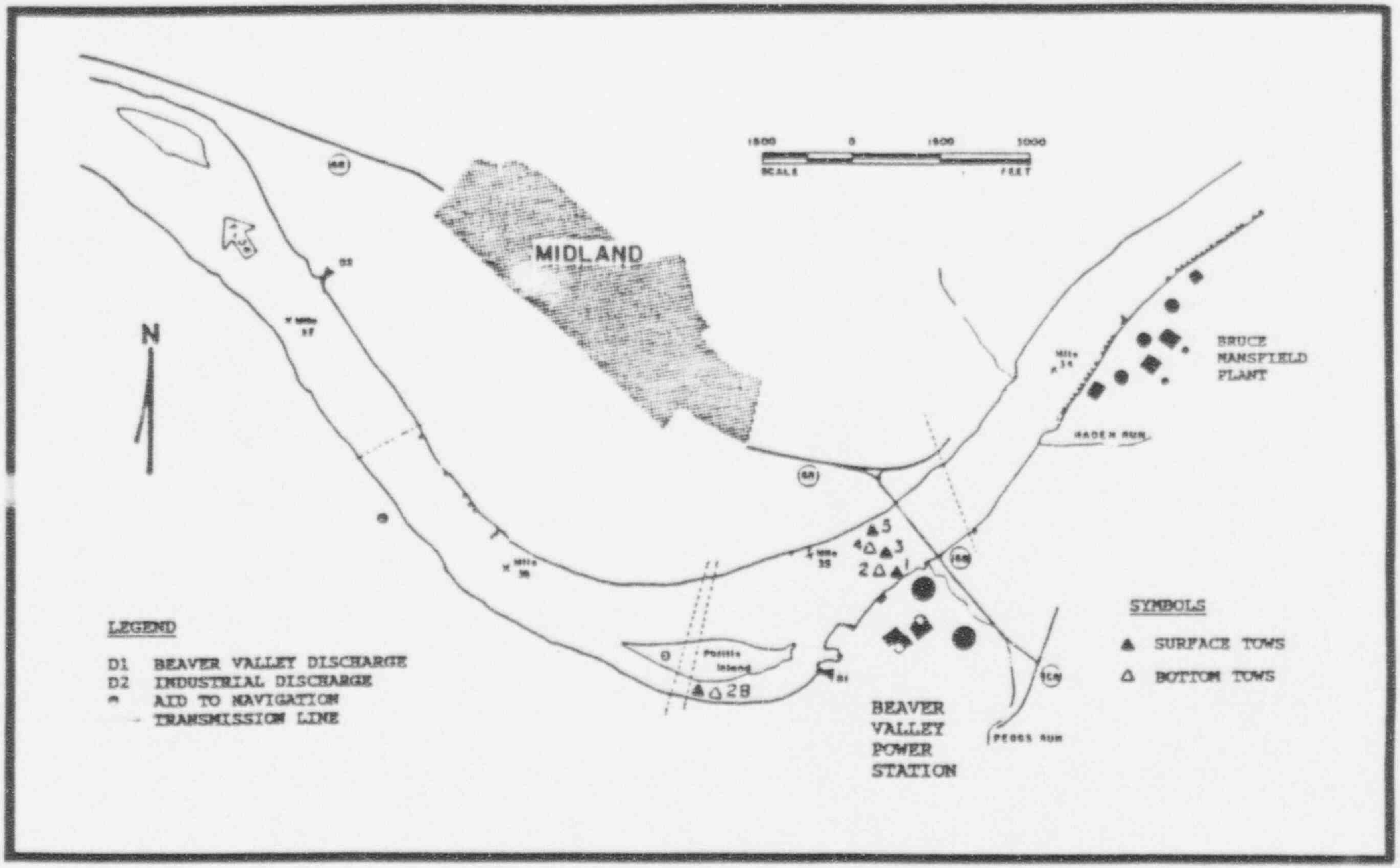

FIGURE V-F-1

ICHTHYOPLANKTON SAMPLING STATIONS
BVPS

(egg, yolk-sac larvae, early larvae, juvenile, or adult) and to the lowest possible taxon. Densities of ichthyoplankton (numbers/100 m^3) were calculated fo. each sample using flowmeter data.

Results

A total of 227 eggs, 809 larvae and 5 juveniles were collected in 1992 from 1,471.2 m^3 of water sampled (Table V-F-1). Eight taxa representing seven families were identified. Gizzard shad larvae accounted for 62.7% of the total catch. For 1992, the night collections produced a total density of 132.20 individuals per 100 m^3 (surface and bottom samples) compared to day collections which produced 44.12 individuals per 100 m^3. For the day collections, the highest density occurred on June 16, with a total density of 148.13 individuals per 100 m^3 (mostly freshwater drum eggs and gizzard shad larvae). The highest density for the night collections occurred on July 9, with a total density of 150.27 individuals per 100 m^3 (predominantly gizzard shad larvae). No ichthyoplankton were collected in the April 1992 survey.

Comparison of Preoperational and Operational Data

Species composition has remained similar between preoperational and operational years, while ichthyoplankton abundance has shown natural fluctuations when examined through the survey years of 1973 through 1992. The May 1992 ichthyoplankton density was the highest total for that month for the survey years 1973-1974, and 1976-1992. Densities of ichthyoplankton collected in the back channel of Phillis Island (Station 2B) from 1973-1974, 1976-1992, are presented in Table V-F-2.

Summary and Conclusions

Gizzard shad and freshwater drum dominated the 1992 ichthyoplankton catch from the back channel of Phillis Island. The peak density occurred in June and consisted mostly of gizzard shad larvae and freshwater drum eggs. The month of April showed no spawning activity. The

TABLE V-F-1

NUMBER AND DENSITY OF FISH EGGS, LARVAE, JUVENILES, AND ADULTS (Number/100 m^3) COLLECTED WITH A 0.5 m PLANKTON NET IN THE OHIO RIVER BACK CHANNEL OF PHILLIS ISLAND (STATION 2B), 1992
BVPS

	Depth of Collection				
	Surface		Bottom		Total Collection and Taxa Density
Date	Day	Night	Day	Night	
April 21					
Vol. water filtered (m^3)	67.7		80.3		148.0
Number eggs collected	0		0		0
Number larvae collected	0		0		0
Number juveniles collected	0		0		0
Number adults collected	0		0		0
May 18/19					
Vol. water filtered (m^3)	113.3	105.3	110.0	104.1	432.7
Number eggs collected	1	56	4	49	110
Number larvae collected	43	107	6	23	79
Number juveniles collected	0	0	0	0	0
Number adults collected	0	0	0	0	0
Density (number collected)					
Eggs					
Aplodinotus grunniens	0.88 (1)	53.18 (56)	3.64 (4)	47.07 (49)	25.42 (110)
Larvae					
Dorosoma cepedianum (YL)	33.54 (38)	90.22 (95)	1.82 (2)	11.53 (12)	33.97 (147)
Cyprinidae (YL)	3.53 (4)	0	0	0	0.92 (4)
Cyprinus carpio (YL)	0	0	0	1.92 (2)	0.46 (2)
Notropis sp. (EL)	0	0.95 (1)	0	0	0.23 (1)
Catostomidae (EL)	0.88 (1)	0	0.91 (1)	0	0.46 (2)
Morone chrysops (YL)	0	0	0	0.96 (1)	0.23 (1)
Morone chrysops (EL)	0	10.45 (11)	0.91 (1)	5.76 (6)	4.16 (18)
Percidae (EL)	0	0	0	1.92 (2)	0.46 (2)
Perca flavescens (EL)	0	0	1.82 (2)	0	0.46 (2)
Total Density (number collected)	38.83 (44)	154.80 (163)	9.10 (10)	69.16 (72)	66.79 (289)

TABLE V-F-1
(Continued)

Date	Depth of Collection				Total Collection and Taxa Density
	Surface		Bottom		
	Day	Night	Day	Night	
June 16					
Vol. water filtered (m^3)	102.6		103.9		206.5
Number eggs collected	30		68		98
Number larvae collected	34		175		209
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Density (number collected)					
Eggs					
Aplodinotus grunniens	29.24 (30)		65.45 (68)		47.46 (98)
Larvae					
Dorosoma cepedianum (YL)	32.16 (33)		3.85 (4)		17.92 (37)
Dorosoma cepedianum (EL)	0.97 (1)		147.26 (153)		74.58 (154)
Aplodinotus grunniens (YL)	0		7.70 (8)		3.87 (8)
Aplodinotus grunniens (EL)	0		9.62 (10)		4.84 (10)
Total Density (number collected)	62.38 (64)		233.88 (243)		148.67 (307)
July 8/9					
Vol. water filtered (m^3)	106.9	116.5	118.8	115.7	457.9
Number eggs collected	7	1	3	3	14
Number larvae collected	10	41	68	298	417
Number juveniles collected	0	0	0	5	5
Number adults collected	0	0	0	0	0
Density (number collected)					
Eggs					
Aplodinotus grunniens	5.61 (6)	0	0	0	1.31 (6)
Unidentified egg	0.94 (1)	0.86 (1)	2.53 (3)	2.59 (3)	1.75 (8)

TABLE V-F-1
(Continued)

	Depth of Collection				
	Surface		Bottom		Total Collection and Taxa Density
Date	Day	Night	Day	Night	
July 8/9 Continued					
Larvae					
Dorosoma cepedianum (EL)	8.42 (9)	15.45 (18)	20.20 (24)	186.69 (216)	58.31 (267)
Dorosoma cepedianum (LL)	0	0	3.37 (4)	38.03 (44)	10.48 (48)
Cyprinus carpio (EL)	0	0.86 (1)	1.68 (2)	0	0.66 (3)
Lepomis sp. (EL)	0.94 (1)	0	0	0	0.22 (1)
Aplodinotus grunniens (YL)	0	6.87 (8)	5.05 (6)	8.64 (10)	5.24 (24)
Aplodinotus grunniens (EL)	0	12.02 (14)	26.94 (32)	24.20 (28)	16.16 (74)
Juveniles					
Dorosoma cepedianum (JJ)	0	0	0	4.32 (5)	1.09 (5)
Total Density (number collected)	15.90 (17)	36.05 (42)	59.76 (71)	264.48 (306)	95.22 (436)
August 11					
Vol. water filtered (m^3)	114.4		111.7		226.1
Number eggs collected	3		2		5
Number larvae collected	0		4		4
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Density (number collected)					
Eggs					
Aplodinotus grunniens	2.62 (3)		0.90 (1)		1.77 (4)
Unidentified egg	0		0.90 (1)		0.44 (1)
Larvae					
Aplodinotus grunniens (YL)	0		3.58 (4)		1.77 (4)
Total Density (number collected)	2.62 (3)		5.37 (6)		3.98 (9)

TABLE V-F-1
(Continued)

	Depth of Collection				
	Surface		Bottom		Total Collection and Taxa Density
Date	Day	Night	Day	Night	
Yearly Totals					
Vol. water filtered (m^3)	504.9	221.8	524.7	219.8	1,471.2
Number eggs collected	41	57	77	52	227
Number larvae collected	87	148	253	321	809
Number juveniles collected	0	0	0	5	5
Number adults collected	0	0	0	0	0
Eggs					
Aplodinotus grunniens	7.92 (40)	25.25 (56)	13.91 (73)	22.29 (49)	14.82 (218)
Unidentified eggs	0.20 (1)	0.45 (1)	0.76 (4)	1.36 (3)	0.61 (9)
Larvae					
Dorosoma cepedianum (YL)	14.06 (71)	42.83 (95)	1.14 (6)	5.46 (12)	12.51 (184)
Dorosoma cepedianum (EL)	1.98 (10)	8.12 (18)	33.73 (177)	98.27 (216)	28.62 (421)
Dorosoma cepedianum (LL)	0	0	0.76 (4)	20.02 (44)	3.26 (48)
Cyprinidae (YL)	0.79 (4)	0	0	0	0.27 (4)
Cyprinus carpio (YL)	0	0	0	0.91 (2)	0.14 (2)
Cyprinus carpio (EL)	0	0.45 (1)	0.38 (2)	0	0.20 (3)
Notropis sp. (EL)	0	0.45 (1)	0	0	0.07 (1)
Catostomidae (EL)	0.20 (1)	0	0.19 (1)	0	0.14 (2)
Morone chrysops (YL)	0	0	0	0.45 (1)	0.07 (1)
Morone chrysops (EL)	0	4.96 (11)	0.19 (1)	2.73 (6)	1.22 (18)
Lepomis sp. (EL)	0.20 (1)	0	0	0	0.07 (1)
Percidae (EL)	0	0	0	0.91 (2)	0.14 (2)
Perca flavescens (EL)	0	0	0.38 (2)	0	0.14 (2)
Aplodinotus grunniens (YL)	0	3.61 (8)	3.43 (18)	4.55 (10)	2.45 (36)
Aplodinotus grunniens (EL)	0	6.31 (14)	8.00 (42)	12.74 (28)	5.71 (84)
Juveniles					
Dorosoma cepedianum (JJ)	0	0	0	2.27 (5)	0.34 (5)
Total Density (number collected)	25.35 (128)	92.43 (205)	62.89 (330)	171.97 (378)	70.76 (1041)

Developmental Stages

YL - Hatched specimens with yolk and/or oil globules present.

EL - Specimens with no yolk and/or oil globules and with no development of fin rays and/or spiny elements.

LL - Specimens with developed fin rays and/or spiny elements and evidence of a fin fold.

JJ - Specimens with complete fin and pigment development, i.e., immature adult.

TABLE V-F-2

DENSITY OF ICHTHYOPLANKTON (Number/100m^3) COLLECTED IN THE OHIO RIVER BACK CHANNEL OF PHILLIS ISLAND (STATION 2B) 1973-1974, 1976-1992, BVPS

Date	Density	Date	Density	Date	Density
1973		1974		1976	
Apr 12	0	Apr 16	0	Apr 26	0.70
May 17	0	May 24	0	May 19	0
Jun 20	16.10	Jun 13	6.98	Jun 18	5.99
Jul 26	3.25	Jun 26	9.25	Jul 2	6.63
		Jul 16	59.59	Jul 15	3.69
		Aug 1	6.85	Jul 29	4.05
1977		1978		1979	
Apr 14	0	Apr 22	0	Apr 19	0
May 11	0.90	May 5	0	May 1	0
Jun 9	24.22	May 20	0.98	May 17	0.81
Jun 22	3.44	Jun 2	4.01	Jun 7	0.39
Jul 7	3.31	Jun 16	12.15	Jun 20	11.69
Jul 20	28.37	Jul 2	13.32	Jul 5	14.82
1980		1981		1982	
Apr 23	0.42	Apr 20	1.10	Apr 19	0
May 21	0.53	May 12	0	May 18	3.77
Jun 19	9.68	Jun 17	26.40	Jun 21	7.54
Jul 22	107.04	Jul 22	17.14	Jul 20	31.66
1983		1984		1985	
Apr 13	0	Apr 16	0	Apr 18	0
May 11	0.66	May 10	0	May 14	1.81
Jun 14	4.46	Jun 8	15.46	Jun 10	13.36
Jul 12	44.05	Jul 12	44.23	Jul 11	117.59
1986		1987		1988	
Apr 18	0.63	Apr 21	0	Apr 18	0
May 13^a	5.93	May 19^a	16.22	May 10^a	0.42
Jun 19	34.52	Jun 19	40.02	Jun 14	162.43
Jul 15^a	26.15	Jul 14^a	19.26	Jul 14^a	39.41
Aug 12	9.89	Aug 10	7.87	Aug 16	1.32
1989		1990		1991	
Apr 17	0	Apr 18	0.37	Apr 19	0.38
May 23^a	0.91	May 24^a	2.15	May 13^a	21.98
Jun 19	25.50	Jun 12	20.67	June 13	5.91
Jul 12^a	438.61	Jul 25^a	2.91	Jul 24^a	2.88
Aug 15	4.20	Aug 21	6.09	Aug 16	0
1992					
Apr 21	0				
May 18^a	66.79				
Jun 16	148.67				
Jul 8^a	95.22				
Aug 11	3.98				

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[a] Day and night survey was conducted.

ichthyoplankton densities for July and August were within the ranges reported for those months in previous survey years.

G. FISH IMPINGEMENT

Objective

Impingement surveys were conducted to monitor the quantity of fish, other aquatic organisms and Corbicula impinged on the traveling screens. These surveys were also conducted to monitor for the potential infestation of the zebra mussel.

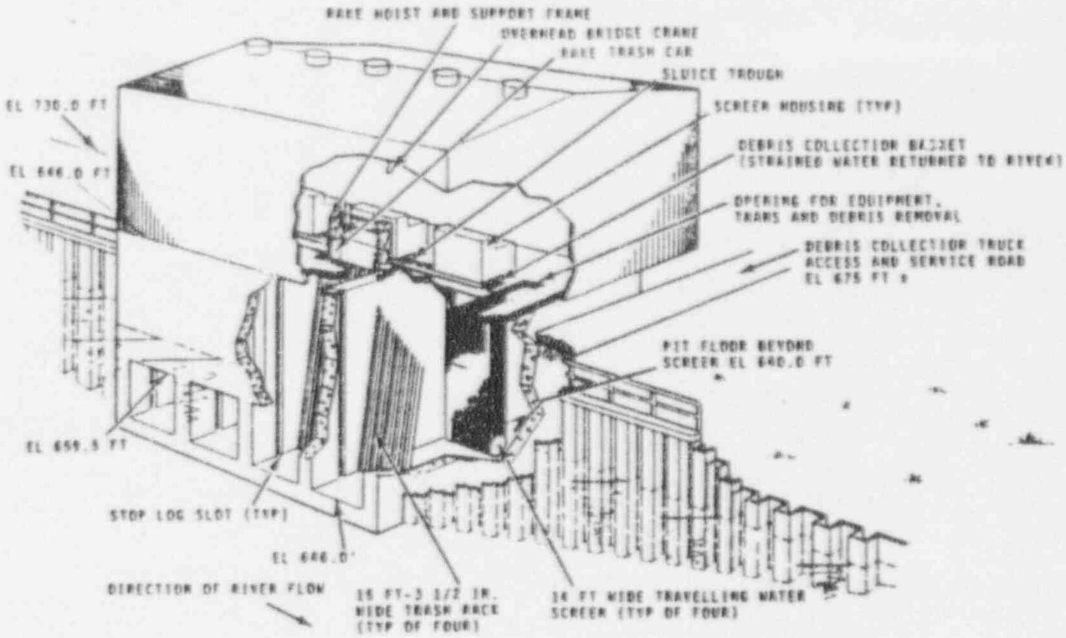
Methods

The surveys were conducted weekly throughout 1992 for a total of 43 weeks (Table V-A-1). Except when technical difficulties delayed the start of collections, weekly fish impingement sampling began on Thursday mornings when all operating screens were washed. A collection basket of 0.25 inch mesh netting was placed at the end of the screen washwater sluiceway (Figure V-G-1). On Friday mornings, after approximately 24 hours, each screen was washed individually for 15 minutes (one complete revolution of the screen) and all aquatic organisms collected. Fish were identified, counted, measured for total length (mm), and weighed (g). Data were summarized according to operating intake bays (bays that had pumps operating in the 24 hour sampling period) and non-operating intake bays.

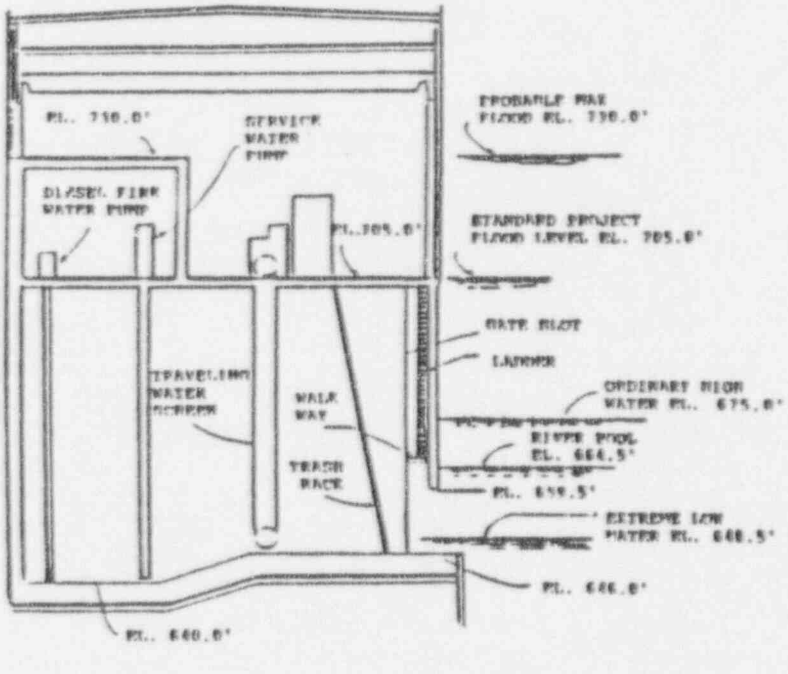
Results

The BVPS impingement surveys of 1976 through 1992 have resulted in the collection of 42 species of fish representing ten families (Table V-G-1). A total of 36 fishes, representing 14 species were collected in 1992 (Table V-G-2).

Rock bass were the most numerous fish, comprising 16.3% of the total annual catch, followed by flathead catfish (11.6%) and five other



(Three dimensional: Cutaway View)



(Two dimensional: Side View)

FIGURE V-G-1

INTAKE STRUCTURE
BVPS

TABLE V-G-1

FISH COLLECTED DURING THE
IMPINGEMENT SURVEYS, 1976-1992
BVPS

Family and Scientific Name[1]	Common Name
Clupeidae (herrings)	
Dorosoma cepedianum	Gizzard shad
Cyprinidae (minnows and carps)	
Cyprinus carpio	Common carp
Hybopsis storeriana	Silver chub
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald shiner
N. hudsonius	Spottail shiner
N. spilopterus	Spotfin shiner
N. stramineus	Sand shiner
N. volucellus	Mimic shiner
Pimephales notatus	Bluntnose minnow
P. promelas	Fathead minnow
Semotilus atromaculatus	Creek chub
Catostomidae (suckers)	
Carpiodes cyprinus	Quillback
Catostomus commersoni	White sucker
Moxostoma carinatum	River redhorse
Ictaluridae (bullhead and catfishes)	
Ictalurus catus	White catfish
I. natalis	Yellow bullhead
I. nebulosus	Brown bullhead
I. punctatus	Channel catfish
Noturus flavus	Stonecat
Pylodictis olivaris	Flathead catfish
Percopsidae (trout-perches)	
Percopsis omiscomaycus	Trout-perch
Cyprinodontidae (killifishes)	
Fundulus diaphanus	Banded killifish
Percichthyidae (temperate basses)	
Morone chrysops	White bass
M. chrysops x *M. saxatilis*	Striped bass hybrid

TABLE V-G-1
(Continued)

Family and scientific Name[1]	Common Name
Centrarchidae (sunfishes)	
Ambloplites rupestris	Rock bass
Lepomis cyanellus	Green sunfish
L. gibbosus	Pumpkinseed
L. macrochirus	Bluegill
Micropterus dolomieui	Smallmouth bass
M. punctulatus	Spotted bass
M. salmoides	Largemouth bass
Pomoxis annularis	White crappie
P. nigromaculatus	Black crappie
Percidae (perches)	
Etheostoma nigrum	Johnny darter
E. zonale	Banded darter
Perca flavescens	Yellow perch
Percina caprodes	Logperch
P. copelandi	Channel darter
Stizostedion canadense	Sauger
S. vitreum vitreum	Walleye
Sciaenidae (drums)	
Aplodinotus grunniens	Freshwater drum

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[1] Nomenclature follows Robins et al. (1980)

TABLE V-G-2

SUMMARY OF FISH COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK DURING 1992
BVPS

				OPERATING INTAKE BAYS[1]				NON-OPERATING INTAKE BAYS[2]				
				Alive		Dead		Alive		Dead		
Taxa	Number	Percent Frequency Occurrence	Percent Composition	Number	Weight (g)	Number	Weight (g)	Number	Weight (g)	Number	Weight (g)	Length Range (mm)
Gizzard shad	3	7.0	8.3			3	37					48-130
Carp	3	4.7	8.3			1	2	1	3	1	2	50-58
Emerald shiner	1	2.3	2.8			1	4					98
Channel catfish	1	2.3	2.8	1	2							53
Flathead catfish	5	11.6	13.9	2	4	2	2			1	1	34-68
White bass	2	2.3	5.6			2	174					190-205
Striped bass hybrid	1	2.3	2.8			1	140					230
Rock bass	7	16.3	19.4	3	11	2	211	1	1	1	4	20-215
Green sunfish	1	2.3	2.8	1	26							105
Bluegill	2	4.7	5.6			2	3					41-62
Smallmouth bass	1	2.3	2.8					1	5			82
Spotted bass	3	7.0	8.3	1	2	2	107					51-200
Logperch	3	7.0	8.3	1	8	1	8	1	3			80-98
Freshwater drum	3	7.0	8.3			3	5					39-60
Total	36			9	53	20	693	4	12	3	7	

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[1] Intake bays that had pumps operating within the 24-hour sampling period.

[2] Intake bays that had no pumps operating within the 24-hour sampling period.

species (8.3% each). The fishes ranged in size from 20 mm to 230 mm, with the majority under 100 mm. The total weight of all fishes collected in 1992 was 0.75 kg (1.6 lbs). No endangered or threatened species were collected (Commonwealth of Pennsylvania, 1990). The 1992 impingement catch was the lowest catch ever recorded for the period (1976 to 1992) (Tables V-G-3 and V-G-4). During each year, generally the largest numbers of fish have been collected in the winter months (December-February) and then the catch has gradually decreased until the late summer period when another, smaller peak has occurred.

Other organisms collected in the impingement surveys include 76 crayfish, 18 native clams, and 37 dragonflies (Tables V-G-6 and V-G-8). In addition, 1,531 Asiatic clams (Corbicula) were collected (Table V-G-7).

Comparison of Impinged and River Fish

A comparison of the numbers of fish collected in the river and traveling screens is presented in Table V-G-5. Of the 28 species collected, 14 were observed in both locations, while 14 other species were collected exclusively in the river. The major difference in species composition between the two types of collections is the absence of large species in the impingement collections. There were eight species of suckers and five game fish species which were collected only in the river studies. Game fish which were collected on the traveling screens (channel catfish, flathead catfish, white bass, rock bass, bluegill, smallmouth and spotted bass) were smaller than individuals of those species collected by river sampling.

Comparison of Operating and Non-Operating Intake Bay Collections

Of the 36 fishes collected during the 1992 impingement studies, 29 (80.6%) were collected from operating intake bays and 7 (19.4%) from non-operating intake bays (Table V-G-2). However, due to differences between the number of operating (113) and non-operating (21) screens washed in 1992, the impingement data were computed with catch expressed as fish per 1,000 m^2 of screen surface area washed. These results

TABLE V-G-3

SUMMARY OF IMPINGEMENT SURVEY DATA FOR 1992
BVPS

Date		Number of Fish	Percent	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water	River Elevation Above Mean
Month	Day	Collected	Annual Total	Alive	Dead	Alive	Dead	A	B	C	D	Temp °F	Sea Level (Ft.)
January	3	2	5.6			1	1		X		X	35.4	664.8
	10	1	2.8		1			X	X		X	37.4	664.6
	$17^{(5)}$	-	-					-	-	-	-	35.1	666.7
	$24^{(5)}$	-	-					-	-	-	-	32.8	667.3
	31	4	11.1	1	3			X	X	X		32.7	665.0
February	7	1	2.8		1			X	X	X		33.0	665.0
	14	0	0.0					X	X	X		32.7	665.0
	21	0	0.0					X	X	X		35.7	667.4
	28	1	2.8		1			X	X	X		40.0	667.0
March	$6^{(5)}$	-	-					-	-	-	-	42.0	665.4
	13	0	0.0					X	X	X		41.3	667.3
	20	1	2.8		1			X		X		37.9	670.0
	27	0	0.0					X		X		40.6	666.1
April	3	0	0.0					X		X		40.3	668.0
	10	0	0.0					X	X			46.1	665.7
	17	0	0.0					X				53.0	665.6
	$24^{(4)}$	-	-					-	-	-	-	56.1	667.2
May	1	0	0.0					X		X	X	52.5	665.2
	8	0	0.0					X	X		X	55.5	665.6
	15	0	0.0					X	X		X	61.1	665.0
	$22^{(5)}$	-	-					-	-	-	-	62.8	665.2
	$29^{(5)}$	-	-					-	-	-	-	65.1	665.0
June	5	1	2.8	1					X		X	66.0	665.0
	12	2	5.6		1	1		X	X		X	69.4	665.0
	19	0	0.0					X	X	X	X	74.0	665.0
	26	4	11.1	1	1	1	1	X	X		X	69.2	664.6

TABLE V-G-3
(Continued)

Date		Number of Fish Collected	Percent Annual Total	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water Temp °F	River Elevation Above Mean Sea Level (Ft.)
Month	Day			Alive	Dead	Alive	Dead	A	B	C	D		
July	3	0	0.0					X	X		X	73.9	665.0
	10$^{(5)}$	-	-					-	-	-	-	75.0	6[illegible]
	17	1	2.8		1			X	X		X	76.8	666.[illegible]
	24	1	2.8		1			X	X		X	68.9	666.1
	31	0	0.0					X	X		X	71.2	668.0
August	7	2	5.6	2				X	X		X	67.2	664.9
	14	2	5.6		1		1	X	X		X	70.8	664.9
	21	1	2.8		1			X	X		X	70.0	665.0
	28	1	2.8		1			X		X	X	74.6	665.1
September	4	2	5.6		1	1		X		X	X	69.2	665.0
	11	0	0.0					X	X	X	X	70.9	665.0
	18	0	0.0					X	X	X	X	71.3	665.0
	25	2	5.6	1	1			X	X	X		62.0	665.8
October	2	0	0.0					X	X	X	X	60.0	665.2
	9	0	0.0					X		X	X	59.3	665.9
	16	1	2.8		1			X		X	X	59.0	665.7
	23 [illegible]	-	-					-	-	-	-	52.0	665.5
	30	0	0.0					X		X	X	51.0	665.0
November	6	0	0.0					X	X	X	X	48.5	666.3
	13	0	0.0					X	X	X	X	46.2	667.7
	20	3	8.3	2	1			X	X	X	X	41.2	665.4
	27	1	2.8		1			X	X	X	X	46.0	667.4
December	4	0	0.0					X	X	X	X	41.0	665.0
	11	0	0.0					X	X	X	X	36.5	665.4
	18$^{(3)}$	-	-					-	-	-	-	38.0	671.0
	24$^{(3)}$	-	-					-	-	-	-	37.8	669.5
	31	2	5.6	1	1			X	X	X	X	35.8	667.4
Total		36		9	20	4	3						

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[1] Intake bays that had pumps operating in the 24-hour sampling period.
[2] Intake bays that had no pumps operating in the 24-hour sampling period.
[3] Impingement could not be conducted due to high water conditions.
[4] Impingement could not be conducted due to diving operations in screenhouse.
[5] Impingement could not be conducted due to maintenance.

TABLE V-G-4

SUMMARY OF FISH COLLECTED IN IMPINGEMENT SURVEYS, 1976-1992
BVPS

	Number of Fish Collected Unit 1																	
	1976			1977			1978			1979			1980			1981		
Month	Oper(1)	N-Oper(2)	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total
January	3,792	2,021	5,813	1,136	2,869	4,005	186	41	227	66	16	82	5	0	5	5	1	6
February	1,087	1,034	2,121	3,622	2,039	5,661	99	73	172	9	8	17	5	7	12	21	1	22
March	260	128	388	314	72	386	36	113	149	15	10	25	16	13	29	4	2	6
April	19	11	30	7	3	10	3	1	4	1	0	1	0	11	11	8	0	8
May	5	2	7	3	0	3	-	-	-	3	1	4	0	2	2	7	2	9
June	4	1	5	4	3	7	2	4	6	2	0	2	0	4	4	3	0	3
July	20	12	32	27	5	32	9	3	12	5	2	7	3	10	13	5	2	7
August	27	10	37	6	1	7	6	12	18	20	34	54	10	4	14	12	1	13
September	8	6	14	1	4	5	7	15	22	9	9	18	4	0	4	15	4	19
October	35	8	43	8	3	11	4	14	18	21	6	27	2	2	4	10	2	12
November	15	4	19	9	0	9	1	2	3	7	6	13	3	1	4	4	0	4
December	374	219	593	174	12	186	20	3	23	8	4	12	6	0	6	28	4	32
Total	5,646	3,456	9,102	5,311	5,011	10,322	373	281	654	162	100	262	54	54	108	122	19	141

	Number of Fish Collected Unit 1																	
	1982			1983			1984			1985			1986			1976-1986 Ave.		
Month	Oper(1)	N-Oper(2)	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total
January	30	16	44	9	0	9	34	5	39	4	2	6	90	4	94	487	452	939
February	24	42	66	10	1	11	19	11	30	2	0	2	20	2	22	447	293	740
March	4	7	11	5	5	10	23	7	30	3	4	7	6	3	9	62	33	95
April	3	6	9	11	7	18	15	4	19	0	0	0	1	0	1	6	4	10
May	1	1	2	16	3	19	4	1	5	2	0	2	0	1	1	4	1	5
June	0	2	2	3	6	9	7	2	9	1	1	2	0	3	3	2	2	4
July	4	5	9	1	3	4	27	2	29	4	0	4	6	1	7	10	4	14
August	14	0	14	2	5	7	7	1	8	4	3	7	3	3	6	10	7	17
September	13	3	16	16	13	29	0	4	4	8	4	12	3	4	7	8	6	14
October	7	12	19	15	8	23	0	0	0	8	9	17	18	4	22	12	6	18
November	4	4	8	9	9	18	1	1	2	70	10	80	26	1	27	14	3	17
December	16	9	25	49	10	59	0	2	2	24	1	25	14	0	14	65	24	89
Total	120	107	227	146	70	216	137	40	177	130	34	164	187	26	213	1,127	835	1,962

TABLE V-G-4
(Continued)

Number of Fish Collected Unit 1 and Unit 2

	1987			1988			1989			1990			1991			1992		
Month	Oper (1)	N-Oper (2)	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total	Oper	N-Oper	Total
January	242	0	242	25	4	29	387	4	391	16	0	16	1	0	1	5	2	7
February	27	1	28	5	1	6	34	1	35	0	0	0	0	0	0	2	0	2
March	5	4	9	2	2	4	70	8	78	2	1	3	2	0	2	1	0	1
April	4	1	5	12	1	13	7	1	8	1	1	2	-	-	-	0	0	0
May	3	0	3	0	0	0	1	1	2	0	1	1	2	1	3	0	0	0
June	1	1	2	2	0	2	2	0	2	2	1	3	16	24	40	4	3	7
July	11	1	12	63	0	63	5	0	5	2	1	3	42	45	87	2	0	2
August	11	1	12	24	27	51	12	0	12	16	0	16	24	0	24	5	1	6
September	10	0	10	12	3	15	3	4	7	10	2	12	5	0	5	3	1	4
October	0	1	1	3	0	3	1	6	7	1	1	2	5	4	9	1	0	1
November	0	1	1	29	12	41	2	0	2	5	0	5	8	1	9	4	0	4
December	20	0	20	247	7	254	0	1	1	5	0	5	77	3	80	2	0	2
Total	334	11	345	424	57	481	524	26	550	60	8	68	182	78	260	29	7	36

Number of Fish Collected Unit 1 and Unit 2

	1987-1992 Ave.		
Month	Oper	N-Oper	Total
January	113	2	115
February	11	1	12
March	14	3	17
April	4	1	5
May	1	1	2
June	5	5	10
July	21	8	29
August	15	5	20
September	7	2	9
October	2	2	4
November	8	2	10
December	59	2	61
Total	260	34	294

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[1] Intake bays that had pumps operating in the 24-hour sampling period.
[2] Intake bays that had no pumps operating in the 24-hour sampling period.

Symbols

Oper - Operating intake bays.
N-Oper - Non-operating intake bays.

TABLE V-G-5

NUMBER AND PERCENT OF ANNUAL TOTAL OF FISH COLLECTED IN IMPINGEMENT SURVEYS AND IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1992
BVPS

Species[a]	Total Number of Fish Collected		Percent of Annual Total	
	Impingement	River	Impingement	River
Longnose gar		3		0.7
Gizzard shad	3	137	8.3	30.5
Tiger muskellunge		5		1.1
Common carp	3	61	8.3	13.6
Emerald shiner	1	1	2.8	0.2
River carpsucker		4		0.9
Quillback		11		2.4
Highfin carpsucker		1		0.2
Northern hog sucker		5		1.1
Spotted sucker		1		0.2
Silver redhorse		10		2.2
Golden redhorse		32		7.1
Shorthead redhorse		14		3.1
Channel catfish	1	71	2.8	15.8
Flathead catfish	5	9	13.9	2.0
White bass	2	4	5.6	0.9
Striped bass hybrid	1	14	2.8	3.1
Rock bass	7	3	19.4	0.7
Green sunfish	1	1	2.8	0.2
Pumpkinseed				
Bluegill	2	1	5.6	0.2
Smallmouth bass	1	23	2.8	5.1
Spotted bass	3	16	8.3	3.6
White crappie		1		0.2
Logperch	3	4	8.3	0.9
Sauger		10		2.2
Walleye		4		0.9
Saugeye		1		0.2
Freshwater drum	3	2	8.3	0.4
Total	36	449		

(a) Includes only those specimens identified to species or stocked hybrids.

TABLE V-G-6

SUMMARY OF CRAYFISH COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK, 1992
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	3	0	0	0	0
	10	0	2	0	0
	17(c)	-	-	-	-
	24(c)	-	-	-	-
	31	0	0	0	0
February	7	0	1	0	0
	14	0	0	0	0
	21	0	0	0	0
	28	6	0	0	0
March	6(c)	-	-	-	-
	13	1	3	0	0
	20	1	0	0	0
	27	1	0	0	0
April	3	2	0	0	0
	10	0	0	0	0
	17	0	0	0	0
	24(b)	-	-	-	-
May	1	0	0	0	0
	8	0	0	0	0
	15	0	0	0	0
	22(c)	-	-	-	-
	29(c)	-	-	-	-
June	5	1	1	0	0
	12	0	1	0	0
	19	0	0	0	0
	26	0	1	0	0
July	3	1	2	2	0
	10(c)	-	-	-	-
	17	7	0	0	0
	24	7	3	0	0
	31	4	3	0	0
August	7	0	1	0	0
	14	1	3	0	0
	21	2	1	4	2
	28	0	2	0	0

TABLE V-G-6
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
September	4	1	0	0	1
	11	0	1	0	0
	18	0	0	0	0
	25	1	3	0	0
October	2	0	0	0	0
	9	0	0	0	0
	16	0	0	0	0
	23(c)	-	-	-	-
	30	0	0	0	0
November	6	0	0	0	0
	13	0	0	0	0
	20	0	0	0	0
	27	0	0	0	0
December	4	1	0	0	0
	11	0	0	0	0
	18(a)	-	-	-	-
	24(a)	-	-	-	-
	31	2	0	0	0
Total		39	28	6	3

(a) Impingement could not be conducted due to high water conditions.

(b) Impingement could not be conducted due to diving operations in screenhouse.

(c) Impingement could not be conducted due to maintenance.

TABLE V-G-7

SUMMARY OF *Corbicula* COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1992
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	3	0	0	0	2
	10	2	1	0	0
	17(c)	-	-	-	-
	24(c)	-	-	-	-
	31	2	1	0	0
February	7	1	3	0	0
	14	0	2	0	0
	21	2	3	0	0
	28	0	3	0	0
March	6(c)	-	-	-	-
	13	0	2	0	0
	20	0	1	0	0
	27	0	1	0	0
April	3	0	0	0	0
	10	0	2	0	10
	17	0	0	0	10
	24(b)	-	-	-	-
May	1	0	4	1	5
	8	0	4	0	2
	15	0	1	0	1
	22(c)	-	-	-	-
	29(c)	-	-	-	-
June	5	2	3	0	1
	12	4	5	0	1
	19	32	51	0	0
	26	91	16	2	5
July	3	8	12	1	2
	10(c)	-	-	-	-
	17	31	9	0	0
	24	10	11	0	0
	31	30	8	0	0

TABLE V-G-7
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	7	40	7	0	0
	14	85	108	0	6
	21	71	30	0	21
	28	58	64	3	4
September	4	110	62	11	11
	11	103	95	0	0
	18	77	48	0	0
	25	27	45	0	0
October	2	2	1	0	0
	9	8	11	0	0
	16	1	5	0	0
	23(c)	-	-	-	-
	30	0	2	0	2
November	6	0	2	0	0
	13	1	4	0	0
	20	0	1	0	0
	27	2	0	0	0
December	4	0	0	0	0
	11	0	2	0	0
	18(a)	-	-	-	-
	24(a)	-	-	-	-
	31	0	0	0	0
Total		800	630	18	83

(a) Impingement could not be conducted due to high water conditions.

(b) Impingement could not be conducted due to diving operations in screenhouse.

(c) Impingement could not be conducted due to maintenance.

TABLE V-G-8

SUMMARY OF MOLLUSKS (OTHER THAN *Corbicula*) AND DRAGONFLIES COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK, 1992

BVPS

Date		Number of Organisms in all Bays	
Month	Day	Mollusks	Dragonflies
January	3	2	0
	10	0	0
	17(c)	-	-
	24(c)	-	-
	31	0	0
February	7	0	0
	14	0	0
	21	0	0
	28	0	0
March	6(c)	-	-
	13	0	0
	20	0	0
	27	0	0
April	3	0	0
	10	0	0
	17	0	0
	24(b)	-	-
May	1	0	0
	8	0	0
	15	0	0
	22(c)	-	-
	29(c)	-	-
June	5	0	1
	12	0	0
	19	0	0
	26	0	0
July	3	0	1
	10(c)	-	-
	17	0	1
	24	0	4
	31	1	4

TABLE V-G-8
(Continued)

Date		Number of Organisms in all Bays	
Month	Day	Mollusks	Dragonflies
August	7	0	4
	14	0	3
	21	0	2
	28	1	4
September	4	1	3
	11	0	3
	18	2	1
	25	9	6
October	2	0	0
	9	0	0
	16	0	0
	23(c)	-	-
	30	0	0
November	6	0	0
	13	0	0
	20	0	0
	27	1	0
December	4	0	0
	11	1	0
	18(a)	-	-
	24(a)	-	-
	31	0	0
Total		18	37

(a) Impingement could not be conducted due to high water conditions.

(b) Impingement could not be conducted due to diving operations in screenhouse.

(c) Impingement could not be conducted due to maintenance.

showed 1.4 and 1.9 fish/1,000 m^2 for operating and non-operating screens, respectively. As in previous years, the numbers of fish collected in non-operating bays indicate that fish entrapment, rather than impingement, accounts for some of the catch. Entrapment occurred when fish were lifted out of the water on the frame plates as the traveling screen rotated. Alternatively, impingement occurred when fish were forced against the screen due to velocities created by the circulating water pumps.

Of the 76 crayfish collected in the 1992 impingement studies, 67 (88.2%) were collected from operating bays and 9 (11.8%) were collected from non-operating bays (Table V-G-6). Adjusting these data for screen surface area washed (crayfish per 1,000 m^2) the results show 3.3 and 2.4 crayfish for operating and non-operating screens, respectively.

Corbicula collected in the 1992 studies included 1,430 (93.4%) in the operating bays and 101 (6.6%) in the non-operating bays (Table V-G-7). Again, adjusting these data for the screen surface area washed (Corbicula per 1,000 m^2) the results show 71.0 and 27.0 Corbicula for operating and non-operating screens, respectively.

Summary and Conclusions

The results of the 1992 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has very little effect on the fish populations. Thirty-six (36) fishes were collected, which was the lowest yearly total since initial operation of BVPS in 1976. Rock bass were the most numerous fish, comprising 16.3% of the total annual catch. The total weight of all fishes collected in 1992 was 0.75 kg (1.6 lbs). Of the 36 fishes collected, 13 (36.1%) were alive and returned via the discharge pipe to the Ohio River.

H. PLANKTON ENTRAINMENT

1. Ichthyoplankton

Objectives

The ichthyoplankton entrainment studies are designed to determine the species composition, relative abundance, and distribution of ichthyoplankton found in proximity to the BVPS intake structure.

Methods

Previous studies have demonstrated that species composition and relative abundance of ichthyoplankton samples collected in front of the intake structure were very similar to those ichthyoplankton entrainment samples taken at BVPS (DLC 1976, 1977, 1978, and 1979). Based on these results, a modified sampling program was utilized from 1980 through the current sampling season which sampled the Ohio River along a transect adjacent to the BVPS intake structure (Figure V-F-1). Samples were collected monthly, from April through August, during daylight hours along a five station transect. Night collections were made in May and July. Surface tows were made at Stations 1, 3, and 5 and bottom tows were taken at Station 2 and 4 utilizing a 505 micron mesh plankton net with a 0.5 m diameter mouth. Sample volumes were measured by a General Oceanics Model 2030 digital flowmeter mounted centrically in the mouth of the net. Samples were preserved upon collection in 5% buffered formalin containing rose bengal dye.

In the laboratory, eggs, larvae, juveniles, and adults were sorted from the samples, identified to the lowest possible taxon and stage of development, and enumerated. Densities of ichthyoplankton (number/100m^3) were calculated using appropriate flowmeter data.

Results

A total of 1,201 eggs, 2,191 larvae and two juveniles representing eleven taxa and seven families were collected from 4,114.9 m^3 of water filtered during sampling along the river entrainment transects (Table V-H-1). Gizzard shad, freshwater drum and white bass were the most common taxa, representing 53.0%, 35.7%, and 5.7% of the total catch, respectively. The larvae collected were predominantly gizzard shad, freshwater drum and white bass. Juveniles represented only 0.05% of the total ichthyoplankton catch. No adults were collected during the surveys.

Seasonal Distribution

The initial survey of April 21, 1992 collected two ichthyoplankton larvae (Table V-H-1). No eggs were collected in the April survey. The May survey collection was more productive with 404 eggs (predominantly freshwater drum) and 618 larvae, comprised mostly of gizzard shad and white bass. Total density of ichthyoplankton (individuals/100 m^3) in May (day and night surveys combined) was 83.06/100 m^3. The May night survey total density was more than three times greater than the day survey, with calculated totals of 121.94 and 38.97 individuals/100 m^3, respectively.

June had the highest ichthyoplankton density for the year at 191.82 individuals/100 m^3. Gizzard shad larvae dominated the June collection. The July (day and night surveys combined) total ichthyoplankton density remained elevated with a density of 99.55 individuals/100 m^3. The July collection was dominated by eggs (53.4%) and gizzard shad larvae (34.9%). The August survey collected fewer eggs (10) and larvae (12) with a total density of 3.51/100 m^3.

Spatial Distribution

Larvae were collected at all stations; however, highest densities were collected at Stations 2 and 4 (day surveys) and Stations 1 and 5

TABLE V-H-1

NUMBER AND DENSITY OF FISH EGGS, LARVAE, JUVENILES, AND ADULTS (Number/100 m^3) COLLECTED WITH A 0.5 m PLANKTON NET AT THE ENTRAINMENT RIVER TRANSECT IN THE OHIO RIVER, 1992

BVPS

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
April 21											
Vol. water filtered (m^3)	78.5		109.7		80.8		100.9		82.3		452.2
Number eggs collected	0		0		0		0		0		0
Number larvae collected	0		1		1		0		0		2
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Larvae											
Stizostedion sp. (YL)	0		0.91(1)		0		0		0		0.22(1)
Unidentified (*L)	0		0		1.24(1)		0		0		0.22(1)
Total Station Density (number collected)	0		0.91(1)		1.24(1)		0		0		0.44(2)
May 18/19											
Vol. water filtered (m^3)	104.0	112.0	137.6	125.6	117.4	123.8	133.1	147.0	112.5	117.5	1,230.5
Number eggs collected	7	59	10	59	5	26	4	182	4	48	404
Number larvae collected	30	57	95	92	34	84	48	72	8	98	618
Number juveniles collected	0	0	0	0	0	0	0	0	0	0	0
Number adults collected	0	0	0	0	0	0	0	0	0	0	0
Density (number collected)											
Eggs											
Morone chrysops	0	16.96(19)	0	19.11(24)	0	5.65(7)	0	0	0	0	4.06(50)
Aplodinotus grunniens	6.73(7)	35.71(40)	6.54(9)	26.27(33)	4.26(5)	15.35(19)	3.01(4)	107.48(158)	3.56(4)	40.85(48)	26.58(327)
Unidentified egg	0	0	0.73(1)	1.59(2)	0	0	0	16.33(24)	0	0	2.19(27)
Larvae											
Dorosoma cepedianum (YL)	26.92(28)	32.14(36)	55.96(77)	65.29(82)	23.85(28)	58.16(72)	30.05(40)	24.49(36)	3.56(4)	19.57(23)	34.62(426)
Dorosoma cepedianum (EL)	0	0	0	0	0	0	0	0	0	1.70(2)	0.16(2)
Cyprinidae (EL)	1.92(2)	0.89(1)	0	0	2.56(3)	0	0	0	0	0	0.49(6)
Cyprinus carpio (YL)	0	0.89(1)	0	0	0	0	0	0	0	0	0.08(1)
Cyprinus carpio (EL)	0	0	0	0	0.85(1)	0	0.75(1)	0	0	0	0.16(2)
Notropis sp. (EL)	0	0	0	0	0	4.85(6)	0	0.68(1)	0	15.32(18)	2.03(25)
Catostomidae (EL)	0	0	0.73(1)	0	0	0	0.75(1)	0	0.89(1)	0	0.24(3)
Morone chrysops (YL)	0	5.36(6)	10.90(15)	1.59(2)	1.70(2)	0	3.00(4)	2.72(4)	1.78(2)	0	2.84(35)
Morone chrysops (EL)	0	10.71(12)	0	5.57(7)	0	4.04(5)	1.50(2)	19.73(29)	0.89(1)	45.11(53)	8.86(109)
Pomoxis sp. (EL)	0	0.89(1)	0	0	0	0	0	0	0	0	0.08(1)
Percidae (EL)	0	0	0	0	0	0	0	1.36(2)	0	1.70(2)	0.32(4)
Perca flavescens (EL)	0	0	1.45(2)	0	0	0	0	0	0	0	0.16(2)
Stizostedion sp. (YL)	0	0	0	0.80(1)	0	0.81(1)	0	0	0	0	0.16(2)
Total Station Density (number collected)	35.58 (37)	103.57 (116)	76.31 (105)	120.22 (151)	33.22 (39)	88.85 (110)	39.07 (52)	172.79 (254)	10.67 (12)	124.26 (146)	83.06 (1,022)

TABLE V-H-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
June 16											
Vol. water filtered (m^3)	105.5		125.3		109.9		143.5		112.2		596.4
Number eggs collected	39		23		11		62		9		144
Number larvae collected	17		285		23		612		63		1,000
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs											
Aplodinotus grunniens	15.17(16)		18.36(23)		10.01(11)		20.21(29)		8.02(9)		14.75(88)
Unidentified egg	21.80(23)		0		0		23.00(33)		0		9.39(56)
Larvae											
Dorosoma cepedianum (YL)	6.63(7)		44.69(56)		19.11(21)		94.77(136)		41.00(46)		44.60(266)
Dorosoma cepedianum (EL)	4.74(5)		167.6 (210)		0.91(1)		321.25(461)		8.02(9)		115.02(686)
Cyprinidae (EL)	2.84(3)		0.80(1)		0		0		7.13(8)		2.01(12)
Cyprinus carpio (EL)	0		2.39(3)		0		0		0		0.50(3)
Percidae (EL)	0.95(1)		0		0		0		0		0.17(1)
Aplodinotus grunniens (YL)	0.95(1)		1.60(2)		0.91(1)		3.48(5)		0		1.51(9)
Aplodinotus grunniens (EL)	0		10.37(13)		0		6.97(10)		0		3.86(23)
Total Station Density (number collected)	53.08(56)		245.81(308)		30.94(34)		469.69(674)		64.17(72)		191.82(1144)
July 8/9											
Vol. water filtered (m^3)	111.4	105.4	136.4	132.6	104.5	123.8	137.7	128.9	116.7	112.0	1,209.4
Number eggs collected	5	15	0	113	1	210	1	244	5	49	643
Number larvae collected	9	143	20	49	7	58	33	91	8	141	559
Number juveniles collected	0	0	0	0	0	0	0	2	0	0	2
Number adults collected	0	0	0	0	0	0	0	0	0	0	0
Density (number collected)											
Eggs											
Aplodinotus grunniens	4.49(5)	13.28(14)	0	82.20(109)	0.96(1)	168.82(209)	0	186.97(241)	4.28(5)	41.96(47)	52.17(631)
Unidentified eggs	0	0.95(1)	0	3.02(4)	0	0.81(1)	0.73(1)	2.33(3)	0	1.79(2)	0.99(12)
Larvae											
Dorosoma cepedianum (EL)	7.18(8)	118.60(125)	0.73(1)	13.57(18)	5.74(6)	29.89(37)	3.63(5)	38.79(50)	6.00(7)	110.71(124)	31.50(381)
Dorosoma cepedianum (LL)	0	0	0	4.52(6)	0	0.81(1)	1.45(2)	19.39(25)	0	4.46(5)	3.22(39)
Cyprinus carpio (EL)	0.90(1)	1.90(2)	0.73(1)	0	0	0.81(1)	0.73(1)	0.78(1)	0	0.89(1)	0.66(8)
Notropis sp. (LL)	0	0	0	0	0	0	0	0	0	0.89(1)	0.08(1)
Lepomis sp. (EL)	0	0.95(1)	0	0	0.96(1)	0	0	0	0.86(1)	0	0.25(3)
Pomoxis sp. (EL)	0	0	0	0	0	3.23(4)	0	0	0	2.68(3)	0.58(7)
Etheostoma sp. (EL)	0	1.90(2)	0	0	0	0	0	0	0	0	0.16(2)
Aplodinotus grunniens (YL)	0	3.80(4)	4.40(6)	9.05(12)	0	2.42(3)	3.63(5)	3.88(5)	0	4.46(5)	3.31(40)
Aplodinotus grunniens (EL)	0	8.54(9)	8.80(12)	9.80(13)	0	9.69(12)	14.52(20)	7.76(10)	0	1.79(2)	6.45(78)
Juveniles											
Dorosoma cepedianum (JJ)	0	0	0	0	0	0	0	1.55(2)	0	0	0.16(2)
Total Station Density (Number Collected)	12.57(14)	149.90(158)	14.66(20)	122.17(162)	7.66(8)	216.48(268)	24.69(34)	261.44(337)	11.14(13)	169.64(190)	99.55(1204)

TABLE V-H-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
August 1[illegible]											
Vol. water filtered (m^3)	115.4		151.1		136.8		109.4		113.7		626.4
Number eggs collected	3		4		2		0		1		10
Number larvae collected	0		7		1		1		3		12
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs											
Aplodinotus grunniens	2.60(3)		2.65(4)		1.46(2)		0		0.88(1)		1.60(10)
Larvae											
Cyprinidae (EL)	0		1.32(2)		0		0		2.64(3)		0.80(5)
Etheostoma sp. (EL)	0		0		0.73(1)		0		0		0.16(1)
Aplodinotus grunniens (YL)	0		3.31(5)		0		0.91(1)		0		0.96(6)
Total Station Density (number collected)	2.60(3)		7.28(11)		2.19(3)		0.91(1)		3.52(4)		3.51(22)
Yearly Total											
Vol. water filtered (m^3)	514.8	217.4	660.1	258.2	549.4	247.6	624.6	275.9	537.4	229.5	4,114.9
Number eggs collected	54	74	37	172	19	236	67	426	19	97	1,201
Number larvae collected	56	200	408	141	66	142	694	163	82	239	2,191
Number juveniles collected	0	0	0	0	0	0	0	2	0	0	2
Number adults collected	0	0	0	0	0	0	0	0	0	0	0
Eggs											
Morone chrysops	0	8.74(19)	0	9.30(24)	0	2.83(7)	0	0	0	0	1.21(50)
Aplodinotus grunniens	6.02(31)	24.84(54)	5.45(36)	55.00(142)	3.46(19)	92.08(228)	5.28(33)	144.62(399)	3.54(19)	41.39(95)	25.66(1056)
Unidentified egg	4.47(23)	0.46(1)	0.15(1)	2.32(6)	0	0.40(1)	5.44(34)	9.79(27)	0	0.87(2)	2.31(95)
Larvae											
Dorosoma cepedianum (YL)	6.80(35)	16.56(36)	20.15(133)	31.76(82)	8.92(49)	29.08(72)	28.18(176)	13.05(36)	9.30(50)	10.02(23)	16.82(692)
Dorosoma cepedianum (EL)	2.52(13)	57.50(125)	31.96(211)	6.97(18)	1.27(7)	14.94(37)	74.61(466)	18.12(50)	2.98(16)	54.90(126)	25.98(1069)
Dorosoma cepedianum (LL)	0	0	0	2.32(6)	0	0.40(1)	0.32(2)	9.06(25)	0	2.18(5)	0.95(39)
Cyprinidae (EL)	2.52(5)	0.46(1)	0.45(3)	0	0.55(3)	0	0	0	2.05(11)	0	0.56(23)
Cyprinus carpio (YL)	0	0.46(1)	0	0	0	0	0	0	0	0	0.02(1)
Cyprinus carpio (EL)	0.19(1)	0.92(2)	0.61(4)	0	0.18(1)	0.40(1)	0.32(2)	0.36(1)	0	0.44(1)	0.32(13)
Notropis sp. (EL)	0	0	0	0	0	2.42(6)	0	0.36(1)	0	7.84(18)	0.61(25)
Notropis sp. (LL)	0	0	0	0	0	0	0	0	0	0.44(1)	0.02(1)
Catostomidae (EL)	0	0	0.15(1)	0	0	0	0.16(1)	0	0.19(1)	0	0.07(3)
Morone chrysops (YL)	0	2.76(6)	2.27(15)	0.77(2)	0.36(2)	0	0.64(4)	1.45(4)	0.37(2)	0	0.85(35)
Morone chrysops (EL)	0	5.52(12)	0	2.71(7)	0	2.02(5)	0.32(2)	10.51(29)	0.19(1)	23.09(53)	2.65(109)
Lepomis sp. (EL)	0	0.46(1)	0	0	0.18(1)	0	0	0	0.19(1)	0	0.07(3)
Pomoxis sp. (EL)	0	0.46(1)	0	0	0	1.62(4)	0	0	0	1.31(3)	0.19(8)
Percidae (EL)	0.19(1)	0	0	0	0	0	0	0.72(2)	0	0.87(2)	0.12(5)
Etheostoma sp. (EL)	0	0.92(2)	0	0	0.18(1)	0	0	0	0	0	0.07(3)
Perca flavescens (EL)	0	0	0.30(2)	0	0	0	0	0	0	0	0.05(2)
Stizostedion spp. (YL)	0	0	0.15(1)	0.39(1)	0	0.40(1)	0	0	0	0	0.07(3)
Aplodinotus grunniens (YL)	0.19(1)	1.84(4)	1.97(13)	4.65(12)	0.18(1)	1.21(3)	1.76(11)	1.81(5)	0	2.18(5)	1.34(55)
Aplodinotus grunniens (EL)	0	4.14(9)	3.79(25)	5.03(13)	0	4.85(12)	4.80(30)	3.62(10)	0	0.87(2)	2.45(101)

TABLE V-H-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
Yearly Total (continued)											
Unidentifiable (*L)	0	0	0	0	0.18(1)	0	0	0	0	0	0.02(1)
Juveniles											
Dorosoma cepedianum (JJ)	0	0	0	0	0	0	0	0.72(2)	0	0	0.05(2)
Total Station Density (number collected)	21.37 (110)	126.03 (274)	67.41 (445)	121.22 (313)	15.47 (85)	152.66 (378)	121.84 (761)	214.21 (591)	18.79 (101)	146.40 (336)	82.48 (3,394)

Developmental Stages

YL -- Hatched specimens with yolk and/or oil globules present.
EL -- Specimens with no yolk and/or oil globules and with no development of fin rays and/or spiny elements.
LL -- Specimens with developed fin rays and/or spiny elements and evidence of a fin fold.
*L -- Specimens with undefinable larval stage due to damage or deterioration.
JJ -- Specimens with complete fin and pigment development, i.e., immature adult.

(night). The most larvae (857) were collected at Station 4. Most of the larvae collected in 1992 were gizzard shad, freshwater drum, and white bass. Stations 1, 2, 3, 4, and 5 yielded 256, 549, 208, 857 and 321 larvae, respectively for 1992. Eggs were collected in greatest densities during the night surveys, especially at Stations 2, 3 and 4 (172, 236, and 426 eggs, respectively).

Summary and Conclusions

The majority of the ichthyoplankton collected in 1992 were larvae and eggs, which comprised 64.5% and 35.4% of the total catch, respectively. Juvenile fishes accounted for the remaining percentage of the catch.

The similarity of species composition and relative abundance of ichthyoplankton taken in 1992 along the river transects to those of 1979-1991, combined with the close correlation between river sampling in front of the intake and actual entrainment sampling established in previous years (DLC 1976, 1977, 1978 and 1979) suggest little change in ichthyoplankton entrainment by BVPS in 1992.

2. Phytoplankton

Objectives

The phytoplankton entrainment study was designed to determine the composition and abundance of phytoplankton entrained in the intake water system.

Methods

After April 1, 1980, plankton sampling was reduced to one entrainment sample collected monthly. Each sample was one gallon taken from below the skimmer wall from one operating intake bay.

In the laboratory, phytoplankton analyses were performed in accordance with procedures described in Section C, PHYTOPLANKTON. Total densities (cells/ml) were calculated for all taxa. However, only densities of the 15 most abundant taxa each month are presented in Section C of this report.

Comparison of Entrainment and River Samples

Plankton samples were not collected at any river stations after April 1, 1980 due to a reduction of the Aquatic Monitoring Program, therefore, comparison of entrainment and river samples was not conducted for the 1992 phytoplankton program. Results of phytoplankton analyses for the entrainment sample collected monthly are presented in Section C, PHYTOPLANKTON.

During the years 1976 through 1979, phytoplankton densities of entrainment samples were usually slightly lower than those of mean total densities observed from river samples (DLC 1980). However, the species composition of phytoplankton in the river and in the entrainment samples were similar (DLC 1976, 1977, 1979, and 1980).

Studies from previous years indicate mean Shannon-Weiner diversity indices, evenness and richness values of entrainment samples were very similar to the river samples (DLC 1979, and 1980).

Summary and Conclusions

Past results of monthly sampling of phytoplankton in the Ohio River near BVPS and within the intake structure showed little difference in densities (cells/ml) and species composition. During periods of minimum low river flow, approximately 5.0% of the river would be withdrawn into the condenser cooling system. Based on the similar densities of phytoplankton in the river and the BVPS intake structure, and the small amount of water withdrawn from the river, the loss of phytoplankton was very small, even under worst case low flow conditions.

3. Zooplankton

Objectives

The zooplankton entrainment studies were designed to determine the composition and abundance of zooplankton entrained in the intake water system.

Methods

Plankton entrainment samples were collected and zooplankton were counted. For the zooplankton analyses, a well-mixed sample was taken and processed using the same procedures described in Section D, ZOOPLANKTON.

After April 1, 1980, plankton sampling was reduced to one entrainment sample collected monthly. Each sample was one gallon taken from below the skimmer wall from one operating intake bay.

Total densities (number/liter) were calculated for all taxa, however, only taxa which comprised greater than 2% of the total are presented in Section D, ZOOPLANKTON.

Comparison of Entrainment and River Samples

Plankton samples were not collected at any river stations after April 1, 1980 due to a reduction of the Aquatic Monitoring Program, therefore, comparison of entrainment and river samples was not conducted for the 1992 zooplankton program. Results of zooplankton analyses for the entrainment sample collected monthly are presented in Section D, ZOOPLANKTON.

During past years, composition of zooplankton was similar in entrainment and river samples (DLC 1980). Protozoans and rotifers were predominant, whereas crustaceans were sparse. Densities of the four most abundant taxa for each month (DLC 1976, 1977, 1979, and 1980) indicate the same taxa were present in both river and intake samples. In addition, they were present in similar quantities. Shannon-Weiner diversity indices, evenness and richness values for river and entrainment samples were also similar, further demonstrating similarity between entrained and river zooplankton.

Summary and Conclusions

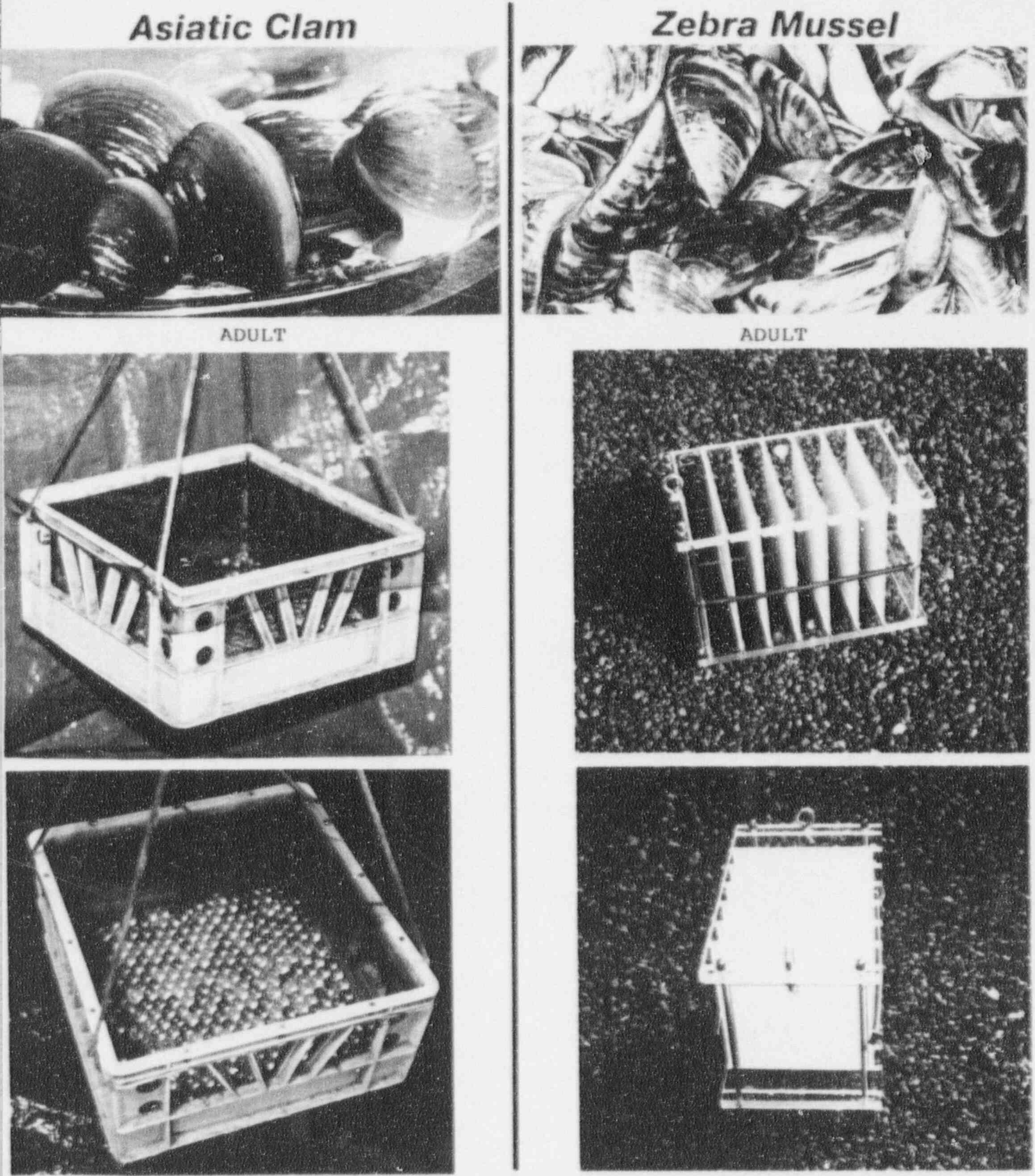
Past results of monthly sampling of zooplankton in the Ohio River near BVPS and within the intake structure showed little difference in densities (number/liter) and species composition. During periods of minimum, low river flow, approximately 5% of the river would be withdrawn into the condenser cooling system. Based on the similar densities of zooplankton in the river and the BVPS intake structure, and the small amount of water withdrawn from the river, the loss of zooplankton was very small, even under worst case low flow conditions.

I. *Corbicula* MONITORING PROGRAM

Introduction

The introduced Asiatic clam, *Corbicula fluminea* (Figure V-I-1), was first detected in the United States in 1938 in the Columbia River near Knappton, Washington (Burch 1944). It has since spread throughout the country, inhabiting any suitable freshwater habitat. Information from prior aquatic surveys has demonstrated the presence of *Corbicula* in the Ohio River in the vicinity of the BVPS, and the plant is listed in NUREG/CR-4233 (Counts 1985).

One adult clam is capable of producing many thousands of larvae called veligers. These veligers are very small (approximately 0.2 mm) and will pass easily through the water passages of a power plant. Once the veliger settles to the substrate, growth of the clam occurs rapidly. If clams develop within a power plant's water passages, they impair the flow of water through the plant. Reduction of flow may be so severe that a plant shutdown is necessary. The clams are of particular concern



Asiatic Clam

Zebra Mussel

ADULT

ADULT

Corbicula LARVAL CAGE

NOT TO SCALE

DER ZEBRA MUSSEL ARTIFICIAL SUBSTRATE

FIGURE V-1-1

PHOTOGRAPHS OF *Corbicula* WITH LARVAL CAGE
AND ZEBRA MUSSEL WITH ARTIFICIAL SUBSTRATE
BVPS

when they develop undetected in emergency systems where the flow of water is not constant (NRC, IE Bulletin 81-03).

The Corbicula Monitoring Program includes the Ohio River and the circulating river water system of the BVPS (intake structure and cooling towers). This report describes this Monitoring Program and the results obtained during field and plant surveys conducted through 1992.

1. Monitoring

Objectives

The two objectives of the Monitoring Program were to evaluate the presence of Corbicula at the BVPS and to assess the population of Corbicula in the Ohio River in order to evaluate the potential for infestation of the BVPS.

Methods

(Unit 2 Cooling Tower)

The Corbicula population in the lower reservoir of the Unit 2 cooling tower was estimated based on sampling performed during a scheduled outage. Ten samples were collected on April 5, 1992 at designated sampling locations using a (6" x 6") petite ponar dredge (Figure V-I-2).

The substrate of each sample was characterized at the time of collection. The samples were returned to the laboratory and sorted for Corbicula within 72 hours of collection. This procedure increased overall sorting efficiency because formalin, normally used to preserve the samples for long periods of time, was not needed and live Corbicula could be seen moving in the sorting trays. Counts were made of live and dead Corbicula in each dredge sample. These sample counts were converted to densities (clams/m^2) based on the surface area sampled by the dredge. An average density was then calculated for the ten samples. An estimate of the area of the cooling tower basin covered by sediment was

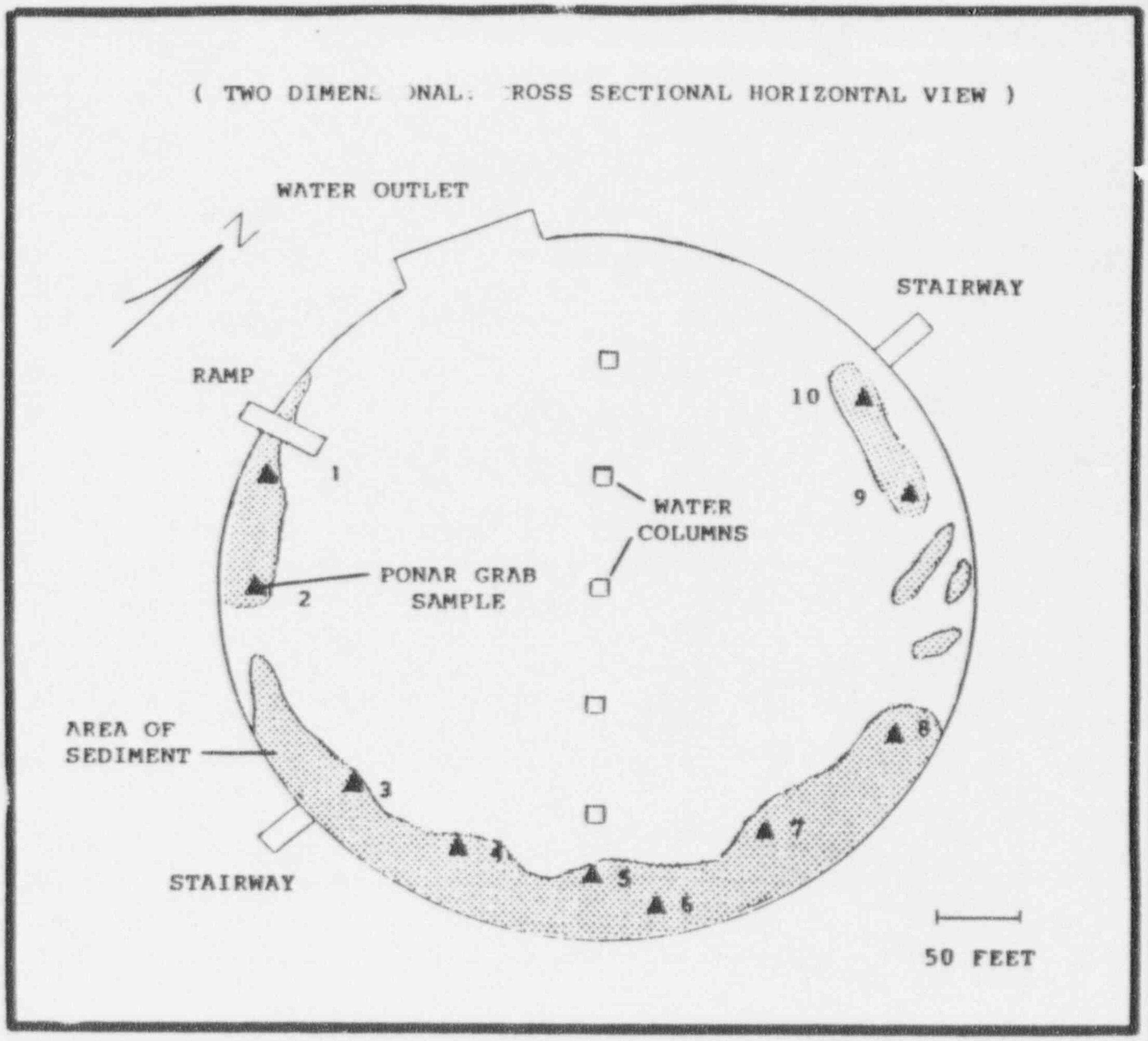


FIGURE V-I-2

Corbicula MONITORING PROGRAM SAMPLING STATIONS OF THE LOWER RESERVOIR OF UNIT 2 COOLING TOWER BVPS calculated, since the Corbicula were concentrated almost entirely in the sediment. The estimated population was calculated by multiplying the average density times the area of sediment coverage.

(Intake)

Plant operations personnel have the intake surveyed semi-annually by divers for silt buildup, and if necessary, the intake bays are cleaned. Cleaning of intake bays occurred in April-May and September 1992, by divers using a Flygt 20-hp submersible pump. This pump has a capacity of 500 gpm (1,750 rpm) and uses a five-inch propeller to push water and debris through a flexible hose (Jenkins and Logar 1985).

(River)

Surveys were performed in May and September of 1992 to monitor for Corbicula in the Ohio River near the BVPS. Ten transects were established along the Ohio River: four upstream, five downstream and one at the plant intake (Figure V-I-3). A transect was also established on Raccoon Creek. Two transects downstream of the BVPS (Phillis Island and Georgetown Island) were divided, resulting in samples being collected on both sides of each island. Each transect was established on suitable substrate (sand and/or gravel) or near a heated discharge (HD). Each transect is identified by river navigation mile on Figure V-I-3. Thirteen additional samples were collected near the left bank next to the BVPS (Figure V-I-4). These samples were concentrated mainly in front of the intake structure.

Samples were collected using either a regular ponar (9" x 9"), (regular benthic program, Stations 1, 2A, 2B and 3) or a petite ponar (6" x 6") dredge. Three samples were collected at each transect (left shore, right shore and mid-channel), except for benthic Stations 1, 2A and 3 which included a duplicate left sample as part of the benthic program.

The substrate of each sample was characterized at the time of collection. The samples were then returned to the laboratory and sorted for

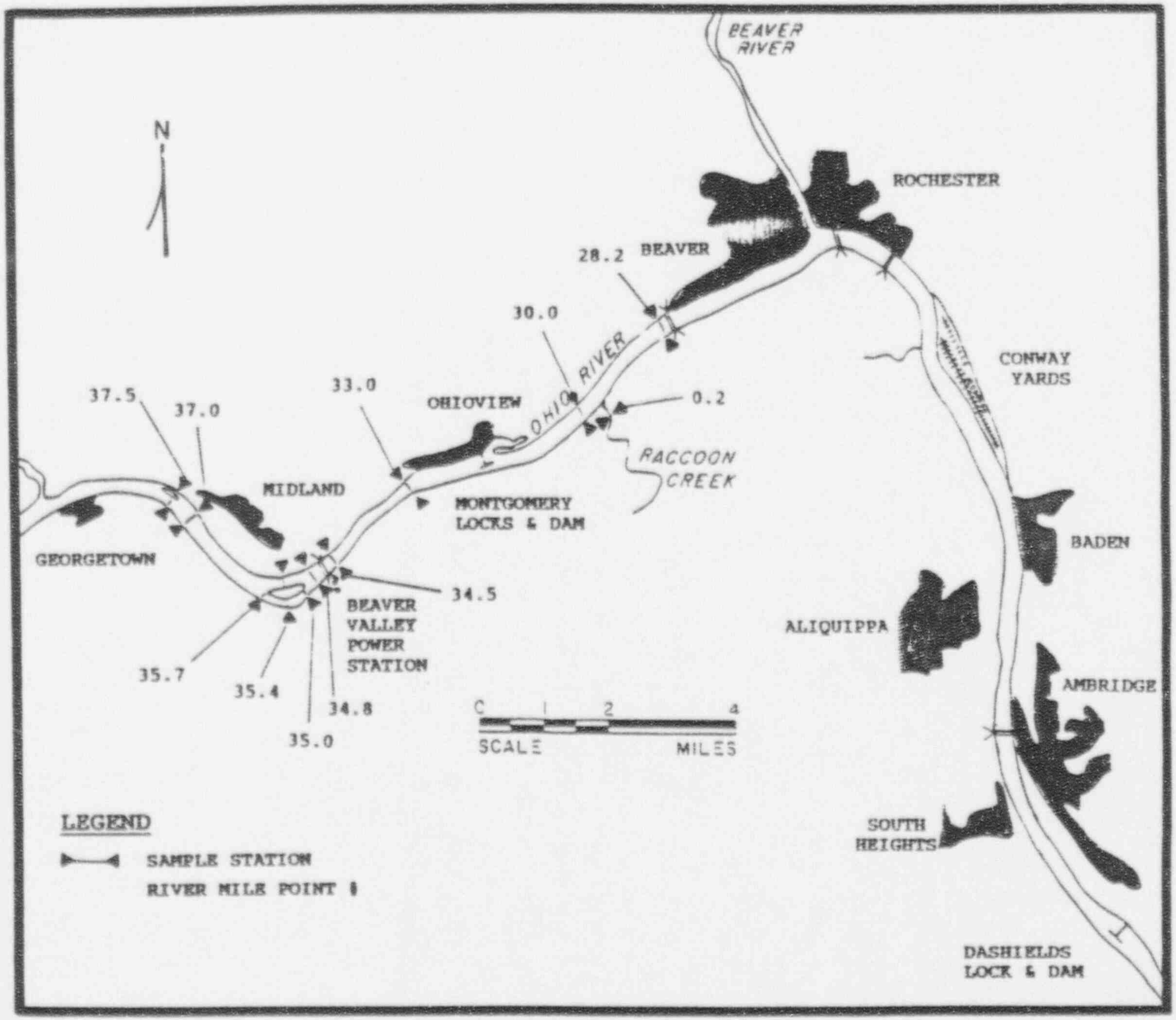


FIGURE V-I-3

Corbicula MONITORING PROGRAM SAMPLING STATIONS, OHIO RIVER SYSTEM
BVPS

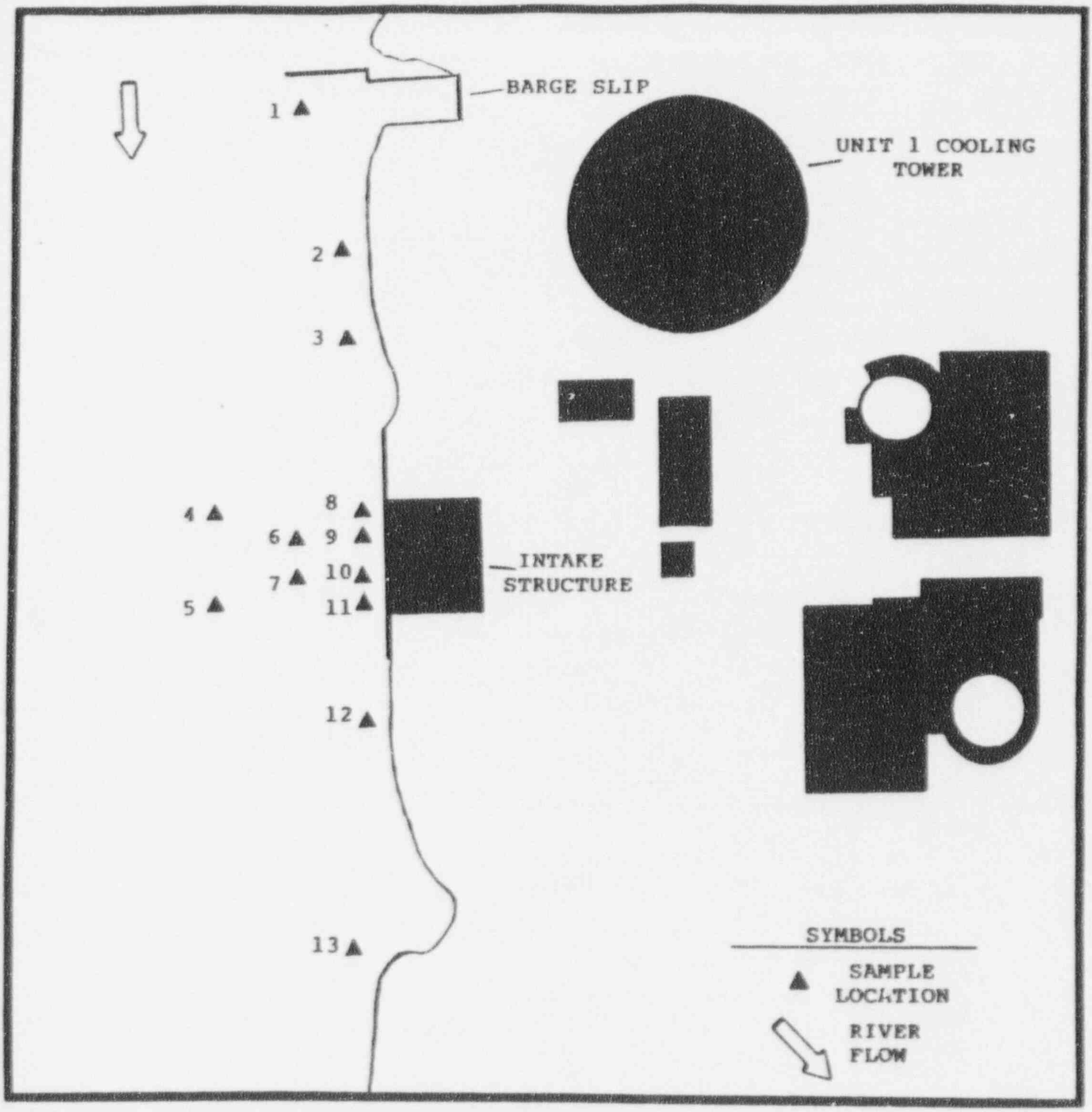


FIGURE V-I-4

<u>Corbicula</u> MONITORING PROGRAM SAMPLING STATIONS, OHIO RIVER SYSTEM IN THE VICINITY OF THE INTAKE STRUCTURE
BVPS

Corbicula. Counts were made of live and dead Corbicula for each dredge sample. Live clam counts were converted to densities (clams/m^2) for each sample based on the surface area sampled by the dredge.

The weekly impingement surveys at the intake structure monitored the number of Corbicula which could potentially enter the BVPS from the Ohio River. Corbicula obtained during the washing of the traveling screens (see Section G, Fish Impingement Methods), were returned to the laboratory. These clams were rinsed through a series of stacked U.S. standard sieves ranging in mesh size from 16.0 mm to 0.6 mm. The number of live clams retained on each sieve was recorded.

Results

(Unit 2 Cooling Tower)

Results of the April 5, 1992 Corbicula survey of the Unit 2 cooling tower are presented in Table V-I-1. Based on the ten ponar samples taken from the lower reservoir, the estimated number of Corbicula inhabiting this area was 11.0 million, of which 37.1% were dead (Figure V-I-5).

(Intake)

While performing the innerbay cleaning operation (April-May and September 1992), the divers observed concentrations of Corbicula in each of the bays close to the intake pumps. As in past years, more clams were removed during the autumn cleaning operation than in the spring cleaning operation. A cut-away diagram of the intake structure is provided in Figure V-I-6.

(River)

The results of the 1992 Corbicula surveys in the Ohio River are presented in Tables V-I-2 and V-I-3 (May) and V-I-4 and V-I-5 (September). Dead Corbicula were not counted in samples of the regular

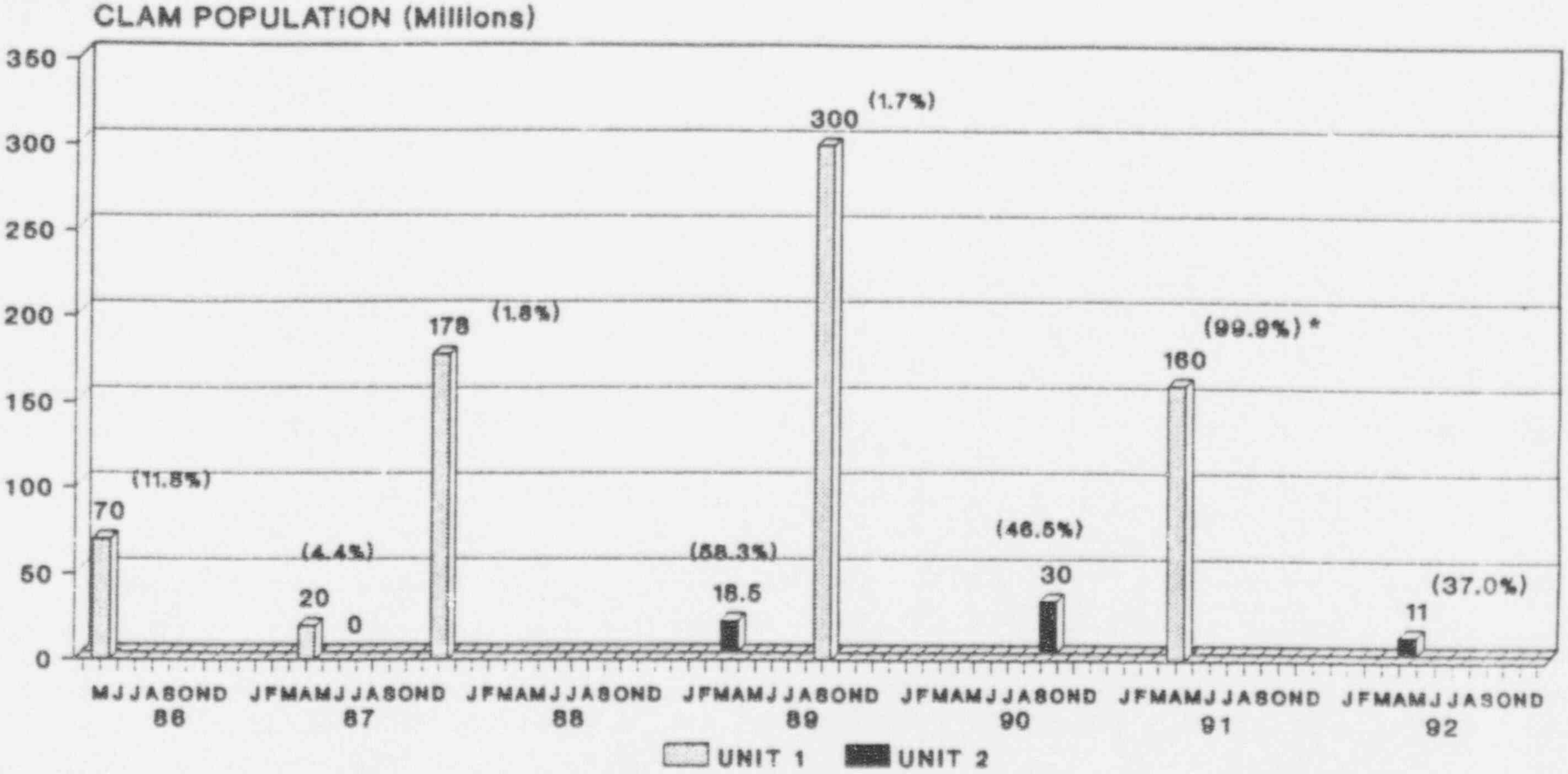
TABLE V-I-1

Corbicula COLLECTED IN UNIT 2 COOLING TOWER
APRIL 5, 1992
BVPS

Sample Location	Substrate	Clams Collected		Station Density
		Alive	Dead	Live Clams/m^2
Lower Reservoir				
1	sil	92	24	5,000
2	sil	81	89	7,327
3	sil	128	40	7,241
4	sil	70	61	5,646
5	sil	179	31	9,051
6	sil	59	15	3,189
7	sil	102	44	6,293
8	sil	77	44	5,215
9	sil	127	31	6,810
10	sil	33	180	9,180

Substrate Codes:

sil - silt



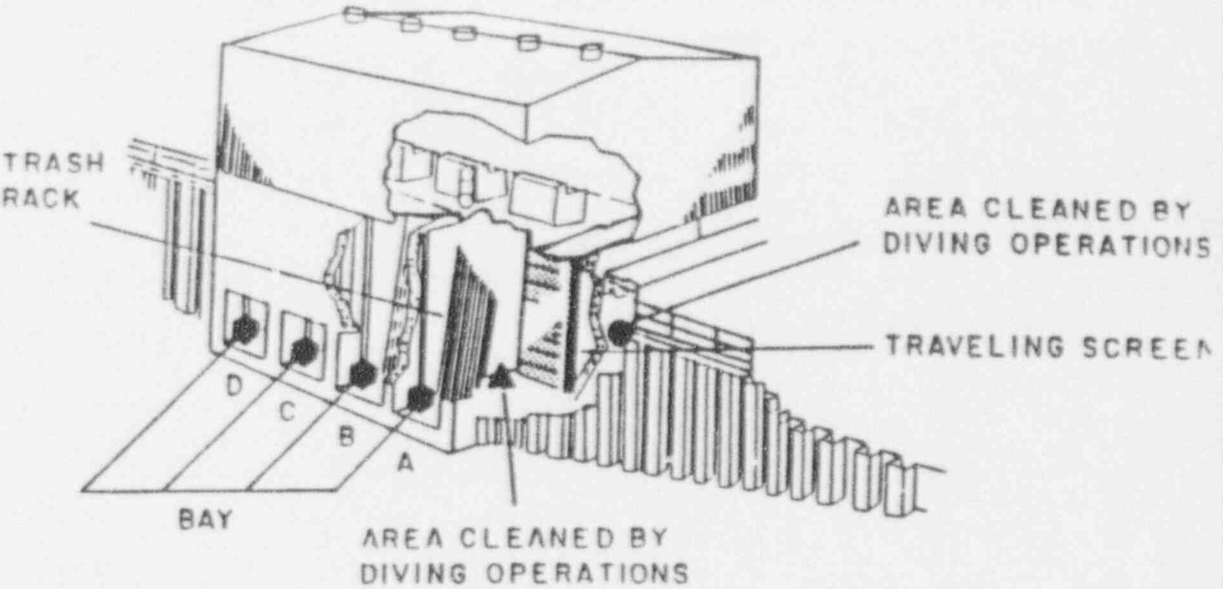
* Survey performed after 1990 Corbicula Control Program, June and November 1990 molluscicide dosings of Unit 1 river water system.

( ) Indicates percentage of dead Corbicula in the estimated total.

FIGURE V-I-5

APPROXIMATE POPULATIONS OF *Corbicula* IN UNITS 1 AND 2 COOLING TOWERS DERIVED FROM SURVEYS CONDUCTED IN 1986 THROUGH 1992
BVPS

(THREE DIMENSIONAL: CUTAWAY VIEW)



BAY D

(TWO DIMENSIONAL: SIDE VIEW)

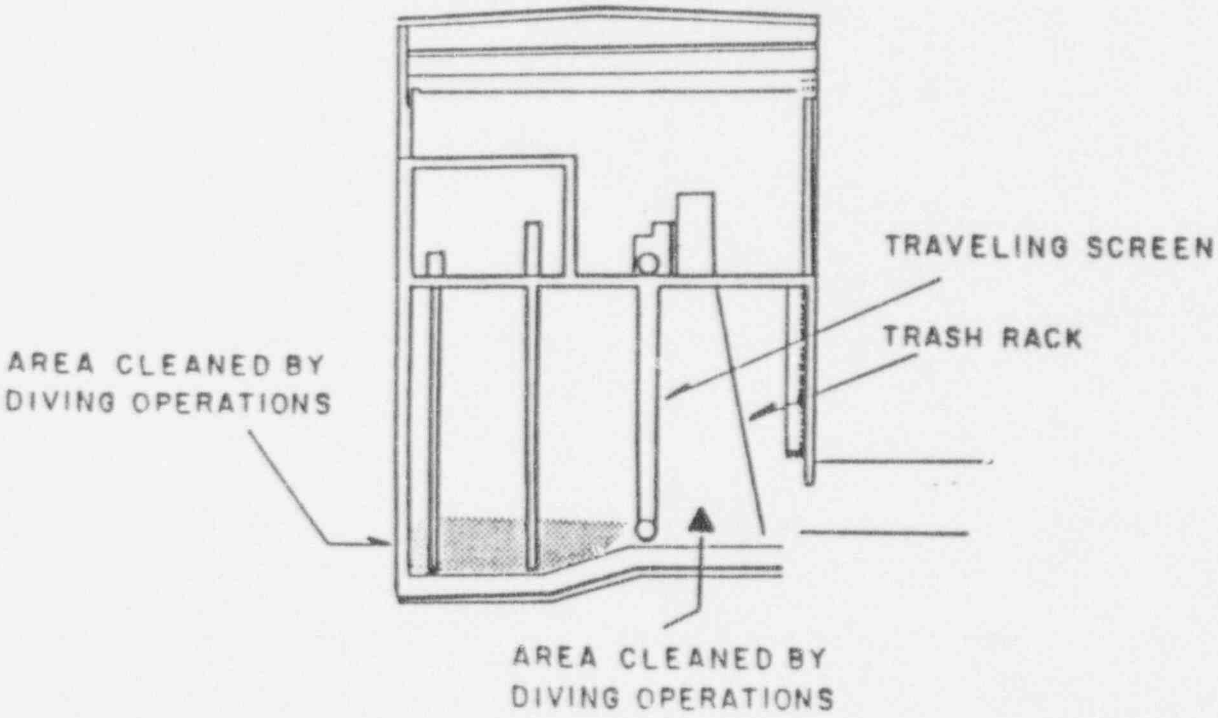


FIGURE V-I-6

Corbicula MONITORING PROGRAM SAMPLING STATIONS
INTAKE STRUCTURE
BVPS

TABLE V-I-2

Corbicula COLLECTED IN THE OHIO RIVER
MAY 20, 1992
BVPS

Sample	River				Clams Collected		Station Density
Location	Mile	Bank	Depth (ft.)	Substrate	Alive	Dead	Live Clams/m^2
Raccoon Creek	0.3	R	4	sil	0	1	0
		M	5	sil	0	1	0
		L	2	sil	1	1	43
Ohio River	28.2	R	2	sil	1	0	43
		M	30	sil/gra	0	7	0
		L	2	sil	1	0	43
	30.0	R	2	sil	2	0	86
		M	35	sil/det	1	3	43
		L	5	sil	1	0	43
	33.0	R	3	sil/san	0	1	0
		M	20	gra	0	1	0
		L	2	sil	1	0	43
	34.5(1)	R	2	sil	0	3	0
		M	19	san/gra	4	2	172
		L	2	sil/san/det	4	-	79
		L	2	sil/san/det	2	-	39
	34.8	R	3	gra	1	3	43
		M	22	cob	0	0	0
		L	22	sil/det	4	4	172
(Back Channel)	35.0	R	4	san	1	10	43
		M	24	sil/gra/san	2	7	86
		L(HD)	2	sil	0	1	0
	35.4(2A)	R	4	gra	0	0	0
		M	17	gra/cob	8	0	345
		L	2	san/cla	6	-	118
		L	1	san/cla	2	-	39
(Back Channel)	35.4(2B)	R	2	sil/det	0	-	0
		M	11	cob/gra	2	-	39
		L	2	sil/det	3	-	59
(Back Channel)	35.7	R	2	sil/san	1	5	43
		M	12	cob	0	0	0
		L	2	sil/det/gra	0	0	0
	37.0(3)	R(HD)	2	sil/det	2	3	86
		M	18	san/gra	11	0	474
		L	1	sil	6	-	118
		L	2	sil	3	-	59
	37.5	R	3	cla/san	4	0	172
		M	24	gra	1	3	43
		L	3	sil/gra/det	0	4	0
(Back Channel)	37.5	R	4	sil/det/gra	0	6	0
		M	14	sil/gra	1	2	43
		L	3	sil/det/san	0	11	0

Substrate Codes:

bed - bedrock
cla - clay
cob - cobble
det - detritus
gra - gravel
san - sand
sil - silt

Footnotes:

(HD) - Heated Discharge
(1) - Transect 1
(2A) - Transect 2A (Main Channel)
(2B) - Transect 2B (Back Channel)
(3) - Transect 3

TABLE V-I-3

Corbicula COLLECTED IN THE OHIO RIVER IN THE VICINITY OF THE INTAKE STRUCTURE
MAY 20, 1992
BVPS

Sample Location	Depth (ft.)	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
(Left bank)					
1	3	sil/san/gra	0	1	0
2	3	gra	0	0	0
3	5	cob	0	0	0
4	18	gra	3	1	129
5	10	cob	0	0	0
6	21	sil	1	2	43
7	22	sil	1	4	43
8	21	sil/det	0	0	0
9	22	sil/det	0	0	0
10	22	sil/det	1	0	43
11	21	sil/det	1	1	43
12	2	sil	2	2	86
13	1	sil	0	1	0

Substrate Codes:

cob - cobble
det - detritus
gra - gravel
san - sand
sil - silt

TABLE V-I-4

Corbicula COLLECTED IN THE OHIO RIVER SEPTEMBER 8, 1992 BVPS

Sample Location	River Mile	River Bank	Depth (ft.)	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Raccoon Creek	0.3	R	4	sil	0	0	0
		M	5	sil	0	0	0
		L	3	sil	0	0	0
Ohio River	28.2	R	2	sil/det	0	0	0
		M	34	gra	2	3	86
		L	2	sil/det	2	3	86
	30.0	R	2	sil	0	2	0
		M	35	gra	0	2	0
		L	3	sil/san	0	0	0
	33.0	R	3	cla	0	7	0
		M	22	bed	0	0	0
		L	2	sil	0	3	0
	34.5(1)	R	4	sil/det	3	9	129
		M	23	gra	2	1	86
		L	2	sil/san	4	-	79
		L	2	sil/san	6	-	118
	34.8	R	3	sil/gra	0	7	0
		M	20	gra	0	3	0
		L	22	sil/det	1	9	43
(Back Channel)	35.0	R	4	sil/det	0	1	0
		M	22	sil/det	2	3	86
		L(HD)	2	sil/det	0	1	0
	35.4(2A)	R	5	gra/cob	0	1	0
		M	18	gra/cob	0	0	0
		L	2	cla/san	8	-	158
		L	2	cla/san	0	-	0
(Back Channel)	35.4(2B)	R	2	sil/det	5	-	99
		M	12	san/gra/bed	1	-	20
		L	2	san/sil/det	1	-	20
(Back Channel)	35.7	R	2	sil/san	0	8	0
		M	11	gra/cob	0	0	0
		L	3	sil/san	0	2	0
	37.0(3)	R(HD)	2	sil/det	2	3	86
		M	29	gra	4	2	172
		L	2	sil/san	2	-	39
		L	2	sil/san	2	-	39
	37.5	R	2	cla/san	0	1	0
		M	22	gra	4	3	172
		L	4	sil/san/det	0	7	0
(Back Channel)	37.5	R	3	sil	0	3	0
		M	13	san	0	2	0
		L	4	san	2	2	86

Substrate Codes:

bed - bedrock
cla - clay
cob - cobble
det - detritus
gra - gravel
san - sand
sil - silt

Footnotes:

(HD) - Heated Discharge
(1) - Transect 1
(2A) - Transect 2A (Main Channel)
(2B) - Transect 2B (Back Channel)
(3) - Transect 3

TABLE V-I-5

Corbicula COLLECTED IN THE OHIO RIVER IN THE VICINITY OF THE INTAKE STRUCTURE
SEPTEMBER 8, 1992
BVPS

Sample Location	Depth (ft.)	Substrate	Clams Collected		Station Density
			Alive	Dead	Live Clams/m^2
(Left bank)					
1	3	sil/san	0	3	0
2	4	gra/cob	0	0	0
3	3	gra	0	2	0
4	18	sil/san/gra	1	8	43
5	19	sil/gra	3	8	129
6	21	sil/det	0	5	0
7	22	sil/det	1	20	43
8	21	sil/det	0	6	0
9	22	sil/det	1	10	43
10	22	sil/det	1	12	43
11	20	sil/det	0	0	0
12	2	sil/det	0	9	0
13	3	sil	0	8	0

Substrate Codes:

cob - cobble
det - detritus
gra - gravel
san - sand
sil - silt

benthic macroinvertebrate monitoring program. Live Corbicula were collected primarily in substrates composed of silt, sand, and/or gravel.

More live Corbicula were collected in May (85 in 55 samples) than in the September survey (60 in 55 samples). Live Corbicula densities exceeded 100/m^2 for eight of the May samples and six of the September samples. The highest density of 474 clams/m^2 (May) occurred at mile 37.0 of the Ohio River, downstream from the BVPS. However, Corbicula densities were comparable in the majority of samples collected upstream and downstream from BVPS.

Table V-I-6 summarizes Corbicula densities in past macroinvertebrate collections for the BVPS (1973 through 1992). No Corbicula were found at any sampling station during 1973, 1979 and 1980. Corbicula densities were generally higher in the fall than in the spring surveys.

Table V-I-7 summarizes Corbicula densities (clams/100 m^3 volume water filtered) in ichthyoplankton samples collected monthly April through August for 1988 through 1992. In 1992, Corbicula densities were highest in the night ichthyoplankton samples. The maximum density (366.07 clams/100 m^3) in 1992 was in the July 9 (night) sample from Transect 5 surface. The July 1991 night survey collected the most Corbicula in the five-year period. The highest density to date was 640.30/100 m^3, calculated for the July 25 (night) 1991 Station 4 bottom sample.

Size distribution data for live Corbicula collected from the traveling screens during the weekly impingement surveys in 1992 are presented in Table V-I-8 (see Table V-G-7, Section G). The majority of clams collected (49.5%) were retained on the 6.3 mm mesh size sieve. The largest number of Corbicula (121) were collected on September 4. Young clams (sieve mesh sizes 3.35 and 6.3 mm) were consistently collected from mid-June through September. Young adults (sieve 9.5 mm) were common from mid-July through September. Larger Corbicula (12.5 mm sieve) comprised only 2.4% of the impingement total. No juvenile clams (≥1.00 mm) were collected due to the large mesh size (1/4") of the impingement collection basket.

TABLE V-I-6

Corbicula DENSITIES (Clams/m^2) SUMMARIZED FROM BENTHIC MACROINVERTEBRATE COLLECTIONS 1973 THROUGH 1992 BVPS

			TRANSECT									
			1			2A			2B	3		
Date			L	M	R	L	M	R	Back Channel	L	M	R
1973	Nov		0	0	0	0	0	0	0	0	0	0
1974	May		0	0	0	0	0	0	0	0	0	0
	Jun		0	0	0	0	0	0	0	0	0	0
	Jul		0	0	0	0	0	0	0	0	0	0
	Aug		0	0	0	0	0	0	0	0	0	0
	Sep		0	0	7	0	0	0	0	0	0	0
1975	Aug	26	7	0	20	20	20	33	20	7	0	0
	Nov	13	0	0	0	7	46	0	7	0	198	0
1976	Feb	24	7	0	0	0	0	0	13	0	0	0
	May	25	0	0	0	0	0	0	0	0	0	0
	Aug	18	40	20	290	99	0	53	92	0	20	0
	Nov		0	0	356	13	475	20	139	7	422	13
1977	Feb	24	0	0	7	7	53	508	7	0	7	0
	May	17	0	0	0	0	7	0	0	0	0	0
	Aug	17	0	0	0	0	86	7	13	0	172	0
	Nov		13	20	59	0	46	13	46	7	145	0
1978	Feb	15	0	13	0	0	0	132	6	6	6	32
	May	18	0	0	0	0	0	0	0	0	0	0
	Aug	9	0	0	0	6	13	0	0	0	0	0
	Nov	14&15	25	13	0	6	403	38	32	6	19	6
1979	Mar	22	0	0	0	0	0	0	0	0	0	0
	May	25	0	0	0	0	0	0	0	0	0	0
	Aug	1	0	0	0	0	0	0	0	0	0	0
	Nov	14	0	0	0	0	0	0	0	0	0	0
1980	Feb	13	0	0	0	0	0	0	0	0	0	0
	May	21	0	-	-	0	-	-	0	0	-	-
	Sep	23	0	-	-	0	-	-	0	0	-	-
1981	May	12	0	-	-	0	-	-	7	0	-	-
	Sep	22	40	-	-	90	-	-	408	99	-	-
1982	May	18	0	-	-	0	-	-	0	0	-	-
	Sep	23	0	-	-	10	-	-	0	0	-	-
1983	May	11	20	-	-	0	-	-	0	0	-	-
	Sep	13	59	-	-	20	-	-	251	40	-	-
1984	May	10	0	-	-	0	-	-	7	0	-	-
	Sep	6	0	-	-	0	-	-	0	0	-	-
1985	May	15	0	-	-	0	-	-	0	0	-	-
	Sep	19	89	-	-	0	-	-	99	40	-	-
1986	May	13	0	-	-	0	-	-	0	0	-	-
	Sep	15&16	20	-	-	20	-	-	184	0	-	-
1987	May	13	0	-	-	10	-	-	20	30	-	-
	Sep	16&17	30	-	-	118	-	-	59	99	-	-
1988	May	10	0	-	-	49	-	-	33	30	-	-
	Sep	13	325	-	-	118	-	-	92	79	-	-
1989	May	23	0	-	-	0	-	-	39	10	-	-
	Sep	14	20	-	-	118	-	-	197	108	-	-
1990	May	4&5	0	-	-	0	-	-	111	10	-	-
	Sep	13	197	-	-	148	-	-	112	30	-	-
1991	May	13	30	-	-	20	-	-	79	20	-	-
	Sep	30	276	-	-	571	-	-	690	108	-	-
1992	May	20	59	-	-	79	-	-	33	89	-	-
	Sep	8	99	-	-	79	-	-	46	39	-	-

(-) indicates area not sampled

TABLE V-I-7

Corbicula DENSITIES (Clams/100 m^3) PRESENT IN ICHTHYOPLANKTON SAMPLES COLLECTED WITH A 0.5m PLANKTON NET IN THE OHIO RIVER, 1988 THROUGH 1992
BVPS

	Sample Location						
	Back Channel		Main Channel				
Date	2B Sur	2B Bot	1 Sur	2 Bot	3 Sur	4 Bot	5 Sur
1988							
April 18	0.62	1.96	0	0	0	0	0
May 10	0	0	0	0	0	0	0
May 11(a)	21.87	18.95	0	0.88	0	7.08	23.00
June 14	0	0	0	0	0	0	0
July 14	0.98	0	0	9.24	0	0	0
July 14(a)	0.54	9.09	0	14.75	0	17.86	3.52
August 17	0	0	0	1.68	0	2.70	2.06
1989							
April 13	0	0	0	0	0	0	0
May 23	0	0	0	0	0	0	0
May 24(a)	0.78	6.48	2.08	0	0	0	2.68
June 19	0	0	0	0	0	0	0
July 12	0	0	0	0	0	0	0
July 13 (a)	4.84	9.89	4.37	3.38	0	1.67	1.78
August 15	0	0	0	0	0	0	0

TABLE V-I-7
(Continued)

	Sample Location						
	Back Channel		Main Channel				
Date	2B Sur	2B Bot	1 Sur	2 Bot	3 Sur	4 Bot	5 Sur
1990							
April 18	0	0	0	0	0	0	0
May 24	0.79	0	0.88	0.70	0.70	0	0
May 25[(a)]	0.79	3.33	0	0	0	5.83	2.98
June 12	0	0	1.82	0	0	0	0
July 25	46.32	48.62	47.97	77.62	40.36	47.18	80.34
July 26[(a)]	38.40	26.81	53.65	30.42	15.44	14.52	375.47
August 21	1.01	0	1.71	1.95	0	3.70	0
1991							
April 19	0	0	0	0	0	0	0
May 13	0	0	0	0	0	0	0
May 14[(a)]	14.29	21.68	2.94	0.65	0	2.24	6.99
June 13	0	0	0	0	0	0	0
July 24	0	0	0	0	0	0	0
July 25[(a)]	8.59	5.77	2.62	36.08	275.78	640.30	351.43
August 16	0	0.69	0	0	0.82	0	0.95
1992							
April 21	0	0	0	0	0	0	0
May 18	0	0	0	0	0	0	0
May 19[(a)]	71.23	62.44	37.50	99.52	34.73	91.84	30.64
June 16	0	0	0	0	0	0	0
July 8	0	0.84	0	2.20	0	0	0
July 9[(a)]	37.77	204.84	62.62	130.47	35.54	117.15	366.07
August 11	3.50	1.79	19.06	12.57	7.31	1.83	18.47

[(a)] Night survey was conducted.

TABLE V-I-8

SIZE DISTRIBUTION OF *Corbicula* COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1992
BVPS

Date		Live Clam Size Distribution Numbers						Total
		≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Live Clams
January	3	0	0	0	0	0	0	0
	10	0	0	0	2	0	0	2
	17(c)	-	-	-	-	-	-	-
	24(c)	-	-	-	-	-	-	-
	31	0	0	1	0	1	0	2
February	7	0	0	1	0	0	0	1
	14	0	0	0	0	0	0	0
	21	0	0	0	2	0	0	2
	28	0	0	0	0	0	0	0
March	6(c)	-	-	-	-	-	-	-
	13	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0
April	3	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0
	24(b)	-	-	-	-	-	-	-
May	1	0	0	0	1	0	0	1
	8	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0
	22(c)	-	-	-	-	-	-	-
	29(c)	-	-	-	-	-	-	-
June	5	0	2	0	0	0	0	2
	12	0	2	2	0	0	0	4
	19	0	19	13	0	0	0	32
	26	0	29	62	2	0	0	93

TABLE V-I-8
(Continued)

Date		Live Clam Size Distribution Numbers						Total Live Clams
		≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	
July	3	0	1	8	0	0	0	9
	10(c)	-	-	-	-	-	-	-
	17	0	2	19	10	0	0	31
	24	0	0	2	8	0	0	10
	31	0	7	8	15	0	0	30
August	7	0	19	8	13	0	0	40
	14	0	49	16	20	0	0	85
	21	0	40	27	4	0	0	71
	28	0	27	34	0	0	0	61
September	4	0	37	68	11	5	0	121
	11	0	23	69	7	4	0	103
	18	0	6	43	20	8	0	77
	25	0	6	16	4	1	0	27
October	2	0	2	0	0	0	0	2
	9	0	1	5	2	0	0	8
	16	0	0	1	0	0	0	1
	23(c)	-	-	-	-	-	-	-
	30	0	0	0	0	0	0	0
November	6	0	0	0	0	0	0	0
	13	0	0	1	0	0	0	1
	20	0	0	0	0	0	0	0
	27	0	0	1	0	1	0	2
December	4	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0
	18(a)	-	-	-	-	-	-	-
	24(a)	-	-	-	-	-	-	-
	31	0	0	0	0	0	0	0
Total		0	272	405	121	20	0	818

(a) Impingement could not be conducted due to high water conditions.
(b) Impingement could not be conducted due to diving operations in screenhouse.
(c) Impingement could not be conducted due to maintenance.

Table V-I-9 uses the size distribution data from Table V-I-8 and converts it to a standard unit, which is the number of live Corbicula collected/1000 m^2 of traveling screen washed. This was done because the number of intake bays which were in operation was not always constant from one week to the next. Figure V-I-7 presents the data from Table V-I-9 as an average for each month in 1992.

Figure V-I-8 presents monthly totals for Corbicula collected during impingement surveys for the years 1981 through 1992. The Corbicula impingement data for 1992 was comparable to 1990 and 1991. The large peaks observed in 1989 (12,362 in September; 2,263 in October) did not occur in 1992.

Summary

Sampling of sediments in the Unit 2 cooling tower lower reservoir was performed on April 5, 1992 during a scheduled outage, in order to estimate the Corbicula population within that structure. The Corbicula population in the reservoir was estimated to be 11.0 million clams (37.1% dead), based upon the ten ponar dredge samples collected. All clams were removed from the Unit 2 cooling tower basin during this outage.

Population surveys of both BVPS cooling tower reservoirs conducted during scheduled outages (1986 through 1992) have resulted in lower estimates of Corbicula in the Unit 2 tower compared to the Unit 1 cooling tower. This can be attributed to differences in cooling tower design and the faster water currents in the Unit 2 cooling tower reservoir, which decrease sediment deposition.

The river surveys conducted in 1992 demonstrate that Corbicula inhabiting the upper Ohio drainage provide a large number of clams to the BVPS. Corbicula densities in 1992 at sampling stations above and below BVPS were either lower or comparable to densities found in the past two years. Cleaning of the intake bays in the spring and fall by divers resulted in removing many live clams from the inner bays; this along

TABLE V-I-9

SIZE DISTRIBUTION OF Corbicula (Clams/1000m^2) COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1992
BVPS

Date		Live Clam Size Distribution (Number/1000m^2 screen)						Total
		≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Live Clams/1000m^2
January	3	0	0	0	0	0	0	0
	10	0	0	0	5.6	0	0	5.6
	17(c)	-	-	-	-	-	-	-
	24(c)	-	-	-	-	-	-	-
	31	0	0	1.9	0	1.9	0	3.8
February	7	0	0	1.9	0	0	0	1.9
	14	0	0	0	0	0	0	0
	21	0	0	0	3.7	0	0	3.7
	28	0	0	0	0	0	0	0
March	6(c)	-	-	-	-	-	-	-
	13	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0
April	3	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0
	24(b)	-	-	-	-	-	-	-
May	1	0	0	0	1.9	0	0	1.9
	8	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0
	22(c)	-	-	-	-	-	-	-
	29(c)	-	-	-	-	-	-	-
June	5	0	2.8	0	0	0	0	2.8
	12	0	2.8	2.8	0	0	0	5.6
	19	0	26.6	18.2	0	0	0	44.8
	26	0	40.7	86.9	2.8	0	0	130.4

TABLE V-I-9
(Continued)

Date		Live Clam Size Distribution (Number/1000m^2 screen)						Total
		≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Live Clams/1000m^2
July	3	0	1.4	11.2	0	0	0	12.6
	10[(c)]	-	-	-	5.6	-	-	-
	17	0	3.7	35.5	18.7	0	0	57.9
	24	0	0	3.7	15.0	0	0	18.7
	31	0	13.1	15.0	28.0	0	0	56.1
August	7	0	35.5	15.0	24.3	0	0	74.8
	14	0	68.7	22.4	28.0	0	0	119.1
	21	0	56.1	37.9	5.6	0	0	99.6
	28	0	37.9	47.7	0	0	0	85.6
September	4	0	51.9	95.3	15.4	7.0	0	169.6
	11	0	32.2	96.7	9.8	5.6	0	144.3
	18	0	11.2	80.4	37.4	15.0	0	144.0
	25	0	16.8	44.9	11.2	2.8	0	75.7
October	2	0	11.2	0	0	0	0	11.2
	9	0	1.9	9.3	3.7	0	0	14.9
	16	0	0	2.8	0	0	0	2.8
	23[(c)]	-	-	-	-	-	-	-
	30	0	0	0	0	0	0	0
November	6	0	0	0	0	0	0	0
	13	0	0	1.4	0	0	0	1.4
	20	0	0	0	0	0	0	0
	27	0	0	1.4	0	1.4	0	2.8
December	4	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0
	18[(a)]	-	-	-	-	-	-	-
	24[(a)]	-	-	-	-	-	-	-
	31	0	0	0	0	0	0	0
Total		0	414.5	632.3	211.1	33.7	0	1,291.6

[(a)] Impingement could not be conducted due to high water conditions.
[(b)] Impingement could not be conducted due to diving operations in screenhouse.

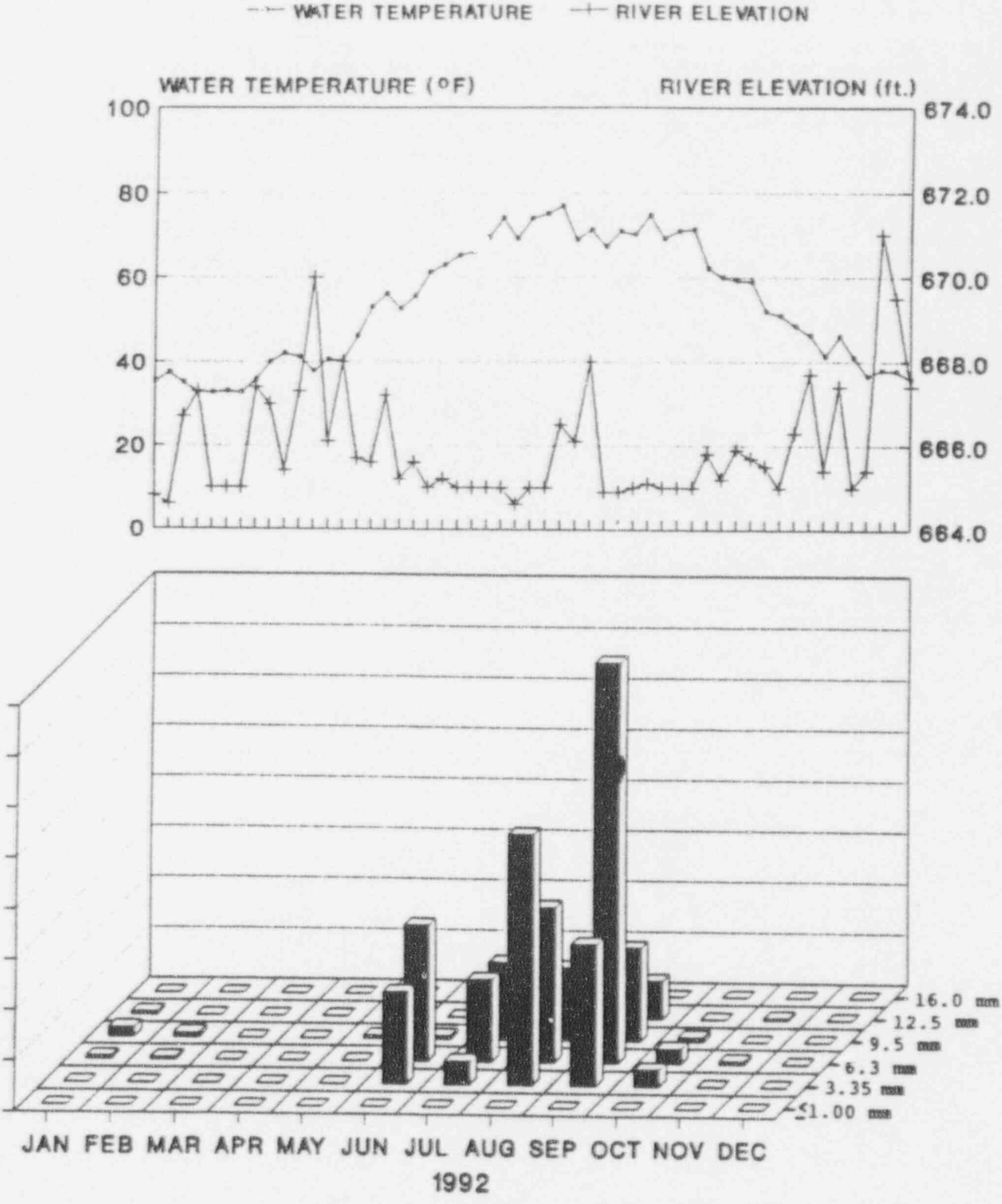
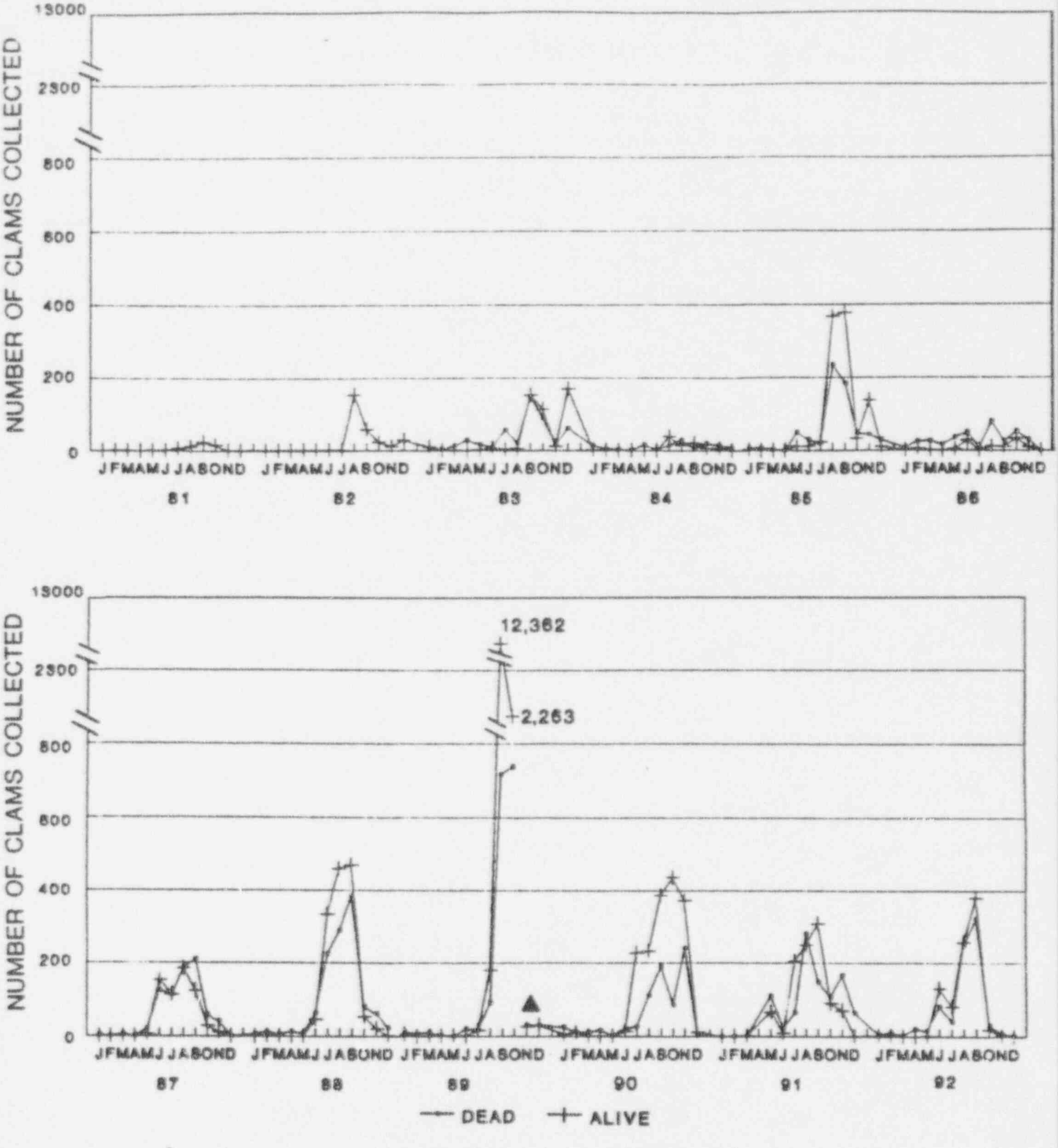


FIGURE V-I-7

SIZE DISTRIBUTION OF *Corbicula* (Number/1000 m^2 Screen)
AVERAGED FOR EACH MONTH FROM WEEKLY IMPINGEMENT SURVEYS, 1992
BVPS



▲ DATA FOR NOVEMBER AND DECEMBER 1989 REPRESENTS ONLY ONE SAMPLING PERIOD FOR EACH MONTH DUE TO EITHER DIVING OR MAINTENANCE.

FIGURE V-I-8

SUMMARY OF Corbicula COLLECTED FROM THE INTAKE STRUCTURE TRAVELING SCREENS DURING IMPINGEMENT SURVEYS, 1981 THROUGH 1992
BVPS

with the weekly impingement data show that adult clams move into the plant with the water currents.

2. Corbicula Larvae Study

Objective

The Corbicula larvae study was designed to collect data on spawning activities in the Ohio River and BVPS Units 1 and 2 cooling towers.

Methods

Specially constructed clam cages (Figure V-I-1) were utilized for this study. Each cage was constructed of 1 mm mesh fiberglass screening secured within a 1 ft^2 durable plastic frame, which contained approximately ten pounds of industrial glass beads (3/8" diameter) to provide ballast and a uniform substrate for the clams. The clam cage mesh size permits only very small clams or pediveliger larvae to enter and colonize the cage.

Larval cages were maintained in the intake structure and cooling towers according to the following procedure. Each month, one empty clam cage was placed in each cooling tower and two cages were placed in the intake structure bays. Each cage was left in place for five months, after which time it was removed and examined for clams. A maximum of five clam cages were maintained in each cooling tower after the initial five-month period. A maximum of ten cages were maintained in the intake structure.

Each clam cage removed after the five-month colonization period was returned to the laboratory where it was washed to obtain the clams which had colonized inside the cage. Corbicula obtained from each cage were rinsed through a series of stacked U.S. standard sieves ranging in mesh size from 16.0 mm to 0.6 mm. Live and dead clams on each sieve were counted and the numbers were recorded. The largest and smallest clams were measured using Vernier calipers to establish a length range for the sample. It should be noted that the size distribution data obtained using the sieves reflects clam width, rather than length.

Results

Monthly totals for Corbicula (live and dead) collected from larval cages placed in the intake structure and cooling towers are presented in Table V-I-10. The length ranges for the Corbicula collected from each cage are also presented in this table.

The larval cage which collected the most Corbicula (434, total of 429 live and 5 dead) was located in the intake structure (sample period August 16, 1991 to January 24, 1992). The largest Corbicula found in the larval cages in 1992 was 19.41 mm in length (intake structure, May 15 to October 23). Table V-I-11 and Figures V-I-9, V-I-10 and V-I-11 present size distribution data for live clams collected in the larval cages. The intake structure graph illustrates size distribution data which represents the average for the two larval cages which were removed each month.

The two intake structure larval cages removed in January 1992 contained moderately high numbers of juvenile Corbicula (average live 252). These clams most likely entered the cages during the late summer spawning period and experienced slight to moderate growth prior to the decrease in ambient river water temperatures (Table V-I-11).

Colonization of intake structure larval cages by juvenile Corbicula from the 1992 Ohio River spawn was initially observed in cages removed on August 13 (Table V-I-10). Live Corbicula densities remained high in the cages removed during the remaining months of 1992. Corbicula removed from intake structure larval cages in September through December were predominantly (75.8%) of the 6.3 and 9.5 mm sieve size categories (Table V-I-11). Larger Corbicula, retained on the 12.5 mm sieve, accounted for only 1.3% of the live clams removed from the larval cages in the months of September through December 1992. River water temperatures in the summer and fall of 1992 (Figure V-I-9) were lower than 1991 readings,

TABLE V-I-10

RESULTS OF THE *Corbicula* LARVAE STUDY IN THE INTAKE STRUCTURE AND UNITS 1 AND 2 COOLING TOWERS, 1992
BVPS

Date		Total Number Clams Collected												Clam Length Range (mm)			
		Intake Structure						Cooling Tower						Intake Structure		Cooling Tower	
		Cage A			Cage B			Unit 1			Unit 2						
Cage Placement	Cage Removal	Alive	Dead	% Mor	Alive	Dead	% Mor	Alive	Dead	% Mor	Alive	Dead	% Mor	Cage A	Cage B	Unit 1	Unit 2
Aug 16	Jan 24	71	9	11.3	429	5	1.2	6	78	92.9	34	6	15.0	1.60-12.85	<1.00-16.45	3.20-9.60	<1.00-7.05
Sep 20	Feb 17	4	4	50.0	39	15	27.8	1	18	94.7	49	3	5.8	1.10-4.70	1.35-7.00	<1.00-3.00	1.60-7.50
Oct 7	Mar 12	0	0	0.0	0	0	0.0	1	23	95.8	0	0	0.0	0	0	<1.00	0
Nov 15	Apr 24(b)	0	1	100.0	0	2	100.0	9	9	50.0	-	-	-	<1.00	<1.00	1.00-2.70	-
Dec 12	May 15(a)	1	0	0.0	0	0	0.0	16	1	5.9	-	-	-	2.00	0	<1.00-4.00	-
Jan 24	Jun 12(a)	2	0	0.0	2	0	0.0	11	6	35.3	-	-	-	<1.00-3.50	<1.00-2.40	3.36-5.64	-
Feb 17	Jul 10(a)	9	0	0.0	7	2	22.2	0	5	100.0	-	-	-	<1.00-6.98	2.02-4.88	3.63-7.06	-
Mar 12	Aug 13(a)	109	39	26.4	139	21	13.1	4	5	55.6	-	-	-	1.97-13.54	3.19-12.28	2.46-3.67	-
Apr 24	Sep 18(a)	150	6	3.8	177	17	8.8	35	28	44.4	-	-	-	3.75-19.00	2.34-17.15	2.00-10.37	-
May 15	Oct 23	221	6	2.6	358	9	2.5	0	17	100.0	76	16	17.4	<1.00-19.41	2.44-17.40	<1.00-12.98	<1.00-12.39
Jun 12	Nov 20	218	0	0.0	332	1	0.3	0	23	100.0	0	133	100.0	<1.00-16.28	2.50-17.42	<1.00-9.36	<1.00-13.22
Jul 10	Dec 18	168	3	1.8	226	39	14.7	0	47	100.0	1	43	97.7	5.00-14.94	3.02-16.42	<1.00-10.57	<1.00-15.34
Aug 13	Jan 22	54	2	3.6	71	6	7.8	30	4	11.8	3	17	85.0	1.88-11.88	2.53-9.77	<1.00-3.19	2.00-7.28
Total		1,007	70		1,780	117		113	264		163	218					

(a) Unit 2 cooling tower cage placement for clam recolonization.

(b) Unit 2 cooling tower cages removed March 12 due to scheduled outage.

TABLE V-I-11

RESULTS OF THE *Corbicula* LARVAE STUDY SIZE DISTRIBUTION IN THE INTAKE STRUCTURE AND UNITS 1 AND 2 COOLING TOWERS, 1992
BVPS

Date	Cage Location	Live Clam Size Distribution Numbers						Total
		≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Live Clams/Cage
January 24	Int[(a)]	86	100	50	16	0	0	252
	1 ct	3	0	3	0	0	0	6
	2 ct	26	8	0	0	0	0	34
February 17	Int	20	2	0	0	0	0	22
	1 ct	1	0	0	0	0	0	1
	2 ct	38	11	0	0	0	0	49
March 12	Int	0	0	0	0	0	0	0
	1 ct	1	0	0	0	0	0	1
	2 ct	0	0	0	0	0	0	0
April 24	Int	0	0	0	0	0	0	0
	1 ct	9	0	0	0	0	0	9
	2 ct[(c)]	-	-	-	-	-	-	-
May 15	Int	1	0	0	0	0	0	1
	1 ct	16	0	0	0	0	0	16
	2 ct[(b)]	-	-	-	-	-	-	-
June 12	Int	2	0	0	0	0	0	2
	1 ct	8	3	0	0	0	0	11
	2 ct[(b)]	-	-	-	-	-	-	-
July 10	Int	6	2	1	0	0	0	9
	1 ct	0	0	0	0	0	0	0
	2 ct[(b)]	-	-	-	-	-	-	-

TABLE V-I-11
(Continued)

Date	Cage Location	Live Clam Size Distribution Numbers ≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Total Live Clams/Cage
August 13	Int	64	57	4	0	0	0	125
	1 ct	4	0	0	0	0	0	4
	2 ct(b)	-	-	-	-	-	-	-
September 18	Int	8	41	97	12	6	0	164
	1 ct	24	10	1	0	0	0	35
	2 ct(b)	-	-	-	-	-	-	-
October 23	Int	8	21	133	121	7	0	290
	1 ct	0	0	0	0	0	0	0
	2 ct	11	1	64	0	0	0	76
November 20	Int	7	53	120	96	0	0	276
	1 ct	0	0	0	0	0	0	0
	2 ct	0	0	0	0	0	0	0
December 18	Int	12	43	98	45	0	0	198
	1 ct	0	0	0	0	0	0	0
	2 ct	0	0	0	1	0	0	1
Total		355	352	571	291	13	0	1,582

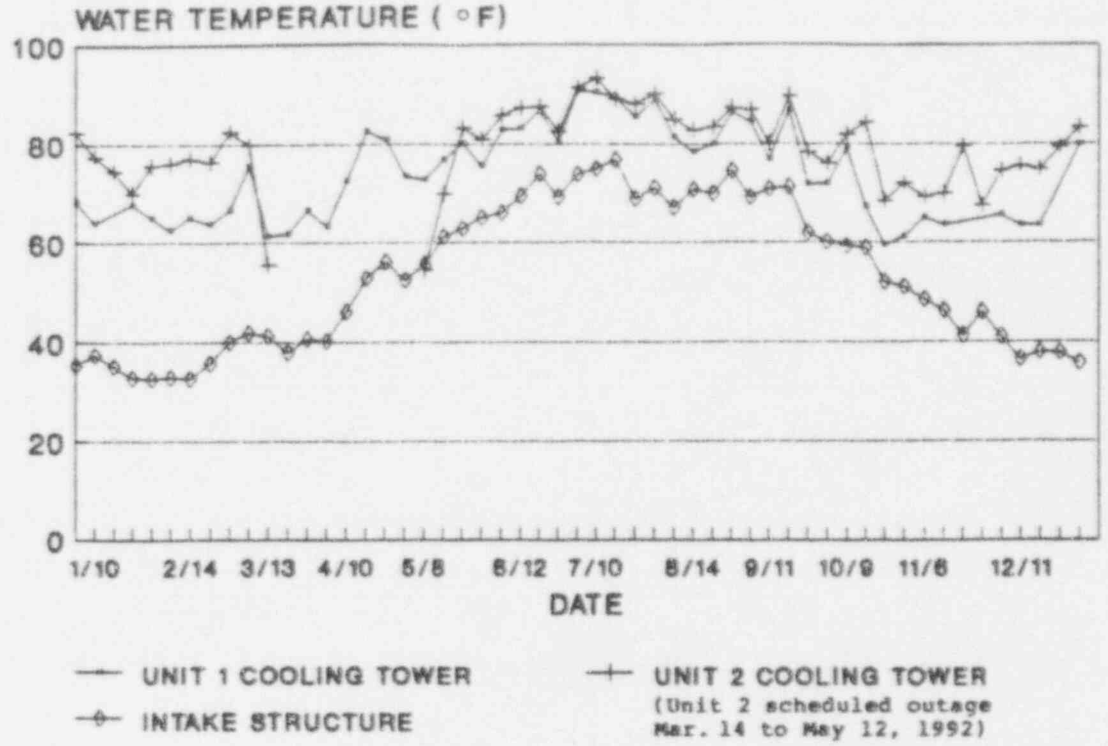
(a) Number of clams represent the average of two cages in the intake structure.

(b) Cage placement for clam recolonization.

(c) Cooling tower cages removed due to scheduled outage.

Symbols

Int - Intake structure
1 ct - Unit 1 cooling tower
2 ct - Unit 2 cooling tower



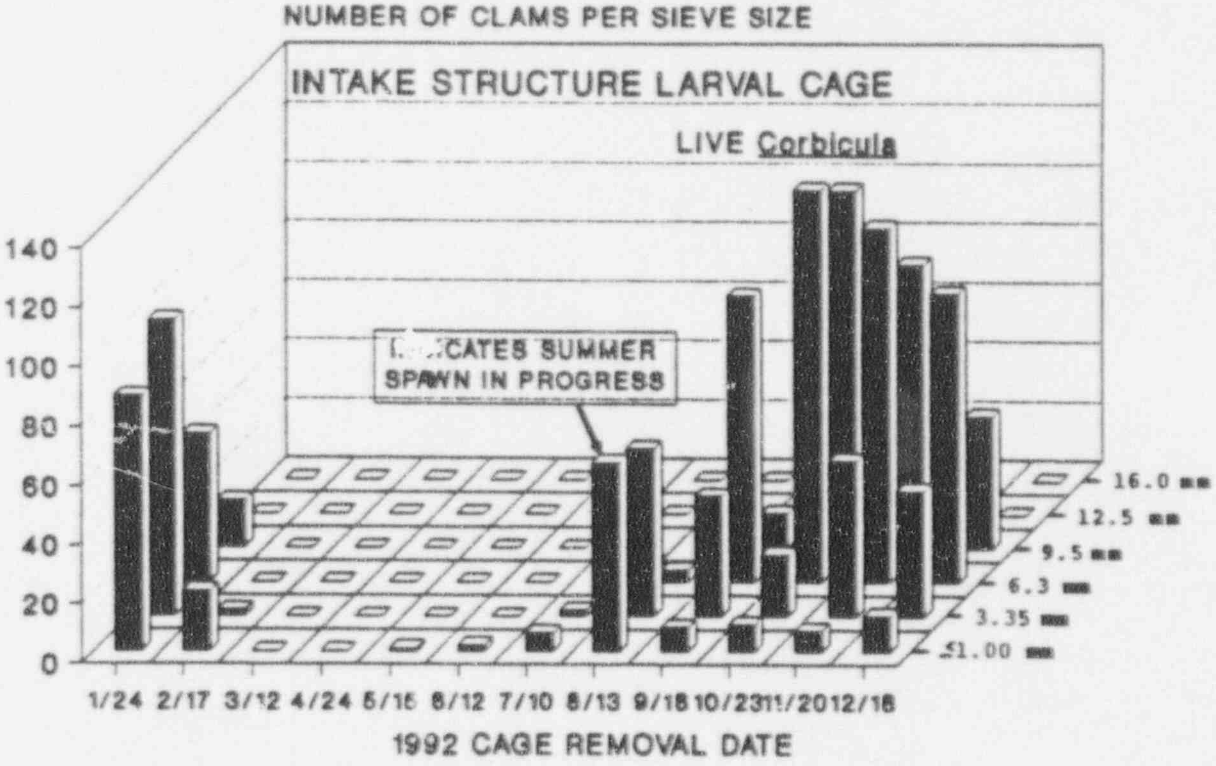


FIGURE V-I-9

RESULTS OF THE Corbicula LARVAE STUDY
SIZE DISTRIBUTION IN THE INTAKE STRUCTURE, 1992
BVPS

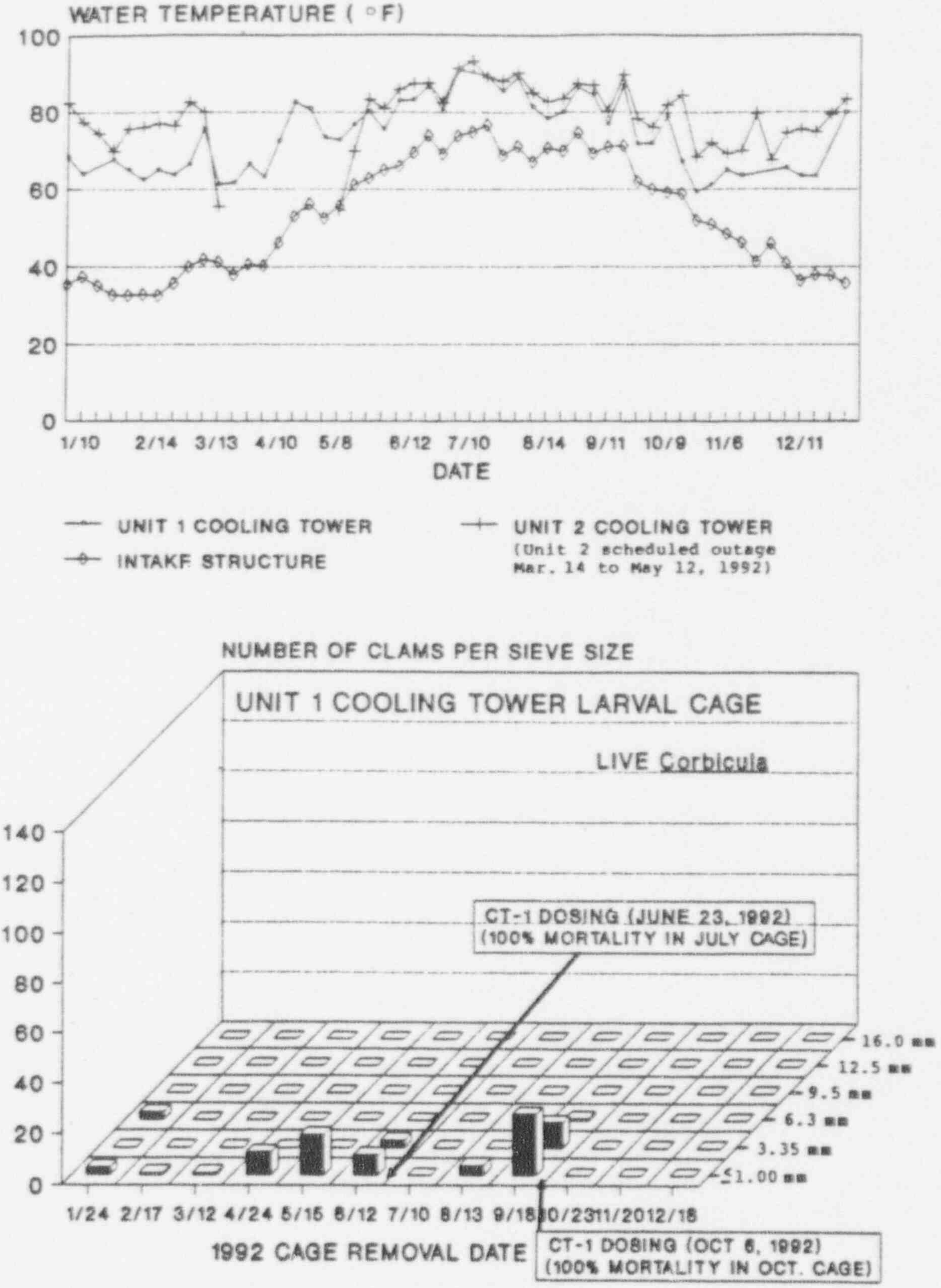


FIGURE V-I-10

RESULTS OF THE Corbicula LARVAE STUDY
SIZE DISTRIBUTION IN THE UNIT 1 COOLING TOWER, 1992
BVPS

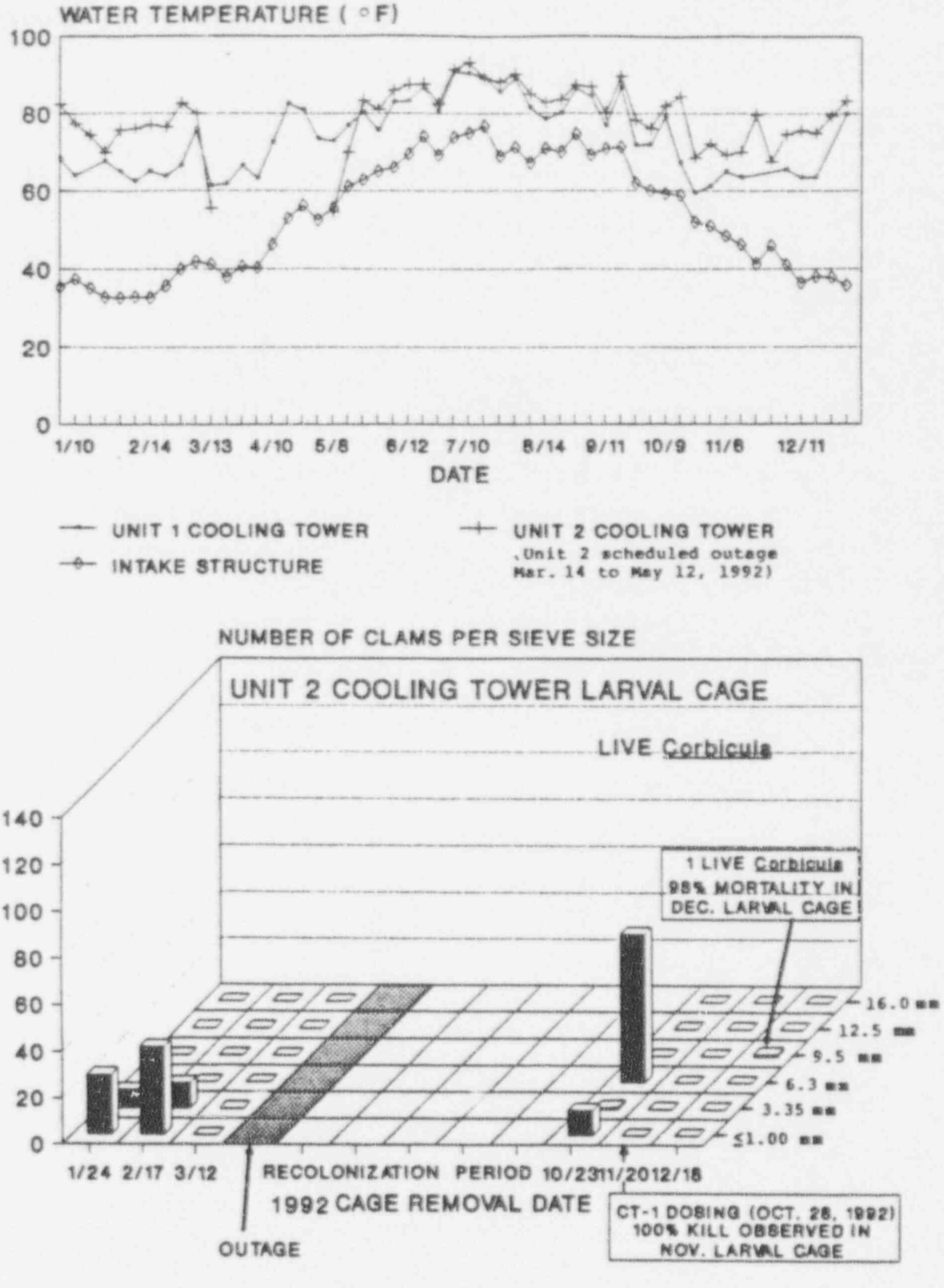


FIGURE V-I-11

RESULTS OF Corbicula LARVAE STUDY
SIZE DISTRIBUTION IN THE UNIT 2 COOLING TOWER, 1992
BVPS

which probably contributed to the decrease in the number of large Corbicula in the intake structure larval cages, compared to 1991.

In 1992, DLC continued its Corbicula Control Program (third year) which included the use of a molluscicide (CT-1) to help prevent the proliferation of Corbicula within the BVPS plant and cooling towers. DLC was granted permission by the Pennsylvania Department of Environmental Resources to use CT-1 in the BVPS Units 1 and 2 river water systems. The larval cages housed in the Unit 1 cooling tower were left in place during the CT-1 dosings on June 23 and October 6, 1992. The Unit 1 cooling tower larval cage removed on July 10 exhibited 100% mortality (5 dead Corbicula). Mortality was also 100% (17 dead) in the larval cage removed from this structure on October 23, 1992, subsequent to the second dosing of Unit 1.

The Corbicula larvae study in the Unit 2 cooling tower was affected by a scheduled outage in April (Figure V-I-11). The larval cage removed in October following the five-month recolonization period contained 76 live Corbicula, most of which were retained on the 6.3 mm mesh size sieve.

The Unit 2 river water system was treated with CT-1 on October 28, 1992 as part of the Corbicula Control Program. The larval cages housed in the Unit 2 cooling tower were left in place during the CT-1 dosing. The larval cage removed one month after dosing (November 20) had 100% mortality (133 dead Corbicula). Recolonization of Unit 2 cooling tower larval cages exposed to CT-1 was not noted in the cage removed in December (Figure V-I-11).

Summary

Corbicula, which colonized the larval cages housed in the BVPS intake structure during the summer of 1992, exhibited rapid growth during the five-month colonization period. Sixty-nine percent of the live Corbicula removed from the intake structure larval cages in August through December were retained on the 6.3 mm and 9.5 mm mesh size sieves during the size analysis. Only 1.2% were retained on the 12.5 mm mesh sieve and none were retained on the 16.0 mm sieve. Elevated river water temperatures through the summer probably contributed to the rapid growth of these clams, in conjunction with an adequate food source for these filter feeders.

The use of CT-1 on June 23 and October 6, 1992 in the Unit 1 river water system produced 100% mortality in the larval cages removed from the Unit 1 cooling tower on July 10 and October 23, 1992.

The Corbicula larvae study in the Unit 2 cooling tower was affected by a scheduled outage in April. The larval cage removed in October following the five-month recolonization period contained 76 live Corbicula, most within the 6.3 mm sieve size category.

The use of CT-1 in the Unit 2 river water system on October 28, 1992 produced 100% mortality (133 dead Corbicula) in the larval cage removed approximately one month after dosing (November 20). Recolonization of Unit 2 larval cages exposed to the CT-1 was not observed in the final cage removed in 1992 (December).

3. Corbicula Growth Study

Objective

The growth study examines the maximum growth attained by Corbicula which colonize the larval cages placed in the BVPS intake structure and cooling towers.

Methods

Empty larval cages were placed in the intake structure and Units 1 and 2 cooling towers each month to determine the maximum growth of invading larvae over a five-month period of colonization. The length and width of the largest Corbicula found in each larval cage removed after the five-month colonization period had been measured to the nearest 0.05 mm using manual Vernier calipers in 1988 through 1991. In 1992, digital

Vernier calipers were used to measure clams to the nearest 0.01 mm. The larvae study began in August 1988 (initial cage placement) and has continued through December 1992 (cage removal after July 1992 placement), resulting in a five-month colonization period per evaluation.

Results

Table V-I-12 lists length data for the largest Corbicula found in each larval cage removed from the BVPS intake structure and cooling towers over the past five years. The largest Corbicula ever collected from a larval cage attained a length of 25.50 mm (intake structure, sample period May to October 1988).

The largest Corbicula collected to date from a Unit 1 cooling tower larval cage measured 17.90 mm in length (Table V-I-12). The maximum length obtained to date for a Corbicula from a Unit 2 cooling tower larval cage was 19.50 mm (sample period March to August 1991), which represents a 3.75 mm increase from the previous maximum length of 15.75 mm (May to October 1988).

Summary

Corbicula larvae which colonized the intake structure larval cages during the summer and early fall have shown rapid growth and reached larger sizes than those entering the cages during the winter and early spring. Corbicula removed from the Units 1 and 2 cooling tower larval cages generally have not attained the maximum sizes observed for clams removed from the intake structure cages for the same period. This may be due to chlorination in the cooling towers.

J. ZEBRA MUSSEL MONITORING PROGRAM

Introduction

Zebra mussels (Dreissena polymorpha) are exotic freshwater mollusks that look similar to marine barnacles, and have brown shells marked with

TABLE V-I-12

MAXIMUM *Corbicula* GROWTH LENGTH ACHIEVED IN A FIVE-MONTH PERIOD SUMMARIZED FROM THE LARVAE STUDY CAGE COLLECTIONS 1988 THROUGH 1992 BVPS

Date		Maximum Clam Growth Length (mm)														
		Intake Structure					Unit 1 Cooling Tower					Unit 2 Cooling Tower				
Cage Placement	Cage Removal	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992
August	January	-	18.10	13.10	12.90	16.45	-	7.95	-	-	9.60	-	3.65	12.70	-	3.05
September	February	-	9.85	4.50	4.75	7.00	-	9.70	-	-	3.00	-	0	8.40	-	7.50
October	March	-	4.00	1.00	2.50	0	-	9.30	-	-	1.00	-	5.10	6.20	-	0
November	April	-	8.40	0	0	1.00	-	4.35	-	0	2.70	-	-	4.70	0	-
December	May	-	7.30	0	0	2.00	-	3.10	-	-	4.00	-	-	7.00	0	-
January	June	6.70	0	5.70	6.15	3.50	0	5.10	6.55	-	5.64	0	-	11.50	8.80	-
February	July	16.00	7.85	13.25	15.70	6.98	9.55	9.30	9.20	-	7.06	9.25	-	10.65	15.75	-
March	August	21.15	17.20	17.20	20.65	13.54	16.00	13.40	10.75	-	3.67	12.75	-	12.25	19.50	-
April	September	23.90	19.20	17.10	25.45	19.00	15.00	13.20	14.70	-	10.37	13.10	-	-	0	-
May	October	25.50	20.10	19.30	22.50	19.41	17.30	-	16.30	-	12.98	15.75	11.60	-	7.15	12.39
June	November	22.60	14.90	18.30	21.30	17.42	17.90	-	15.20	17.50	9.36	13.45	11.70	-	3.90	13.22
July	December	21.00	15.45	16.90	20.50	16.42	16.50	-	-	16.30	10.57	9.70	13.10	-	7.40	15.34

(-) No data was collected due to plant operations.

alternating zig-zag yellowish bands. They are believed to have been introduced into North America through the ballast water of ocean-going cargo vessels probably from Eastern Europe. They first appeared in Lake St. Clair in 1987 and have spread rapidly to other Great Lakes and have begun to infestate the lower Ohio River in recent years. Zebra mussels were found at the Willow Island Lock and Dam at Mile Point 162.0 of the Ohio River in September 1992.

Adult zebra mussels can live up to five years and grow to two inches in length. Recent research suggests that each female may be capable of producing one million microscopic (veliger larvae) offspring per year, that can easily pass through water intake screens. They use very adhesive hairlike (byssus) threads to attach themselves to any hard surfaces (e.g., boat hauls, intake pipes and other mussels). Transportation of these organisms between water bodies is accomplished in part by boats having adult mussels attach to their hauls or larvae in their live wells and/or bilges. BVPS, in anticipation of this possible infestation and responding to NRC Notice No. 89-76 (Biofouling Agent-Zebra Mussel, 21 November 1989), instituted a Zebra Mussel Monitoring Program in January 1990.

The Zebra Mussel Monitoring Program includes the Ohio River and the circulating river water system of the BVPS (intake structure and cooling towers). This report describes this Monitoring Program and the results obtained during field and plant surveys conducted through 1992.

1. Monitoring

Objectives

The objectives of the Monitoring Program were:

(1) to identify if zebra mussels are in the Ohio River adjacent to BVPS and provide an early warning to operations personnel as to their possible infestation.

(2) to provide life history data as to when the larvae are mobile in the Ohio River and provide insights as to their vulnerability to potential treatments.

(3) to provide data as to their growth rates under different water temperatures and provide estimates as to the time it requires for these mussels to reach clogging size.

Methods

(Intake Structure)

The Pennsylvania Department of Environmental Resources (DER) developed a formal Zebra Mussel Monitoring Program in 1992. DER biological sampling protocols involve the deployment of artificial substrates in the water column to detect colonization by zebra mussel larvae.

The DER zebra mussel sampler measures 10" (L) x 6.5" (W) x 7" (D) and holds six PVC plates (each 6" x 6") (see Figure V-I-1). The samplers are deployed at a depth of 2 m or at mid-depth for waters less than 2 m deep. Two plates are pulled from each sampler every two weeks for microscopic examination. The plates that are pulled for examination must be the pair that have been in the sampler (water column) the longest.

BVPS began participating in the DER Zebra Mussel Monitoring Program in April 1992. Two DER zebra mussel samplers were deployed in separate bays of the BVPS intake structure at 2 m depths. Two plates from each sampler were pulled every two weeks (since April) for examination using a dissecting microscope (50X magnification). The results of each examination were submitted to the DER on the standard data forms which they provided.

In addition to the DER artificial substrates specifically designated for zebra mussel surveillance, the <u>Corbicula</u> larval clam cages were also inspected for zebra mussel colonization (Figure V-I-1). Experience with collecting these mussels on the outside of identical cages used in Lake Erie during the summer of 1988 has demonstrated the suitability of these substrates as good monitoring devices.

Two other surveillance techniques used in the intake structure were: 1) the weekly impingement monitoring program, and 2) observations of the divers during regularly scheduled cleanout operations.

(Cooling Towers)

The cooling towers were monitored for zebra mussels using three techniques· 1) checking the outsides and contents of the Corbicula larval clam cages that were already in place, 2) checking for zebra mussels as part of the Corbicula population survey conducted during regularly scheduled outages (Unit 2 in 1992), and 3) checking the walls of both reservoirs.

(Ohio River Shoreline)

Each week, in conjunction with the regular impingement survey, the BVPS discharge area was observed for fish, waterfowl and beaver activities. In 1992, the discharge area, along with the barge slip next to the Unit 1 cooling tower, were designated as observation zones for zebra mussels. The barge slip wall was sampled monthly using a scraper (with net attached). Approximately 12 square feet of the barge slip wall was scraped each month. The pilings and rocks were also checked for colonization since these organisms will attach to any hard surface.

(Communications Network)

In 1992 there was an informal communication network established for zebra mussel movements within the Ohio River. This included an exchange of information between the U.S. Army Corps of Engineers, ORSANCO, universities, industrial water users, and other electric utilities. BVPS is dedicated to cooperation in this communications program and the formal program developed by DER in 1992.

Results

The results of the 1992 Zebra Mussel Monitoring Program have revealed that no zebra mussels were collected in the plant or in the Ohio River adjacent to BVPS as part of any sampling activity. In the summer of 1992, there were confirmed reports of zebra mussel findings in the lower Ohio River (Parkersburg, West Virginia, M.P. 184.5 and Willow Island Lock and Dam M.P. 162.0). In view of the rapid expansion of these organisms within the Great Lakes and these most recent sightings, BVPS is vigilant to their potential arrival in the upper Ohio River.

Summary

The zebra mussel is an exotic freshwater mollusk that is believed to have been introduced into Lake St. Clair in 1987 via ballast water of ocean-going cargo vessels. Since then they have spread rapidly to the Great Lakes and are infesting riverine systems in the United States.

Due to the proximity of the Ohio River to Lake Erie, BVPS initiated a Zebra Mussel Monitoring Program in January 1990. The Zebra Mussel Monitoring Program in 1992 utilized a new artificial substrate sampler developed by the DER, which provides a large surface area for the mussel larvae to attach. In 1992, as the result of plant and river sampling, no zebra mussels have been detected.

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APPENDIX A

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
TERRESTRIAL MONITORING PROGRAM
1992

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION

TERRESTRIAL MONITORING PROGRAM

1992

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Philippe A. Thibault
Terrestrial Environmental Specialists, Inc.
Phoenix, New York

Report Reviewed and Approved by

J. Wayne McIntire

Director of Safety and Environmental Services
Duquesne Light Company
Shippingport, PA 15077

TABLE OF CONTENTS

TERRESTRIAL MONITORING PROGRAM

A. INTRODUCTION

The 1992 Terrestrial Monitoring Program at the BVPS consisted of a survey to detect vegetation stress using aerial color infrared (CIR) photographs, with subsequent field reconnaissance to determine the cause and extent of any stress detected by remote sensing.

Vegetation stress attributable to natural causes such as disease, insect infestations, weather variations, changes in moisture regimes, and human-caused impacts can be detected by experienced photointerpreters using either true color or CIR film. Healthy vegetation reflects electromagnetic radiation in the visible green (500 - 600 nanometers) and invisible near infrared (700 - 1,000 nanometers) portions of the electromagnetic spectrum (Hilborn, 1978). The reflectance from healthy foliage is higher for radiation in the near infrared spectral range than for visible green light. Due to this differential spectral reflectance, reductions in plant vigor that result in changes in reflectivity and the rendition of foliage are most readily apparent when using film sensitive to near infrared wavelengths (Shipley, et al., 1980).

The use of aerial CIR photographs allows large areas of vegetation to be remotely sensed to delineate areas that exhibit stress through reduced plant vigor. Interpretation of the photographs in the laboratory further reduces time and effort by directing field crews to specific locations where the causes of that stress can be determined (Hilborn, 1978). In addition, the use of yellow filters with CIR film decreases the absorption of blue wavelengths, thus reducing the effects of haze that often obscure detail and clarity in true color photographs.

B. AERIAL COLOR INFRARED PHOTOGRAPHY

Objectives

The objectives of this study were to use aerial CIR imagery and ground surveys to evaluate vegetation stress in the vicinity of the BVPS cooling towers and to determine if drift from the towers is adversely affecting vegetation communities in the terrestrial ecosystem surrounding BVPS (Environmental Technical Specifications, Reference 3.1.3.9).

Methods

(1) Aerial Photography

As directed by the Environmental Technical Specifications, an area of 50 square miles comprising a square approximately 7.1 miles on a side and centered on the BVPS cooling towers was photographed and ground-truthed during the 1992 Terrestrial

Monitoring Program. The photomission was scheduled for the period of July 1 through August 31, 1992, to coincide as close as possible to the dates of previous missions. This period falls within the active growing season which ensures maximum contrast between stressed and healthy vegetation. Climatic conditions and haze prevented the mission from being flown until August 6, 1992. The Pittsburgh Approach Control reported air traffic constraints and requested the August 6 flight be terminated. As a consequence, flight lines 1 and 2 were flown on August 21, 1992.

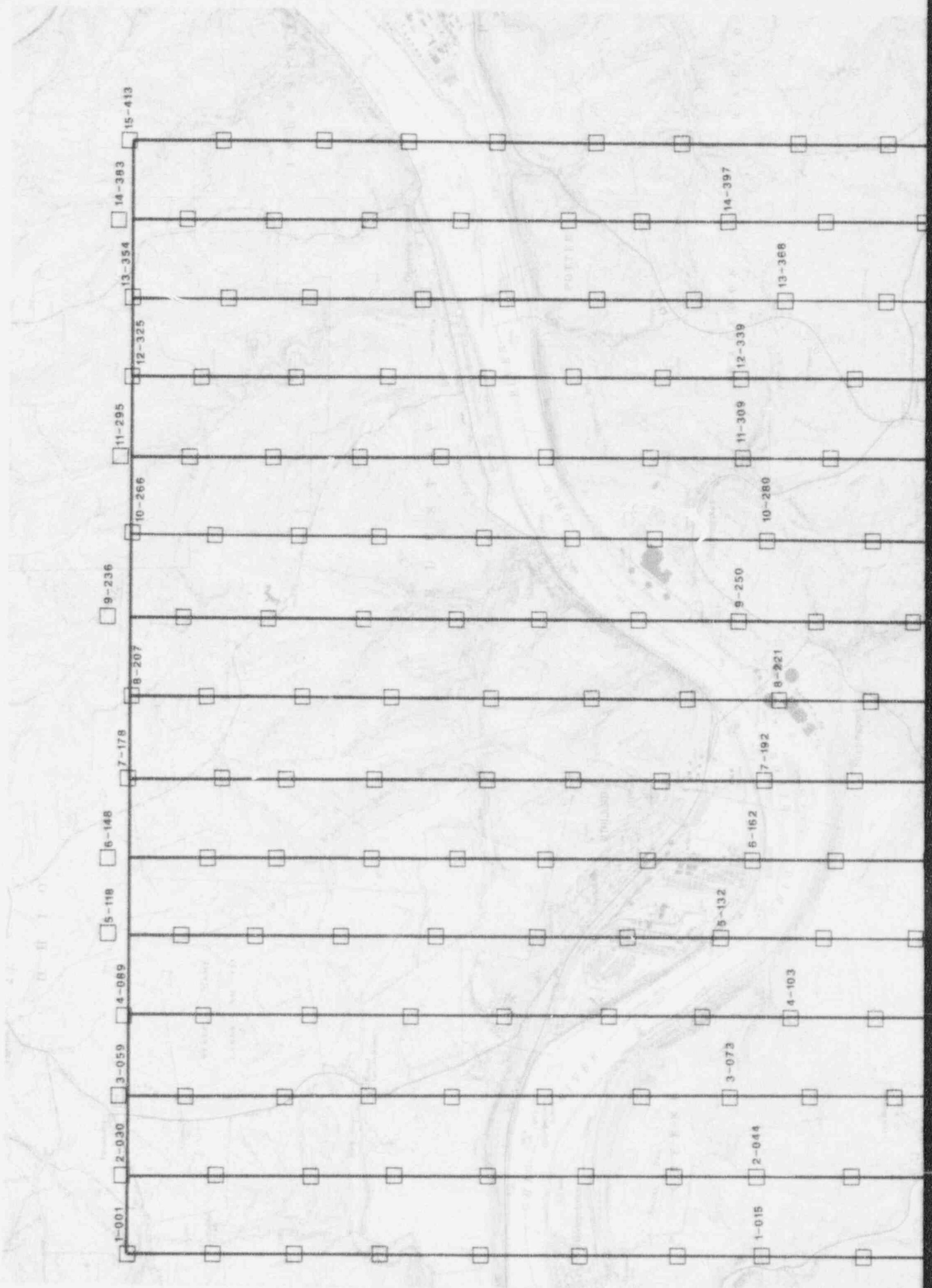
The flight conducted on August 6, 1992 was flown between 1001 and 1123 hours, and the flight conducted on August 21, 1992 was flown between 1423 and 1430 Eastern Standard Time; all flight lines were oriented in a north-south direction. To provide stereographic coverage, the photographs were taken with a 60% overlap in line of flight and a 30% sidelap between flight lines. All lines were flown at an altitude of 2,400 feet above mean ground elevation. The photomission index is shown as Figure VI-B-1. Nearly all photographs were free of cloud shadows, and processing methods and conditions were standardized throughout the project.

A flight log was kept in accordance with the Environmental Technical Specifications. The camera used was a Zeiss Jena LMK 15/2323, and the film was Kodak Aerochrome 2443IR. Other information in the flight log included the camera and lens serial numbers, film and lot number, filter type, altitude, and dates and times of the flight lines (see Table VI-B-1). The data from the flight log are provided as Exhibit VI-B-1.

(2) <u>Aerial Photograph Interpretation</u>

The photographs were scanned in the laboratory for quality of color, resolution, scale, and clarity. Obvious changes in color tone, pattern, or texture that might have indicated possible vegetation stress were delineated on acetate overlays on the photographs and transferred to a base map. Areas with the greatest potential for being affected by drift from cooling towers were designated for exhaustive ground truthing. Equipment used included:

- Artograph DB300, Opaque Projector
- Mirror Stereoscope, Gordon Enterprises, Inc.
- Dissecting Scope, Bausch & Lomb
- Magnifying Reading Glass
- Illuminated Film Viewing Table



1-001
2-030
3-059
4-089
5-118
6-148
7-178
8-207
9-236
10-266
11-295
12-325
13-354
14-383
15-413
1-015
2-044
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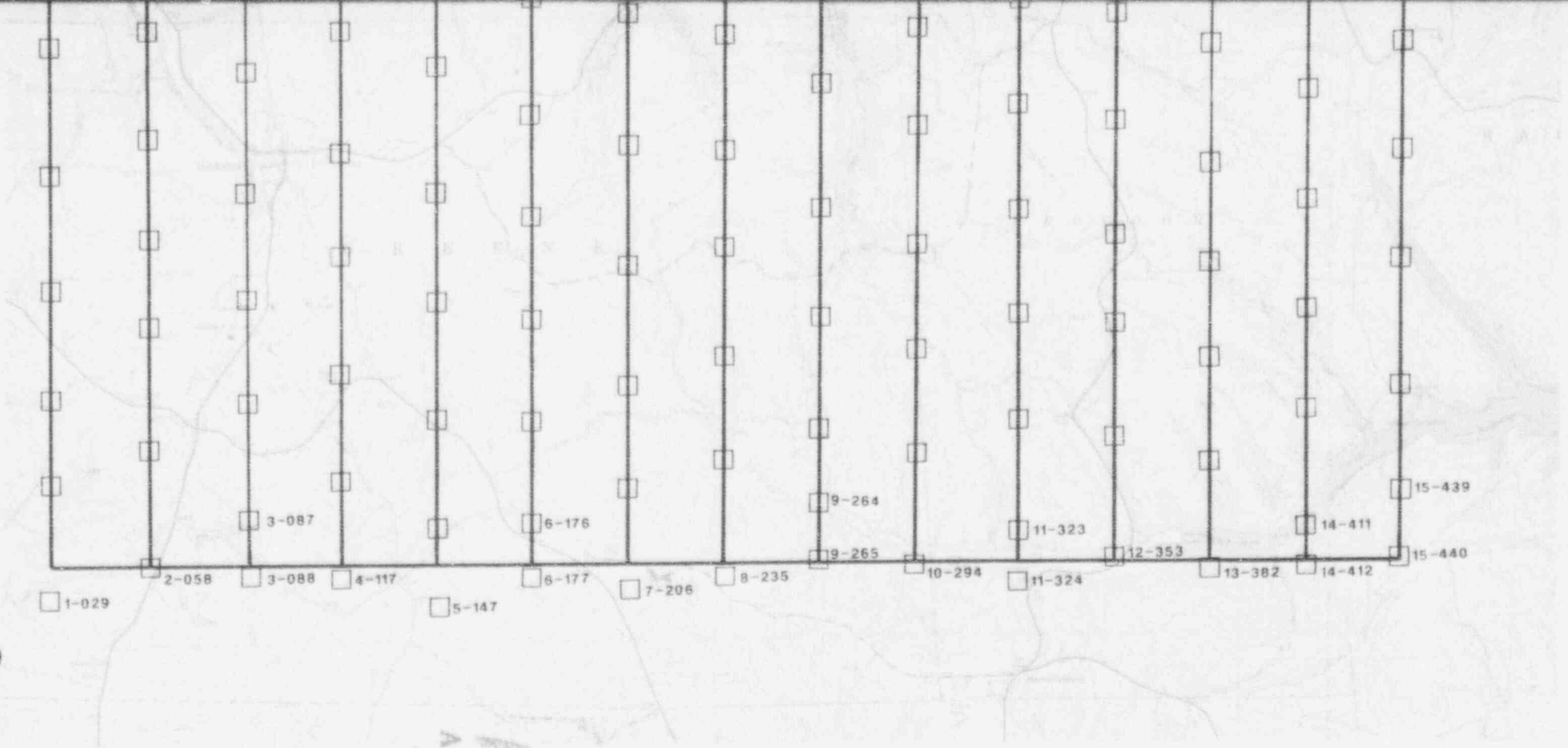
11-309
12-339
13-368
14-397



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☐ Center Point Locations for Infrared Photos

1-001
9-264 Flight Line - Photograph Frame Number

FIGURE VI-B-1

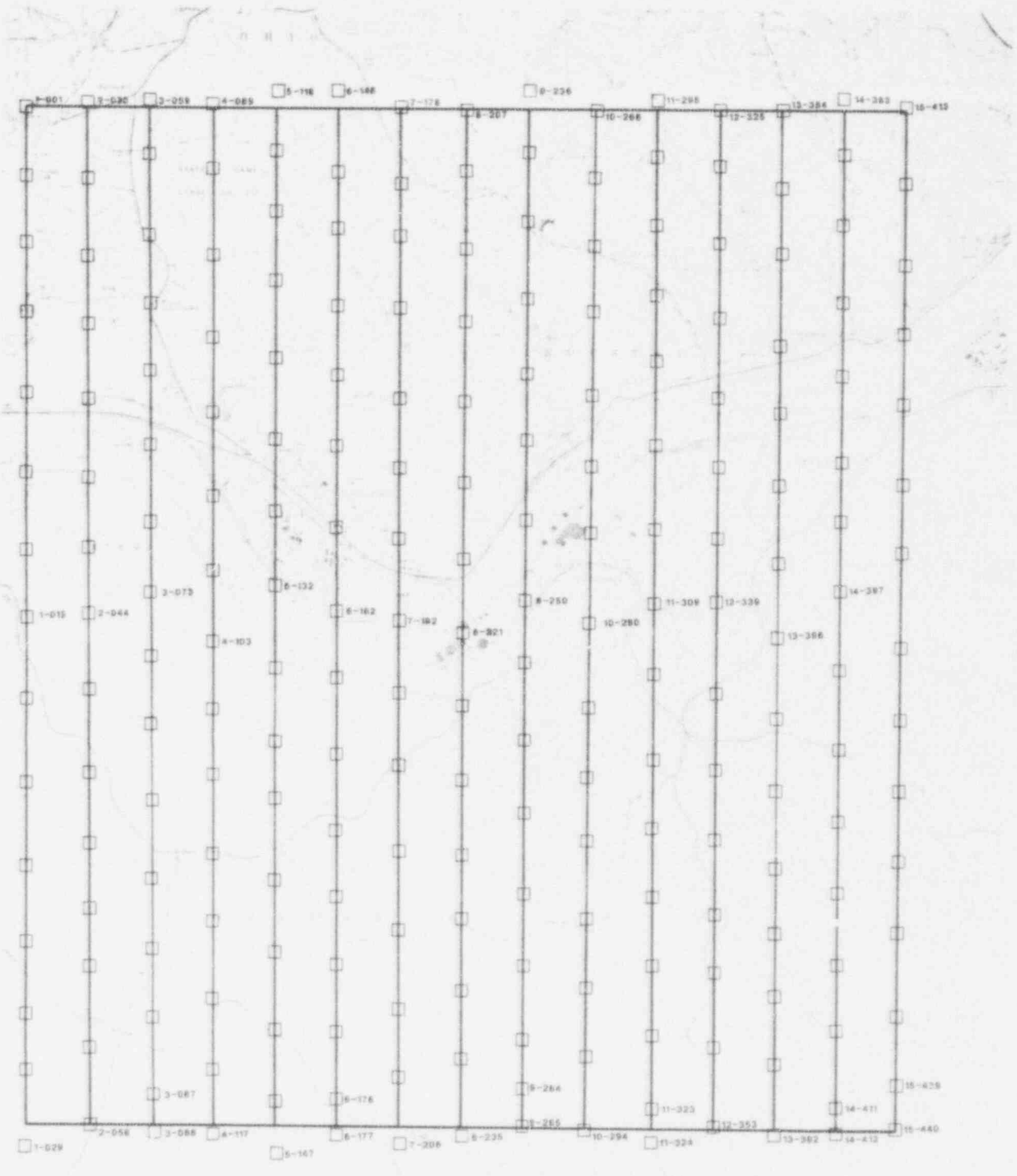
INDEX TO PHOTOGRAPHY

BEAVER VALLEY POWER STATION AND VICINITY

AUGUST 6 & 27, 1992

0 4000 8000 12000 ft

Approximate Scale



☐ Center Point Locations for Infrared Photos

1-001
9-264 Flight Line - Photograph Frame Number

FIGURE VI-B-1

INDEX TO PHOTOGRAPHY

BEAVER VALLEY POWER STATION
AND VICINITY

AUGUST 6 & 27, 1992

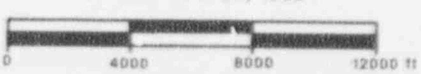


Table VI-B-1

SUMMARY OF THE AERIAL PHOTOMISSION FLOWN IN THE VICINITY OF THE BVPS, 1992

Specifications

Camera:	Zeiss Jena LMK 15/2323
Lens:	Zeiss Jena Lemegon PI/C
Focal Length:	152.311 mm
Shutter Speed:	1/125
F. Stop:	4.5
Filter:	Yellow
Film Type:	Kodak Aerochome 2443IR
Scale:	1" = 400'

Photomissions

Date:	August 6, 1992
Time:	1001-1123 Eastern Standard Time
Weather:	Clear Visibility 10 miles
Altitude:	2,400 feet above MGL for all lines
Date:	August 21, 1992
Time:	1423-1430 Eastern Standard Time
Weather:	Clear Visibility 15 miles
Altitude:	2,400 feet above MGL for all lines

Time lines were flown [1]

Date	Line	Start	End
8-6-92	3	1121	1123
	4	1116	1118
	5	1107	1110
	6	1102	1105
	7	1056	1059
	8	1051	1053
	9	1041	1042
	10	1036	1039
	11	1030	1033
	12	1025	1028
	13	1020	1022
	14	1007	1009
	15	1001	1004
8-21-88	1	1423	1426
	2	1427	1430

[1] Time shown are for exposures utilized in this study

Exhibit VI-B-1
R.M. KEDDAL AND ASSOCIATES, INC.
FLIGHT REPORT

Crew: Barden (Pilot) Mekinda (Operator) Date 8/6/92 Roll #: 1

Film Type: Kodak Aerochrome 2443IR Film Lot # 05/05 Weather: Clear Altitude: 2,400

Shutter Speed: 1/125 F. Stop: 4.5 Filter: 507621A - Yellow-B

Camera: Zeiss Jena LMK 15/2323 Magazine: 266776B Lens: Zeiss Jena Lemegon PI/C

Job: 53749 Location: Beaver County, PA CFL: 152.311

Exposures

LINE	DIR	SHOT	USED	PHOTO NO.	REMARKS
		000-002	-	-	Test
15	S	003-033	006-033	413-440	
14	N	034-067	037-066	383-412	
13	S	068-099	071-099	354-382	
12	N	100-132	103-131	325-353	
11	S	133-165	135-164	295-324	
10	N	166-198	169-197	266-294	
9	S	199-226	201-226	236-260	

Exhibit VI-B-1 (Con't)

R.M. KEDDAL AND ASSOCIATES, INC.
FLIGHT REPORT

Crew: Barden (Pilot) Mekinda (Operator) Date 8/6/92 Roll #: 2

Film Type: Kodak Aerochrome 2443IR Film Lot # 05/06 Weather: Clear Altitude: 2,400

Shutter Speed: 1/125 F. Stop: 4.5 Filter: 507621A - Yellow-B

Camera: Zeiss Jena LMK 15/2323 Magazine: 266776B Lens: Zeiss Jena Lemegon PI/C

Job: 53749 Location: Beaver County, PA CFL: 152.311

Exposures

LINE	DIR	SHOT	USED	PHOTO NO.	REMARKS
		000-002	-	-	Test
9	S	003-011	006-011	261-265	
8	N	012-043	014-042	227-235	
7	S	044-076	047-075	178-206	
6	N	077-107	079-108	148-177	
5	S	108-140	110-139	118-147	
4	N	141-144	-	-	
4	N	145-177	148-176	089-117	
3	S	178-210	180-209	059-088	
		211-214	-	-	Runoff

Exhibit VI-B-1 (Con't)

R.M. KEDDAL AND ASSOCIATES, INC.
FLIGHT REPORT

Crew: Barden (Pilot) Mekinda (Operator) Date 8/21/92 Roll #: 1

Film Type: Kodak Aerochrome 2443IR Film Lot # 05/07 Weather: Clear Altitude: 2,400

Shutter Speed: 1/125 F. Stop: 4.5 Filter: Yellow

Camera: Zeiss Jena LMK 15/2323 Magazine: 266571A Lens: Zeiss Jena Lemegon PI/C

Job: 53749 Location: Beaver County, PA CFL: 152.311

Exposures

LINE	DIR	SHOT	USED	PHOTO NO.	REMARKS
		000-003	-	-	Test
1	S	004-034	006-034	1-29	
2	N	035-067	038-066	30-58	
		068-071	-	-	Test

(3) Field Reconnaissance

Field surveys and observations of the BVPS and vicinity were conducted from September 21 through 25 to verify the photointerpreted results that had indicated areas of stressed vegetation. The 9" by 9" CIR prints were used in conjunction with the photoindex (Figure VI-B-1) and standard USGS 7.5-minute topographic maps to construct preliminary base maps and to locate areas suspected of containing stressed vegetation. Where possible, vegetation was closely examined to determine the cause of stress. Where areas to be surveyed were inaccessible due to terrain difficulties or private property, binoculars were used to aid characterization. During field survey, the location, extent, and severity of stressed areas were documented.

(4) Vegetation Mapping

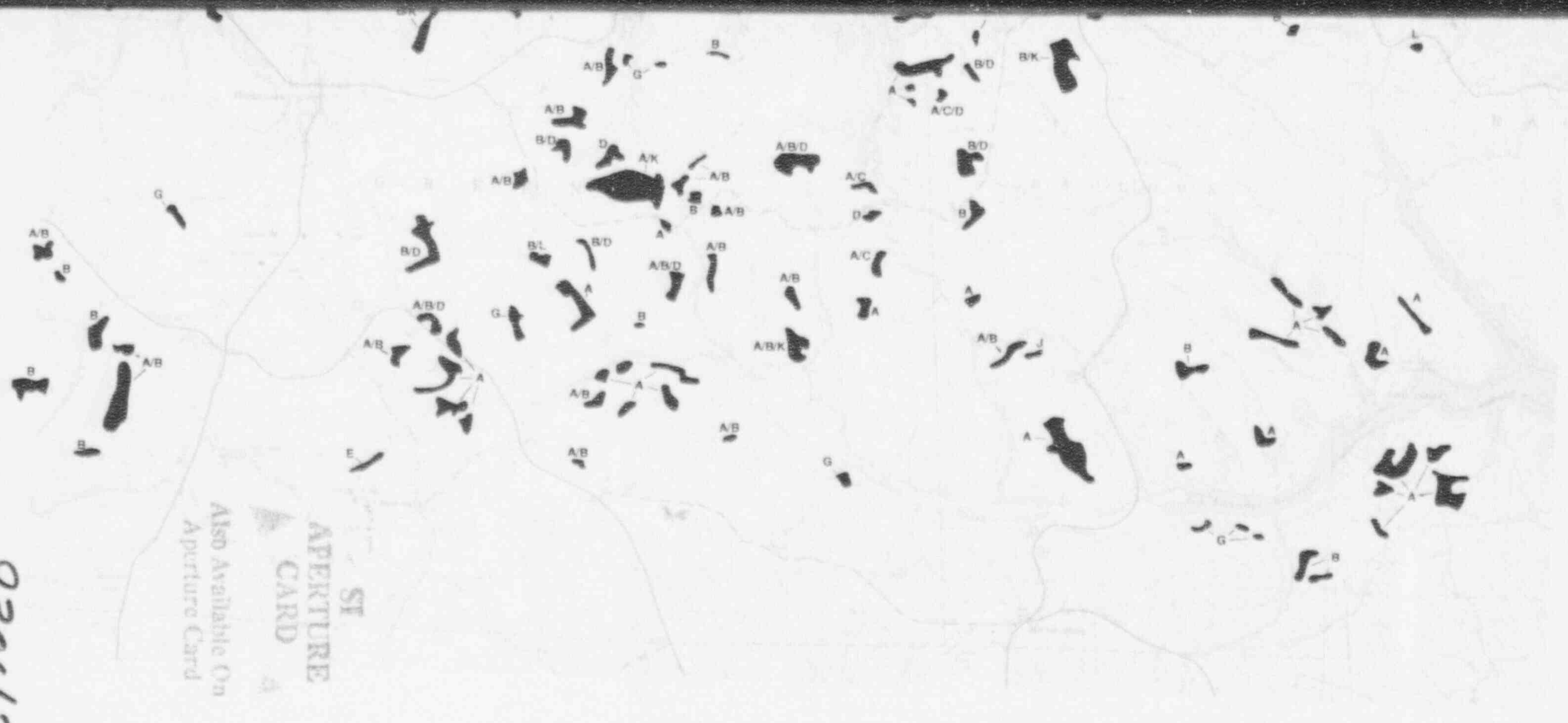
A final map indicating the location and distribution of vegetation stress was constructed from the base maps and results of the field survey (Figure VI-B-2). This map can be compared with similar maps from previous BVPS vegetation monitoring results to note trends in type, location, and extent of vegetation stress.

Results

Exposure of the 1992 photographs was generally good as compared to the results of the 1990 photographs which were somewhat underexposed. Color saturation was generally good on all frames. Since all the 1992 photos were taken in the late morning-early afternoon, there were no problems experienced with shadowing.

As shown on Figure VI-B-2, many areas contained significantly stressed vegetation. These areas are identified by letters on the map, with each letter designating a particular stress type. Primary causal factors of identified stress included insect induced stress, disease, decadence, poor drainage, overcrowding, erosion, and logging activity. Due to the inaccessibility of several areas where vegetation stress was detected, the causal factor had to be labelled as unidentified unless the cause of the stress could be accurately discerned from the photographs (e.g., logging or construction activity).

Twelve major stress types distributed over 402 individual areas were identified based on the field reconnaissance of these areas. A number of the areas contained more than one of the identified stress causal agents, thus, the total number of occurrences of the stress types identified was 546. These areas ranged in size from small clumps of trees less than an acre in extent to relatively large blocks of woodland. Numerous individual and small stands of trees were stressed throughout the area under investigation, but only larger, severely stressed groupings were delineated and visited in the field.



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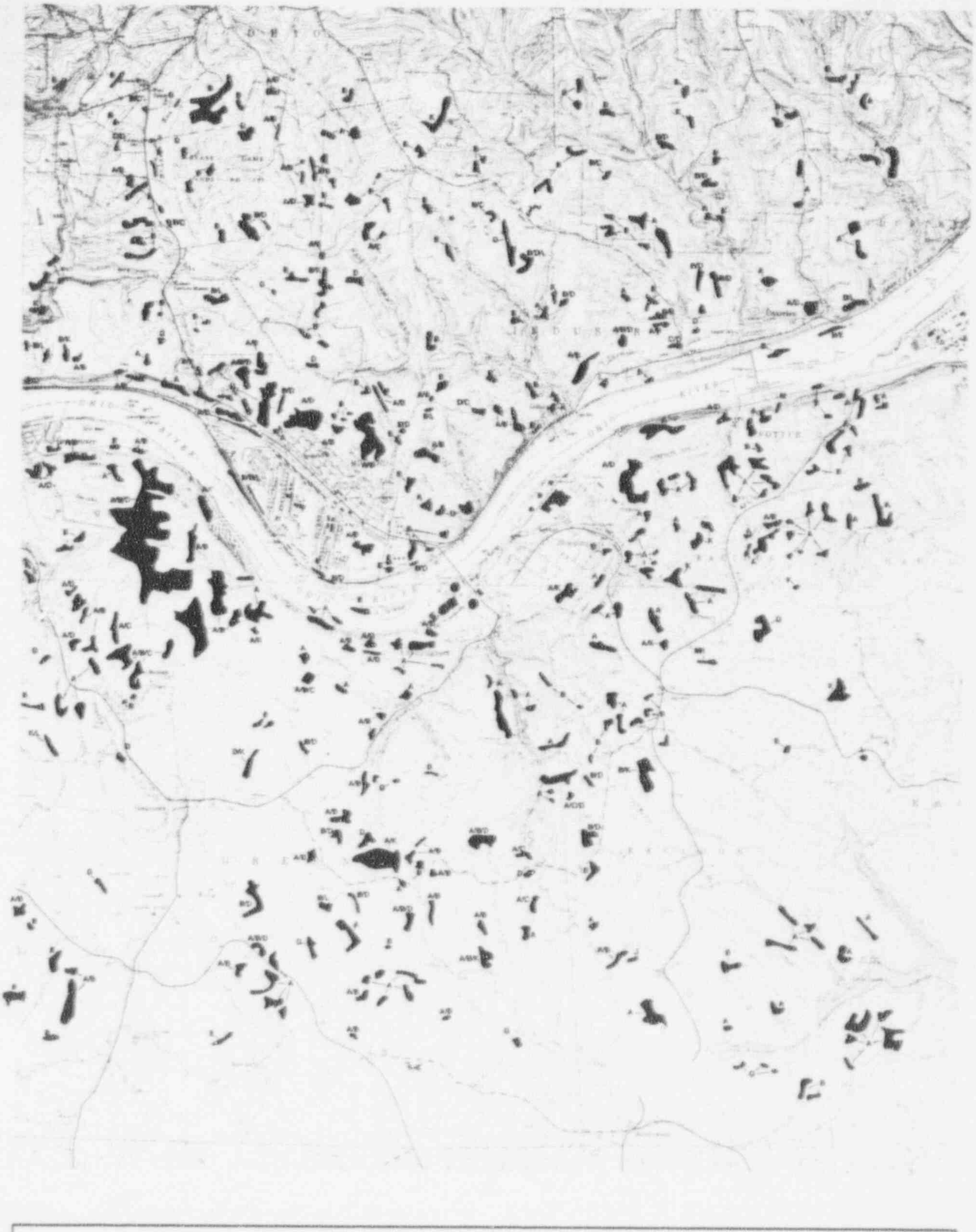
A GYPSY MOTH/FALL WEBWORM/LACE BUG
B LOCUST LEAF MINER
C DUTCH ELM DISEASE
D DEAD/DECADENT/THIN CROWNED TREES
E POOR DRAINAGE/PERIODICALLY FLOODED
F NECROSIS
G UNIDENTIFIED DISTURBANCE
H HEAVY EQUIPMENT ACTIVITY
I EROSION
J UTILITY CORRIDOR MAINTENANCE
K LOGGING ACTIVITY
L OVERGROWN WOODLOT
M WILDFIRE

N

FIGURE VI-B-2

DISTRIBUTION OF VEGETATION STRESS IN THE VICINITY OF THE BEAVER VALLEY POWER STATION, 1992

0 4000 8000 12000
Approximate Scale



A GYPSY MOTH/FALL WEBWORM/LACE BUG
B LOCUST LEAF MINER
C DUTCH ELM DISEASE
D DEAD/DECADENT/THIN CROWNED TREES
E POOR DRAINAGE/PERIODICALLY FLOODED
F NECROSIS
G UNIDENTIFIED DISTURBANCE
H HEAVY EQUIPMENT ACTIVITY
I EROSION
J UTILITY CORRIDOR MAINTENANCE
K LOGGING ACTIVITY
L OVERGROWN WOODLOT
M WILDFIRE

FIGURE VI-B-2

DISTRIBUTION OF VEGETATION STRESS IN THE VICINITY OF THE BEAVER VALLEY POWER STATION, 1992

0 4000 8000 12000

Approximate Scale

Most of the areas of stressed vegetation delineated on the base map, which were identified as insect induced stress, had many smaller areas in close proximity that revealed significant stress due to the same causal agent. These areas, because of their ubiquity, were not mapped for the sake of clarity of the base map.

There was a normal amount of precipitation in the Beaver Valley area in 1992. The amount of precipitation for the June, July and August is less than in 1990, which was much higher than normal.

Natural Causes

Of the 546 occurrences of significant stress, 486 (89.0%) of the occurrences were determined to be the direct result of natural causes (Table VI-B-2). These were sub-divided into four categories discussed below: gypsy moth/fall webworm/lace bug/elm leaf beetle, locust leaf miner. Dutch elm desease, and dead/decadent (over age-over mature)/thin-crowned trees. The letter in parentheses after each category heading corresponds to the map identification symbols. The third category of natural stress causal agents, Dutch elm disease, which was identified in this monitoring program prior to 1984, was not specifically identified in the 1984, 1986, 1988 or 1990 programs. This fungal disease has had catastrophic effects on the American elm (Ulmus americana), in the entire northeast. The slippery elm (Ulmus rubra), which is common in the monitored area, and some introduced elms, are less susceptible to this disease.

Combination of Natural Causes and Human Activities

Seventeen of the 546 occurrences (3.1%) of vegetation stress noted during the 1992 monitoring program were attributed to a combination of natural causes and human activities. These consisted of poor drainage/periodically flooded areas, overgrown woodlots, and wildfire.

Human Activities

Twenty one of the 546 (3.8%) occurrences of stress noted during the 1992 monitoring program were attributed directly to human activities. These consisting of logging, heavy equipment or general construction activity, utility corridor maintenance, and induced erosion.

Table VI-B-2

TYPE AND FREQUENCY OF VEGETATION STRESS IN THE VICINITY OF BVPS, TERRESTRIAL MONITORING PROGRAM, 1992

Code	Vegetation Stress	Cause	Occurrence	Percent
A	Gypsy Moth Fall/Webworm/ Lace Bug/Elm leaf beetle	Natural	208	38.1
B	Locust Leaf Miner	Natural	213	3[illegible]
C	Dutch Elm Disease	Natural	21	3.8
D	Dead/Decadent/ Thin-Crowned Trees	Natural/Unknown	44	8.1
E	Poor Drainage/ Periodically Flooded	Human/Natural	2	0.4
F	Necrosis	Unknown	1	0.2
G	Unidentified Disturbance	Unknown	21	3.8
H	Heavy Equipment Activity	Human	0	0
I	Erosion	Human	3	0.5
J	Utility Corridor Maintenance	Human	1	0.2
K	Logging Activity	Human	17	3.1
L	Overgrown Woodlot	Natural/Human	13	2.4
M	Wildfire	Human/Natural	2	0.4
		Totals	546	100.0

Note: Refer to Figure VI-B-2.

(A) Gypsy Moth/Fall Webworm/Lace Bug/Elm leaf beetle

Two hundred and eight areas (38.1%) contained trees severely stressed by a combination of the Eastern tent caterpillar (Malacosoma americanum), cherry lace bug (Corythucha pruni), gypsy moth (Lymantria dispar) and fall webworm (Hyphantria cunea). Of these insects, the primary stressors in the 1992 study were gypsy moth and an additional insect, the elm leaf beetle (Pyrrhalta luteola).

The Eastern tent caterpillar is a late spring defoliator that in the past has caused high levels of stress in wild cherries (Prunus serotina and P. virginiana) throughout the study area. Outbreaks are cyclic and recur at 8 to 10-year intervals. The most recent outbreak of this pest reached its pinnacle in 1985 with lesser, although heavy, infestations recurring in 1986. During heavy infestations, mature trees can lose all their leaves which seriously weakens them due to the increased energy required to grow new leaves after the caterpillar's 6- to 8-week feeding period. Although acute evidence of stress related to this pest was not readily discernible during the field reconnaissance phase, except for the observation of several dirty, shredded silken tents containing cast larval skins, the yearly heavy infestations of this insect over the past few years has severely stressed wild cherries and other hardwood species in the study area. The Eastern tent caterpillar was a minor cause of vegetation stress in 1992.

There are at least 15 species of lace bugs (Corythucha spp.) that feed on deciduous trees and shrubs in the eastern United States. Most have very specific host tree preferences that include wild cherries, sycamore (Platanus occidentalis), oaks (Quercus spp.), basswood (Tilia americana), hackberry (Celtis occidentalis), hawthorns (Crataegus spp.), and poplars (Populus spp.), which are all common species in the study area. In 1990 the cherry lace bug was the most common insect infestation in the study area. However, in all sections of the 1992 study area where wild cherries are particularly abundant, little stress occurred because of this insect.

Johnson and Lyon (1976) and the USDA Forest Service (1979) indicate that the fall webworm is known to attack over 100 trees species. In the vicinity of the BVPS during the 1984 monitoring program, fall webworm damage was most extensive in wild cherries, hickories (Carya spp.) and to a lesser extent elms, black locust (Robinia pseudoacacia), ashes (Fraxinus spp.), and willows (Salix spp.). Field reconnaissance during the 1986, 1988 1990 and 1992 monitoring programs revealed minor infestations of this insect in the study area. Apparently, the high population encountered in 1984 was in a peak year of this insect's population cycle in the study area.

The gypsy moth (Lymantria dispar) has been considered one of the most important forest insects in the United States. The gypsy moth occurs throughout the New England states. Its hosts included most species of hardwoods, the oaks, apples (Malus sp.), basswoods, willows, birches (Betula sp.), except yellow (B. alleghaniensis) and sweet (B. lenta), and poplars being most highly favored. Larvae emerge in May from over-wintering eggs and feed until mid-June or early July. Adults emerge in July and

August. Larvae consume entire leaves except the large veins and midribs. Defoliated trees show reduced growth and are more susceptible to attack by wood boring insects and fungi than undefoliated trees. Gypsy moth populations were high in western Pennsylvania during 1992. Many trees, particularly oaks, were defoliated at least once during the growing season. At the time of the current aerial photograph mission, there was substantial evidence of gypsy moth damage. Such defoliation can make the trees susceptible to other forms of stress.

The Elm leaf beetle (Pyrrhalta luteola) is an insect not readily apparent in prior study years. However, this insect has regularly affected the elm population in 1992. The elm leaf bettle feeds on most elm species and is one of the most destructive defoliators attacking these trees.

For the purposes of this study, only areas of heaviest infestation of these above-described insects are delineated on the mapping of stressed areas. Due to the dominance of their preferred host tree species throughout the entire study area, all wooded areas exhibited at least minor infestations of one or more of these insects.

(B) Locust Leaf Miner

In comparison to the 1990 vegetation stress survey, the occurrence of locust leaf miner (Odontota dorsalis) remained apparently the same in 1992. This is typical of the cyclic outbreaks that commonly occur in western Pennsylvania. In addition to the leaf miner, another major cause of stress in the locust trees of the study region is attributable to infestations of the locust borer (Megacyllene robiniae). A total of 213 (39.0%) separate stressed areas were identified as being related to a combination of these two insects.

When stands of black locust are infested by locust leaf miner, they appear brownish, as though dead, but late summer defoliation is usually not harmful (Hepting, 1971). Outbreaks of locust leaf miner occur yearly in western Pennsylvania, and tens of thousands of acres are defoliated (Baker, 1972).

The locust borer is a serious pest wherever black locust occurs. Because of the boring activities of the larvae into the sapwood and heartwood, trees are often badly disfigured, and young stands can be entirely destroyed. This results in reduced growth and vigor, and the trees are more susceptible to wind damage (USDA, 1979; Pirone, 1970).

Black locust trees are a dominant species in the study area, being a primary invader or volunteer species on lands disturbed by mining, logging, and abandoned agricultural fields. These trees are often planted in areas for conservation purposes once other trees have been removed because they thrive in direct sunlight and help improve poor soils through nitrogen-fixation. Cyclic increases and decreases in locust leaf miner and locust borer are common.

Although many stands of black locust were present in the portion of the study area south of the Ohio River, they were not as severely damaged as were the stands in the study area north of the river. Many of the stands north of the river that were stressed occur on steep slopes where the soils are thin and thus the availability of water and nutrients is reduced.

(C) Dutch Elm Disease

Dutch elm disease, caused by a fungus (Ceratocystis ulmi) carried by the native elm bark beetle (Hylurgopinus rufipes) and the European elm bark beetle (Scolytus multistratus), was observed in a few locations not large enough to map. Individual and small clumps of dead elms (presumably due to Dutch elm disease) were observed in a few scattered areas in 1992.

The number of areas containing stressed elms in 1992 (21 areas, 3.8%) was less than in 1990 (57 areas, 7.5%). Severely stressed elms result from several factors, among these was the lace bug (Corythuca ulmi). Another possible cause of stress was the elm leaf beetle (Pyrrahalta luteola). An irruption in the population of this insect reportedly occurred in 1988, due to the unusually high survival rates of the first and second generations.

(D) Dead/Decadent/Thin Crowned Trees

Stress attributed to decadent (over mature or over aged) conditions was observed in a total of 44 (8.1%) locations. The loss of vigor due to senescence in short-lived tree species, and the inability to tolerate changing conditions associated with plant community succession may have led to eventual death or to premature death from insect infestations, disease outbreaks, or drought in many of these areas. Many of these areas were located on steep slopes where the soils are relatively thin, and the reduced availability of water and nutrients create a harsher environment than on the plateaus and bottomlands in the study area.

(E) Poor Drainage/Periodically Flooded

Evidence of stress caused by poor drainage or periodic flooding occurred in a total of 2 (0.4%) locations. This is an decrease from that found in 1990 and is due to the decrease in precipitation experienced in 1992. According to Levitt (1972), excess water is not a stress in itself. Flooding does give rise to stresses involving turgor pressures, oxygen-deficiency, and tertiary ionic stress from buildups of phytotoxic levels of manganous and ferrous ions. Vegetation stressed in this manner may become more susceptible to secondary stress from insect and disease attacks (Treshow, 1975).

The areas mapped with this type of stress for the 1992 monitoring program were areas where manmade alterations in drainage patterns flooded areas where trees not adapted to hydric conditions were severely stressed. These alterations include pond or lake construction, stream impedence due to road widening or construction, and rapid runoff due to mining, logging or general construction activity.

(F) Necrosis

One stress area (0.1%) is attributed to necrosis during the 1992 field reconnaissance.

(G) Unidentified Disturbance

The cause(s) of stress could not be accurately identified in 21 (3.8%) of the 546 areas where stress was detected. The causes of vegetation stress not identified was due to a combination of factors including inaccessibility, budget limitations, and inability to adequately ascertain the cause or causes of stress in some instances. However, due to their random distribution and variable sizes, it is most likely that the majority of the stressed areas were the result of insect infestations, particularly gypsy moth, elm leaf beetle, and locust leaf miner.

(H) Heavy Equipment Activity

Activities using heavy equipment resulting in the stress or removal of vegetation were not evident in 1992. Areas identified in the 1986, 1988 or in the 1990 studies were not included in the 1992 study if no expansion of these sites was evident. No increase in mining activity was noted in the 1990 or 1992 surveys.

(I) Erosion

Stress attributed to erosion occurred in 3 (0.5%) locations and is the result of runoff from mining spoils or construction activities. These areas are all relatively small in extent.

(J) Utility Corridor Maintenance

Utility corridor maintenance was evident in 1 (0.2%) of the areas in 1992. Considerable stress on roadside vegetation was also detected in a few locations not conducive to mapping as a result of commercial tree cutting services used to maintain overhead utility lines.

(K) Logging Activity

Seventeen (3.1%) logging sites were identified during the 1992 survey. Logging activity as a whole continues to increase in Beaver county with many of the sites investigated involving large operations covering many acres of woodlands. Stumpage prices of hardwoods have been very attractive in recent years. In addition to the sites mapped, a few areas too small to map that were cleared or heavily thinned by firewood cutting activity were also noted. This activity could be expected to increase due to the increasing popularity of wood-burning stoves and fireplaces in private homes.

(L) Overgrown Woodlot

Overgrown woodlots result from natural forces that govern secondary plant succession on severely disturbed areas whose normal climax plant community has been disrupted through human activities such as abandonment of agriculture, logging, mining, and other intensive land uses, and by natural calamities such as massive storm damage (windthrow), wildfire, and sever insect and disease infestations. Overgrown woodlots are usually composed of hardy, pioneering tree species whose rapid growth and ability to tolerate less than favorable soil conditions allow these species to become quickly established in these areas. The fact that many of these species can reproduce asexually through cloning usually accelerates overcrowded conditions.

Stress attributed to intra- and/or interspecific competition due to overcrowding and poor soil conditions was observed in a total of 13 (2.4%) locations. The majority of these areas were situated on abandoned crop and pastureland in the study area. Most of these areas received intensive agricultural usage for many years causing cumulative soil loss through erosion and severe depletion of available nutrients in the remaining soil. Tree species with the adaptability to exploit these types of areas in the vicinity of BVPS include wild cherries, black locust, hawthorns, sumac (Rhus spp.) poplars, maples (Acer spp.) and Eastern white pine (Pinus strobus). Stress induced by competition in overcrowded conditions also promotes secondary stress agents such as insect infestations and disease.

(M) Wildfire

Acute stress attributed to recent wildfires was noted in 2 (0.4%) locations during the 1992 monitoring program. This is the same amount as observed in 1990. In one area along the Ohio River in Industry Borough, a large tract of woodland had burned intensely between the time of the 1984 and 1986 Monitoring Programs. Large numbers of dead and damaged trees still occur in this area and were noted on the photographs and observed in the field in this area.

Wildfires occur naturally only during times of extremely dry conditions. Most wildfires that have occurred in the study area are the result of arson, accidents, or prescribed burning. In some areas, where the establishment of trees is suppressed due to depleted soils, overgrazing and utility corridor maintenance, stands of broomsedge bluestem (Andropogon virginicus) have become established. This native warm-season grass, also known as "poverty grass", is extremely tolerant of poor soils and seasonal burning, and is maintained by fire. Stands of this grass are often the targets of arsonists or careless rubbish burners, and large areas are burned annually, further suppressing trees and stressing adjacent woodlands in the study area.

SUMMARY AND CONCLUSIONS

During the summer and fall of 1992, vegetation stress was monitored in the vicinity of the Beaver Valley Power Station cooling towers as part of the Terrestrial Monitoring Program. Color infrared aerial photography, photointerpretation of the imagery, and field observations were used to detect stressed or damaged vegetation and to determine probable causes.

Evidence from the aerial photographs and field surveys revealed that the majority of occurrences of vegetation stress were directly due to natural causes or a combination of natural causes and human activities involving intensive land use. These factors included insect infestation (cherry lace bug, gypsy moth, locust leaf miner/locust borer, and elm leaf beetle), decadence (over age-over mature), overgrown woodlot, poor drainage/periodically flooded areas, and wildfire. Human activities resulting in vegetation damage or stress including logging, heavy equipment or construction activity, utility corridor maintenance, and erosion. A few areas of unidentified stress were also delineated (most of which are most likely the result of insect infestations).

Of the 546 identified and delineated occurrences of vegetation stress, 89% were directly attributed to natural causal factors. The number of occurrences of stress is lower than in 1990. This decrease is attributed to a lack of a lace bug infestation affecting large numbers of black cherry trees which are prominent in the study area. A decrease in number of occurrences in 1992 was evident, even though gypsy moth affected large areas not previously affected. Approximately 3.1% of the occurrences were caused by a combination of natural factors and human activities involving land use changes, drainage alterations, and fire. The occurrences of stress categorized as unknown total 3.8%; the majority of these can be assumed to be due to natural causes. About 3.8% of the occurrences are directly attributed solely to human activities.

Based on interpretation of the CIR aerial photographs and field verification, there is no evidence to suggest that the BVPS cooling towers are causing vegetation stress. A combination of drift from the BVPS and Bruce Mansfield cooling towers, regional stack emissions, air pollution from other sources such as automobiles, and the local climate may contribute to vegetation stress in the region. The uncertainties of such combinations and resultant synergistic effects would make it difficult, although not impossible, to measure the actual contribution of the BVPS cooling tower drift to these effects.

It is also possible that the BVPS cooling towers are subtly affecting local microclimatic systems with their input of moisture and heat. Damaged vegetation from winter ice buildup would be a diagnostic measure of this effect, but there was not evidence of heavy limb fall or structural damage in the photographs or field observations.

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APPENDIX B

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
OHIO RIVER
IN-SITU *Corbicula* GROWTH STUDY
1992

Duquesne Light Company
Beaver Valley Power Station
Ohio River
In-Situ Corbicula Growth Study
1992

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Executive Summary

Permission was granted by the Pennsylvania Department of Environmental Resources (DER) to use a chemical additive (Clam-Trol or CT-1) in combination with a detoxification agent (DT-1), a bentonite clay, in the Beaver Valley Power Station (BVPS) Units 1 and 2 river water systems during 1992 for the control of the biofouling clam, *Corbicula*. An extensively coordinated laboratory to field investigation was undertaken in 1990-1991 to determine the efficacy of the additives and their impact on the environment. Results of these studies have been previously forwarded to the DER. As a result of these studies, the DER recommended that an *in-situ* (river study) be carried out in 1992 using the Asiatic clam, *Corbicula*, as an environmental monitor of potential growth impairment in the receiving system.

A 1992 *in-situ* study was conducted where individually marked clams were placed in bioboxes (16) resting at the bottom of the river and attached to shore by individual lines at four river locations or stations (4 bioboxes/station). These stations were at the Intake (above the discharge point of the effluent), and at three stations below the effluent release into the back channel of the Ohio River at Phillis Island. These stations (identification in parentheses) were located ~350 (P5), 700 (2B), and 1050 (P10) m downstream.

Clams were evaluated for potential growth impairment in the following ways: 1) mean clam size, 2) growth increment between selected time intervals over 162 days, 3) accumulative growth increment, and 4) trimming the initially measured size class of clams from 20 to the 10 most similar in size and re-evaluating trends of 1, 2, 3 above.

Plant dosing occurred on 6/23/92 and 10/6/92 for Unit 1 and on 10/28/92 for Unit 2. Clam growth was evaluated at Day 0, 16 days after river acclimation and prior to dosing, followed by selected time intervals when Units 1 and 2 were dosed. Four bioboxes were positioned at each of the four river stations at the start. An organized schedule for biobox rotation was developed to remove potential bias from clam handling. Two of the four bioboxes at each station were removed three days prior to plant dosing and placed in a refugium or "safe place" above the plant at a barge slip. They were returned to their respective stations one day prior to plant dosing. These bioboxes (except Intake station) would be exposed (the "dosed" group) to CT-1:DT-1 in the river during the dosing of the plant. On the day prior to dosing, the other two bioboxes were removed from each station and placed in the refugium for three days. This was the "nondosed" group. The purpose of the refugium was to serve as an additional control where half of the bioboxes at each station would not be exposed to the CT-1/DT-1 treatment in the plant, but all bioboxes would be involved in the handling/transfer process. This process also addressed the concern about inherent variability in growth between clams.

Of the three parameters evaluated (mean clam size, growth increments at selected time intervals, and accumulative growth increments), the latter was considered to be most important in indicating potential stress to clams on a cumulative basis of three molluscicide dosings over the 162-day study period. This approach provides the most relevant measurement on a continual basis that incorporates the potential of additive stress effects of the three dosings over the duration of the test.

Trends in the data were difficult to discern due to inherent variability in clam growth, determining the lower detection limits of actual growth, comparing the ecological response with the high statistical sensitivity in certain clam groups, and incorporating the influence of naturally occurring falling temperature conditions in the river that inhibited growth potential during October and November. Inherent variability of clams in the Intake bioboxes varied from 0.31 to 0.38 mm and none of these clams experienced any exposure to the effluent or CT-1/DT-1. Therefore, significant differences in clam growth that may be related to ecological impairment would have to begin at ∼0.40 mm or higher.

The lower detection limits of measuring clam shell widths consistently may begin at 0.10 mm; however, some statistical differences of 0.03, 0.04 and 0.06 mm in growth between dosed and nondosed clams were reported. These minute detections usually occurred in the October and November data when clam growth was substantially inhibited by rapidly declining river water temperatures. Clam growth in October and November was <0.20 to <0.10 mm, respectively, while growth in June exceeded 1.0 mm.

In some instances, clam growth data did not follow normal toxicological trends. For example, dosed clams in Stations P5, 2B and P10 did not have an anticipated dose dependence response of clam growth effects to the relative distance of the respective stations from the effluent release into the river. Although no significant differences were found between the accumulative growth increment of dosed clams between stations, the station (P5) closest to the effluent release had a substantially higher amount of growth than the other two effluent influenced stations (2B and P10), and clams in the middle station (2B) had the least amount of growth.

A factor potentially affecting data interpretation was the significant differential in mean clam size at the onset of the study. Clams in the nondosed group at the Intake station were significantly smaller than those measured at the three effluent influenced stations. These smaller clams grew faster than the others, and when the clam data were reanalyzed by selecting the ten clams of initial similar size, nondosed clams in the Intake bioboxes were still 0.08 mm smaller at the onset and had an accumulative growth increment difference of 0.09 mm by the end of the test. Although the initial clam differential of 0.08 mm was not statistically significant, the 0.09 mm differential at the end was. Such minute statistically significant differences were not considered to be ecologically significant.

Clams introduced into the system on 6/6/92 did not appear to be significantly or ecologically impaired at the two stations (P5 or 2B) closest to the effluent discharge during the three dosings between June and December 1992. New, smaller clams added into the bioboxes prior to the October 6, 1992 dosing of Unit 1 and the October 28, 1992 dosing of Unit 2, had growth data that was difficult to interpret. The overall growth increment of these new clams was significantly reduced by the rapidly falling river temperature conditions of October-November. This climatic limitation in growth was confirmed by the older clams, placed into the river in June, which also had substantially reduced growth at all stations during the same period.

Other studies carried out included the potential of thermal influence upon the clams held in bioboxes in Stations P5 and 2B, measurement of CT-1 residual in the effluent during dosing, and efficacy of the molluscicide to eradicate clams after the dosing effect. Thermal influence upon the bioboxes was non-existent in the four studies conducted to evaluate thermal dissipation influence upon clam growth in the receiving system. No CT-1 residuals were detected from 10-11 measurements taken/24-hr dosing period in the outfall during the three dosing efforts. The efficacy of CT-1 dosing in the plant was considered acceptable as >90% of the clams contained in bioboxes housed in the cooling towers were eradicated.

Data generated from clams over the 6-month study were difficult to interpret during the last two months. The rapidly falling river temperatures in October-November 1992 complicated the growth potential of *Corbicula* since these cold water conditions naturally inhibited clam growth in all stations. The accumulative growth increment response was the most relevant indicator of potential clam stress since it encompassed multiple exposures of three dosings seasonally and over a 162-day test period. Data obtained from the last two dosings which were conducted in October with young clams (second set), was least reliable and most difficult to interpret due to the overall inhibitory effects of cold river conditions on clam growth.

It was concluded that the extent of molluscicide/bentonite clay interaction during the plant dosings upon *Corbicula* as an environmental monitor in the Ohio River receiving system was minimal to non-existent at BVPS during the 162-day testing period.

Table of Contents

1.0 Introduction

The purpose of this study was to carry out a specific recommendation by the Pennsylvania Department of Environmental Resources (DER) in evaluating the potential environmental effects of a chemical additive for Asiatic clam (*Corbicula fluminea*) control in the Beaver Valley Power Station (BVPS) Units 1 and 2 river water systems. This recommendation follows that of the extensive studies carried out at this facility by Duquesne Light Company in 1990 and 1991 in which annual reports were sent to the DER and presentations made (Cherry et al. 1991, 1992; Shema et al. 1991, 1992). The chemical additives are Clam-Trol or CT-1 and a detoxification agent or bentonite clay (DT-1) from BETZ Laboratories, Inc., Trevose, PA.

During 1990-1991, 4 dosings occurred in the plant to minimize *Corbicula* infestations. From the 12 major study efforts involving toxicity testing and other studies in a formal laboratory at Virginia Tech, in an artificial streams facility located at BVPS, and *in-situ* studies carried out in the Onio River receiving system, the DER requested an *in-situ* growth study of *Corbicula* to be carried out in 1992. The data sets comprise a time interval from 6/6/92 through 12/2/92 where individual clams were measured before and after various plant dosings, allowing documentation of potential accumulative effects on clam growth individually throughout the study.

2.0 Materials and Methods

2.1 Dosings and Clam Measurements

The megadosings of CT-1 were carried out in the plant in 1992. Unit 1 was dosed on June 23, 1992 for ~1 day and again on October 6, 1992. Unit 2 was dosed on October 28, 1992.

Four sampling stations were used for the *in-situ* monitoring at BVPS. Details of the stations were described previously in Cherry et al (1992) in the last annual report sent to the DER (1991 *Corbicula* Control Programs - Environmental Fate and Effects Studies - Summer and Fall Dosing Studies - Duquesne Light Company - Beaver Valley Power Station). These stations included one above the thermal discharge at the pumphouse or Intake structure (Int), and within the thermal discharge release into the back channel at ~350, 700 and 1,050 m downriver at Stations P5, 2B and P10, respectively (Fig. 1). Other details of the sampling stations can be found in Fig. 2.

A total of 16 bioboxes were used. Each of the 4 stations contained 4 bioboxes designated as "A, B, C and D". Two bioboxes (A, B) were removed three days prior to plant dosing and were placed upstream at a barge slip deemed as a refugium or "safe area" (Fig. 2). On the day prior to dosing, these two bioboxes were returned to each station and were in place during the dosing operation. These were referred to as the "dosed" clams. The two remaining bioboxes (C, D) were removed from each station and placed in the refugium during the days that covered the day of dosing and days after dosing. A one day delay in moving these bioboxes may have occurred due to weather conditions and plant dosing schedule. These clams were then returned to their respective stations and were designated the nondosed clams. Each biobox contained 20 clams which were ~14 mm in width at the onset. The strategy in moving bioboxes before and during plant dosings was to address potential experimental bias of handling the clams and to segregate the potential effects of molluscicide-clay exposure from that of the effluent alone.

On June 6, 1992, 16 days prior to the June 23, initial dosing of Unit 1, twenty *Corbicula* were added to each of the four bioboxes at each station and individually marked from 1 through 20. On October 6, 1992, Unit 1 was dosed a second time with the clams experiencing two dosings over ~3.5 months. On October 5, 1992, a new set of 20 marked clams were added to each existing biobox. By this time the earlier clams had reached a width of ~20 mm and were easily differentiated from the new ones of ~14 mm (Fig. 2). The earlier clams were exposed to a total of three dosings (two in Unit 1 and one in Unit 2). The new clams

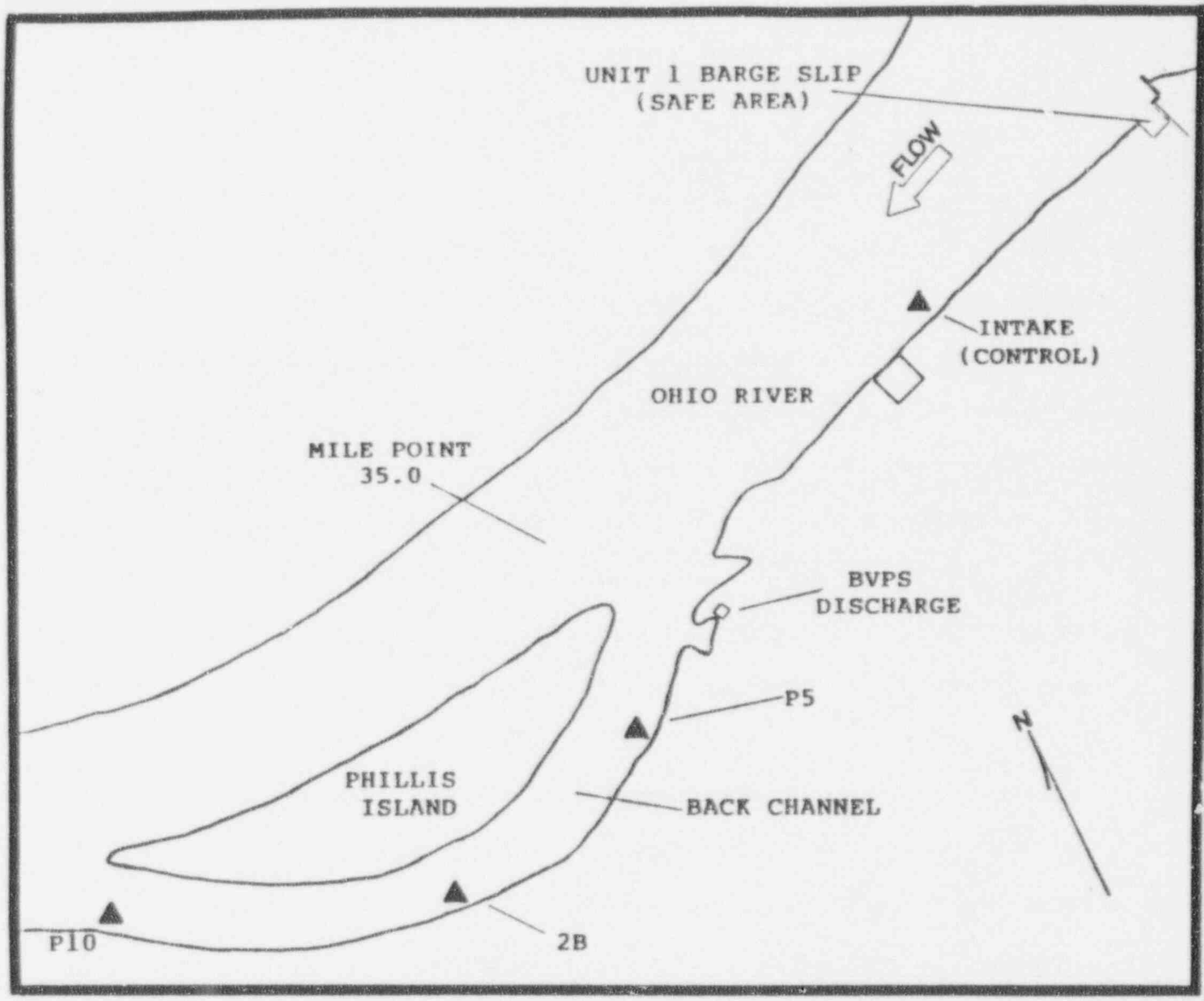
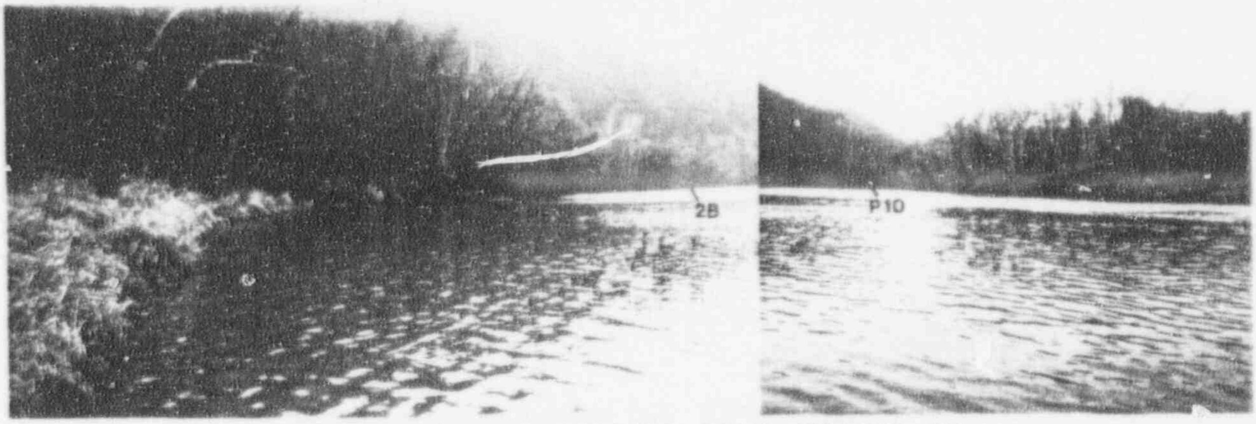
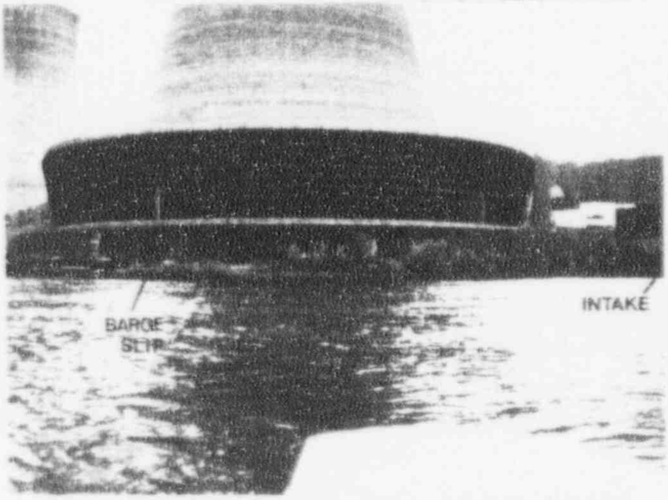


FIGURE 1

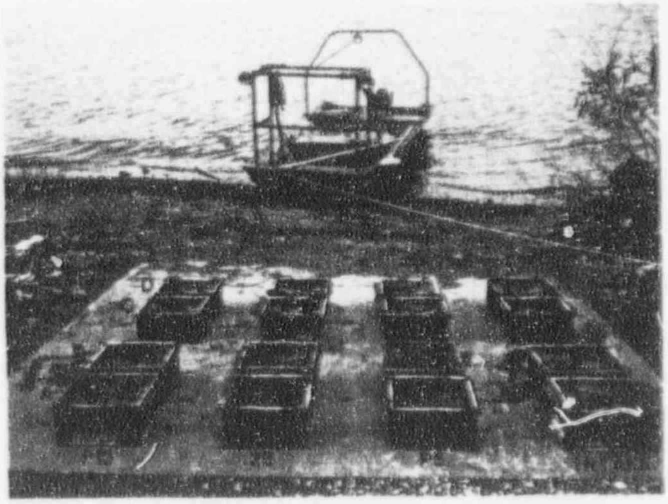
STATION LOCATIONS IN THE OHIO RIVER
Corbicula GROWTH STUDY
BVPS



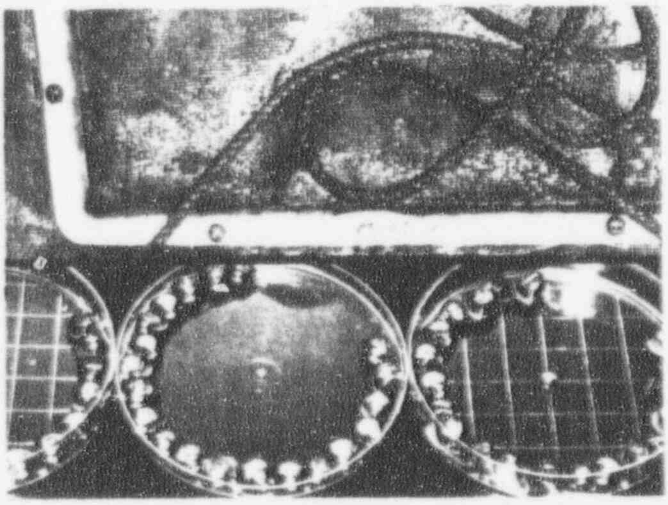
VIEW LOOKING DOWNRIVER BACK CHANNEL OF
PHILLIS ISLAND, OHIO RIVER
STATIONS P5, 2B, AND P10



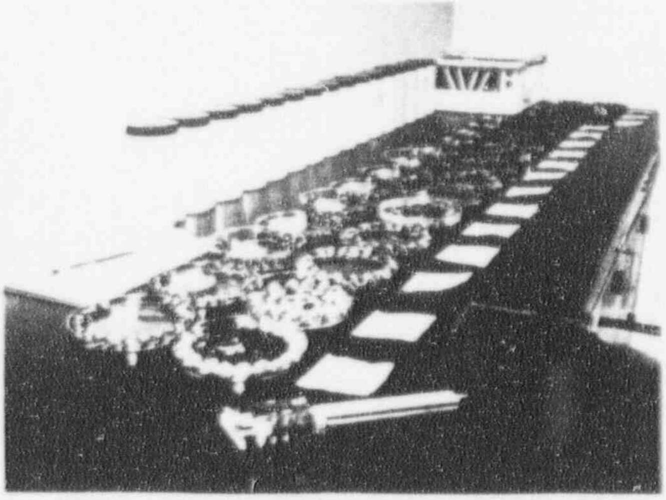
UNIT 1 BVPS BARGE SLIP (SAFE AREA)
AND INTAKE (CONTROL) STATION



WORK BOAT AND Corbicula BIOBOXES
ROWS A & B AT STATIONS DURING DOSING
ROWS C & D AT BARGE SLIP DURING DOSING



INDIVIDUALLY MARKED Corbicula
(1 THROUGH 20) PLACED IN DESIGNATED
(NUMBERED) BIOBOX



FINAL WIDTH (mm) MEASUREMENTS OF
FIRST AND SECOND SET OF
TEST Corbicula DECEMBER 2, 1992

FIGURE 2

1992 Corbicula GROWTH STUDY PHOTOGRAPHS SHOWING
OHIO RIVER STATION LOCATIONS, TEST Corbicula, AND EQUIPMENT
BVPS

were exposed to the second Unit 1 dosing and the Unit 2 dosing. The process of removing bioboxes before and after dosing followed the same schedule as the initial Unit 1 dosing.

Data available include *Corbicula* width at each station taken on 6/6/92 (Day 0), 16 days after river acclimation (6/22/92), after initial plant dosing 30 days later (7/23/92), 58 days thereafter, 104 days later (10/5/92, prior to the second dosing of Unit 1), 122 days later (10/23/92), (prior to the third dosing [first dosing for Unit 2]), and finally on 12/2/92 when the study ended. A composite of measuring nondosed and dosed clams is presented in Fig. 3. All of these data represent potential accumulative effects from three dosings of Units 1 (twice) and 2 (once).

2.2 Statistical Analysis

Data were grouped and analyzed in several ways. The mean clam width of 20 clams and that of the 10 clams closest in size when the clams were initially measured, (trimmed data), was tabulated after each dosing. The latter approach was used to narrow the initial variation in clam sizes across treatment at the start of a test and to follow the growth of these 10 clams throughout the test. Also, the growth increment of each clam group was determined between each measuring interval. Finally, the accumulative growth increment was tabulated as a running score of clam shell deposition over time from June to December 1992.

The Shapiro-Wilks statistic was used to test whether the data were normally distributed (Sokal and Rohlf 1981). Since the vast majority of the data were not normally distributed, non-parametric statistical techniques were used (Hollander and Wolfe 1973). A Wilcoxon's Rank-Sum test was used to evaluate potential clam shell growth and size differences between nondosed and dosed groups. The Kruskal-Wallis test was used to perform a non-parametric one-way analysis of variance between the stations. Duncan's Multiple Range test was then performed on the rank transformed data to determine significant differences between groups ($\alpha = 0.05$).

Fig. 3. Flow chart of dosing strategy, biobox maneuvering to refugium above the plant (barge slip) and times when clams were measured for growth.

			Biobox (A, B, C, D) Maneuvering	
			In Experimental Stations	
Comments	Date	Strategy	(Int, P5, 2B, P10)	In Refugium
Clams initially measured	6/6/92	Start of study	A B C D	
Some clams transferred	6/20-22/92		C D	A B
Other clams transferred	6/22-25/92		A B	C D
Clams measured prior to first dose	6/22/92	16 days after river acclimation		
	6/23/92	Unit 1 dosed	A B	C D
All clams back	6/25/92		A B C D	
Clams measured again	7/23/92	30 days after Unit 1 dosed	A B C D	
Clams measured again	8/20/92	58 days after Unit 1 dosed	A B C D	
Second set of clams placed in each box for river acclimation	9/21/92			
Some clams transferred	10/2-5/92		C D	A B
Other clams transferred	10/5-9/92		A B	C D
Clams measured prior to second dose	10/5/92	104 days after Unit 1 dosed		
New clams (20 at ~14 mm in width) added to each box and measured	10/5/92			
	10/6/92	Unit 1 dosed a second time	A B	C D
All clams back	10/9/92		A B C D	
Clams measured again	10/23/92	122 days after initial Unit 1 dosing	A B C D	
Some clams transferred	10/23-24/92		C D	A B
Other clams transferred	10/26-30/92		A B	C D
	10/28/92	Unit 2 dosed	A B	C D
All clams back	10/30/92		A B C D	
Last measurement	12/2/92	End of Study, 162 days after initial Unit 1 dosing	A B C D	

3.0 Results

3.1 Clam Growth from 6/6/92 to 12/2/92 (First set of clams)

Data from 6/6 to 12/2/92 were tabulated (Tables 1-6 at end of text) for clams involved in both Unit 1 dosings and the Unit 2 dosing (October 28, 1992). Tables 1 and 2 represent mean clam growth at the start of the test, 16 days after river acclimation and then 30 and 58 days after Unit 1 dosing and beyond. The mean growth increment between each measuring period is included. Table 1 represents clam growth in the nondosed groups while Table 2 is the same for the exposed or dosed groups. This time period covers the three dosings over a 162-day period of clam growth as well as selected surveillance times within that time frame. In addition, these data are presented between sampling stations in bar graph design for dosed and nondosed groups (Fig. 4).

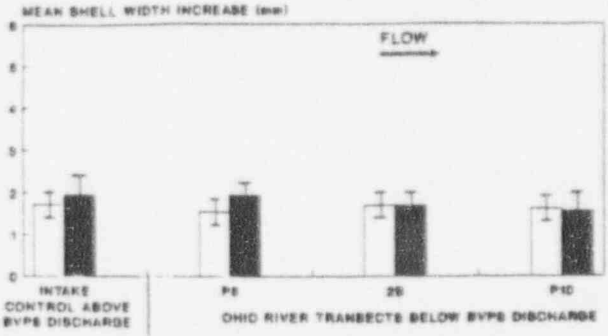
Clam size of nondosed organisms at the start of the test was highest at Station P5, second at 2B, and then lower at Stations P10 and the Intake (Table 1). Clams in the Intake were significantly smaller relative to the other three stations. This trend continued 16 days after river acclimation and then was no longer significant between stations from day 81 to the end of the test. By the end of the test, mean clam width for Intake clams had exceeded that for the other three stations.

The growth increment of clams usually was not significantly different between each interval of measurement (Table 1). At one period it was significant between the intervals of 10/5/92 and 10/23/92 and overall when clams at the Intake grew more than those at the other stations. Reasons for this unusual pattern are unclear since none of the clams experienced any of the molluscicide exposures. From 10/23/92 to the end of the study, clam growth increments were not significantly different between stations.

The accumulative growth increment data in Table 1 represent the potential acquisition of three molluscicide dosing effects over time. However, none of the clams used from these data were exposed to treatment. Accumulative growth became significantly different after

Figure 4

BVPS CT-1 MOLLUSCICIDE DOSING
Corbicula GROWTH STUDIES - OHIO RIVER



JUNE 22 TO JULY 23, 1992 (31 DAYS)

FIRST SET OF CLAMS
JUNE 6 TO DECEMBER 2, 1992

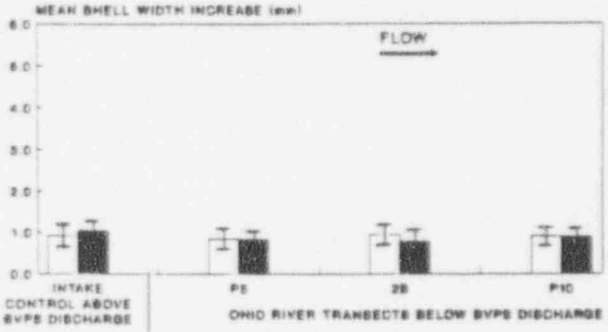
CT-1 DOSING UNIT 1 BVPS- JUNE 23 AND OCTOBER 6, 1992
UNIT 2 BVPS- OCTOBER 28, 1992

EACH COLUMN REPRESENTS MEAN SHELL WIDTH INCREASE (mm) OF TOTAL NUMBER OF *Corbicula* IN THAT POPULATION

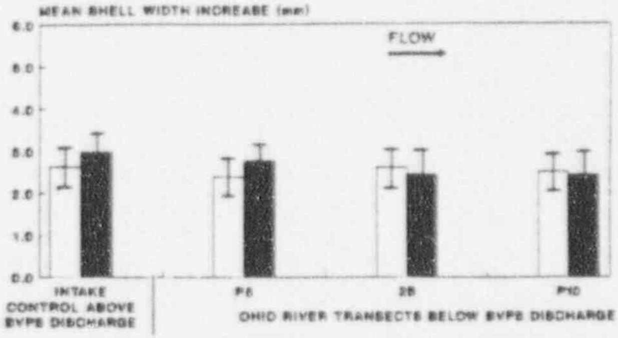
I -REPRESENTS STANDARD DEVIATION

TYPE OF TREATMENT

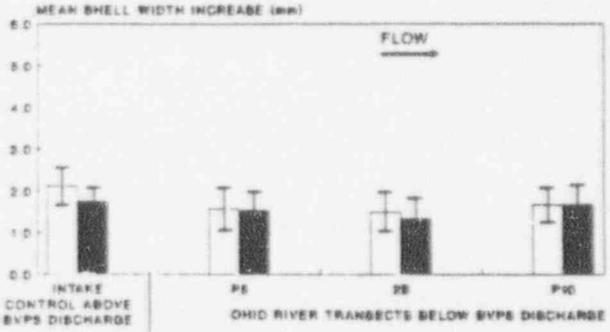
☐ AT BARGE SLIP DURING DOSING ■ AT STATION DURING DOSING



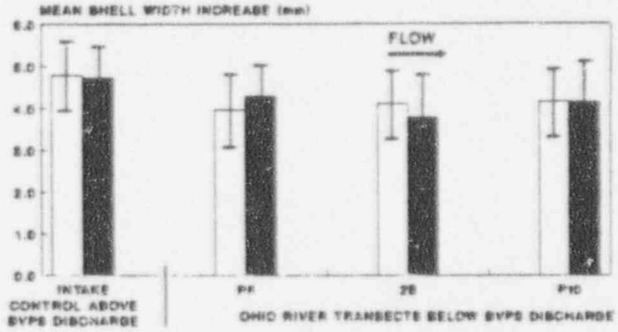
JULY 23 TO AUGUST 20, 1992 (28 DAYS)



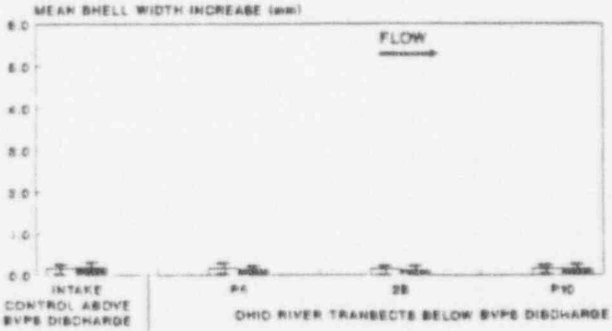
JUNE 22 TO AUGUST 20, 1992 (59 DAYS)



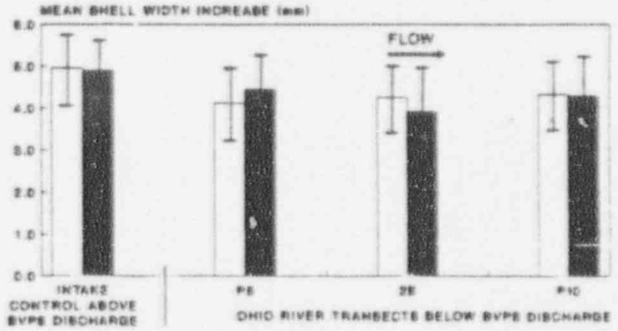
AUGUST 20 TO OCTOBER 5, 1992 (46 DAYS)



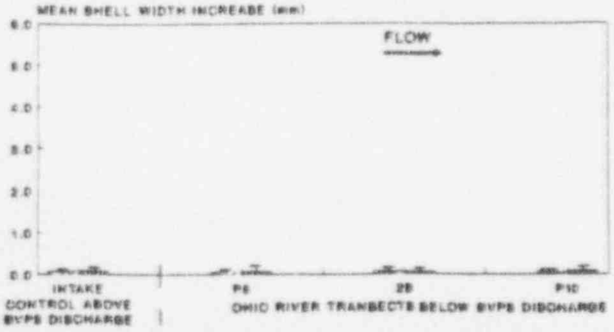
JUNE 22 TO OCTOBER 5, 1992 (105 DAYS)



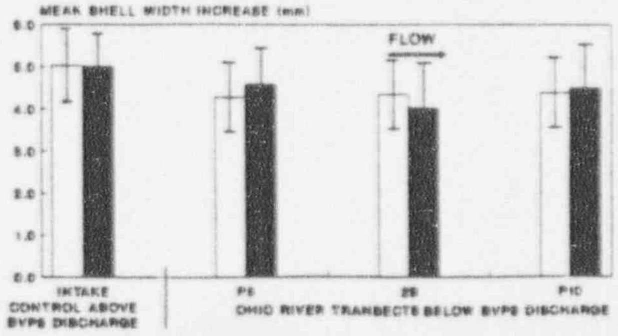
OCTOBER 5 TO OCTOBER 23, 1992 (18 DAYS)



JUNE 22 TO OCTOBER 23, 1992 (123 DAYS)



OCTOBER 23 TO DECEMBER 2, 1992 (40 DAYS)



JUNE 22 TO DECEMBER 2, 1992 (163 DAYS)

10/5/92 and remained that way throughout the 10/23/92 and 12/2/92 measurements. That is, nondosed clams grew significantly larger in the Intake than they did at the other three stations below the plant during the latter three intervals of data measurement (2.12 mm at the Intake on 10/5/92, which was 0.44 mm higher than the next higher growth obtained at Station P10).

Clam size in the "dosed" group was significantly different initially at day 0 between Stations 2B and P10 versus P5 and the Intake (Table 2). Stations 2B and P10, which were furthest from the plant discharge, had significantly higher clam sizes at the start of the test. This trend continued after the initial 16 days of river acclimation into the dosed intervals. After 30 and 58 days following dosing, clams in Station 2B had significantly higher growth than those at the Intake station. From 58 to 162 days of dosing, mean clam width in Stations 2B and P10 remained significantly higher than in Stations P5 and the Intake. Overall, no dose-dependent response was observed; that is, clams closest to the discharge did not have the lowest amount of growth or size. Conversely, clam size continued to be lowest at the Intake station throughout the test.

Sixteen days after acclimation in the river, clam growth increments were the same between all stations except at Station 2B, which was significantly lower than the rest (Table 2). Thirty days after plant dosing, the growth increment was significantly lower in Stations 2B and P10. Fifty-eight days after plant dosing, the growth increment was significantly highest at the Intake station and lowest at Stations 2B, P5 and P10. By the 122nd day of initial dosing to the end of the test, growth increments of clams were not significantly different between stations.

The accumulative growth increment of dosed clams, as stated earlier, represents the potential acquisition of multiple molluscicide exposures over time, or from the first to the second and third treatments. Following days 30 and 58 after treatment of Unit 1, the accumulative growth increment was significantly higher for clams housed in the Intake and P5 stations and lower in Station 2B and P10. From the 104th day to the end of the test (162 days), the accumulative growth increment was not significantly different between stations.

Tables 3-6 represent statistical analysis of clam growth between nondosed versus dosed [illegible] by station. In Table 3, the mean width of clams was not significantly different between each clam group at the Intake station throughout the test period. Clam growth increments were inconsistent at day 16 before dosing versus days 30 and 58 after dosing. Clams grew significantly faster after 30 and 58 days for the dosed group while in the 16-day period prior to dosing the trend was reversed. Prior to and after the second dosing, mean clam width was significantly higher in the nondosed versus the dosed group. The overall gain in width from 6/6 to 10/23/92 was not significantly different between each group. This trend continued to the end of the test. The accumulative growth increment data showed that clams had significantly lower growth in the dosed versus the nondosed group from 10/5/92 through 12/2/92. These results would appear to be contradictory since no clams in the Intake were exposed to the molluscicide. The data suggest that a 0.20-0.30 mm accumulative growth increment is needed in order to identify any ecologically significant measurement for clams in bioboxes below the plant if inherent differences occur in the reference (Intake) station.

At Station P5, clam size was significantly greater for the nondosed clams after the initial 16 days in the bioboxes prior to dosing the plant (Table 4). Clam size through most of the test was not significantly different between groups until the latter two measurements when nondosed clams were larger than the dosed clams. The growth increment data generally contradicts the trend seen in the clam size data. After the initial increment was significantly higher in the nondosed clams, the trend reversed 30 days thereafter (after plant dosing) where dosed clams had a significantly higher increment than nondosed clams. Thereafter, no significant differences in growth were evident until the last measurement was taken (12/2/92) where dosed clams grew more than nondosed clams. Note that this growth differential is only 0.06 mm. The accumulative growth increment provides the clearest evidence of a trend for how clams responded at Station P5. After the initial higher growth of nondosed clams 16 days into the test, the accumulative growth of dosed clams caught up with and surpassed nondosed clams 30 days after the first plant dosing. The accumulative growth was higher, though not significantly so, for dosed clams throughout the test period.

At Station 2B, next in line below Station P5 from the effluent release, significant differences in clam size occurred at the start (Day 0) between dosed versus nondosed groups (Table 5). Clam size was significantly larger in dosed clams at Day 0, Day 16 before dosing, and 30 days after in-plant dosing. Fifty-eight days after in-plant dosing no significant differences in clam size were observed, and it remained that way through 12/2/92. The growth increment between nondosed versus dosed clams was significantly higher in the nondosed group 16 days before the first dose and 58 days after. From 10/5/92 through 12/2/92, the growth increment was not significantly different between each group. The accumulative growth increment was always significantly higher for nondosed clams throughout the test period. Since this station is beyond the initial station (P5) that is closest to the effluent release, no dose-dependent response relative to distance from the effluent release was evident. It appears that the larger dosed clams (15.88 mm) at Day 0 grew considerably less than the nondosed clams (14.99 mm) during the first 16 days before dosing (0.85 vs. 1.23 mm, respectively) so that this initial growth differential could not be overcome over the five months of the test.

At Station P10, mean clam sizes were not significantly different at Days 0 and 16 before dosing, nor were they different at any other time after in-plant dosing throughout the testing period (Table 6). The growth increment of 0.20 mm between dosed (0.96 mm) versus nondosed (0.16 mm) groups was significantly higher for nondosed clams 16 days after the start of the test (prior to the first dosing) but essentially had no significant differences thereafter. The overall or accumulative growth increment data showed a similar pattern as the growth increment measurements. The data suggest that an initial difference of 0.20 mm in growth increment prior to plant dosing is statistically significant but ecological impairment consequences must exceed a differential of 0.30 mm as reported earlier for discussion of Intake Station data.

3.2 Clam Growth from 10/5/92 to 12/2/92 (Second set of clams)

A second group of 20 clams was added into each biobox on 10/5/92 before the second dosing of Unit 1 and prior to the dosing of Unit 2. The nondosed clams at Station P10 were significantly greater in size at Day 0 than all the rest (Table 7). Clam sizes between the Intake, P5 and 2B stations were not significantly different from each other. This trend continued through 12/2/92. Clam growth increments on 10/23/92 were significantly higher at the Intake station and P5 versus 2B and P10. At the end of the test, the accumulative clam growth increment was significantly highest at the Intake station than at the other three stations P5, 2B and P10 (Fig. 5).

Data for the dosed clams followed a similar trend as observed for nondosed clams (Table 7). Clam size was not significantly different between stations anytime during the three measurements obtained. The growth increment was significantly higher at the Intake and P10 stations on 10/23/92, and at the end of the test, growth was significantly higher at Stations Intake, P5 and 2B versus P10. The accumulative growth increment on 12/2/92 indicated that clam growth was significantly highest at the Intake and significantly lower at Stations P5, 2B and P10.

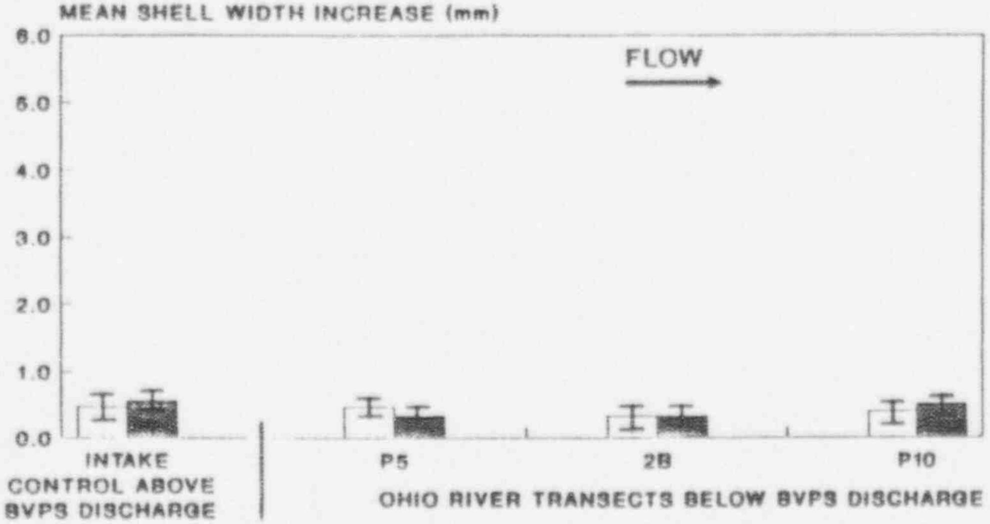
Clam size and growth were compared between nondosed and dosed clams within each station (Table 8). At the Intake station, clam size did not vary significantly throughout the test period, nor did the growth increments change substantially within each testing interval.

At Station P5, dosed clams were significantly larger than nondosed ones at the beginning and end of the testing period (Table 8). The growth increment data collected on 10/23/92 and 12/2/92, however, indicated that the larger, dosed clams grew significantly less than nondosed ones.

At Station 2B, clam size was not significantly different between groups anytime during the test (Table 8). The growth increment between 10/23 and 12/2/92 was significantly higher for dosed clams, but the accumulative growth increment at the end of the test indicated no significant differences occurred.

Figure 5

BVPS CT-1 MOLLUSCICIDE DOSING
Corbicula GROWTH STUDIES - OHIO RIVER



OCTOBER 5 TO OCTOBER 23, 1992 (18 DAYS)

SECOND SET OF CLAMS
SEPTEMBER 21 TO DECEMBER 2, 1992

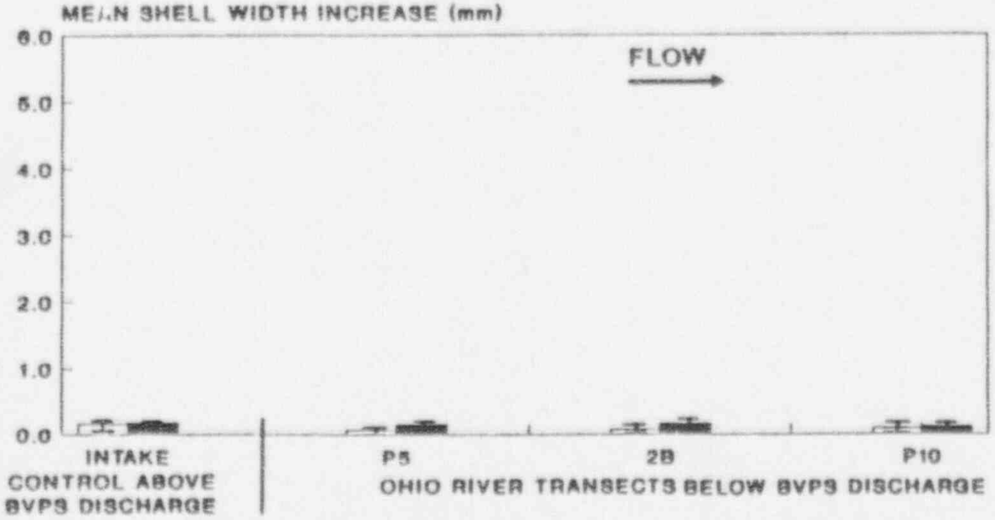
CT-1 DOSING UNIT 1 BVPS- JUNE 23 AND OCTOBER 6, 1992
UNIT 2 BVPS- OCTOBER 28, 1992

EACH COLUMN REPRESENTS MEAN SHELL WIDTH INCREASE (mm) OF TOTAL NUMBER OF *Corbicula* IN THAT POPULATION

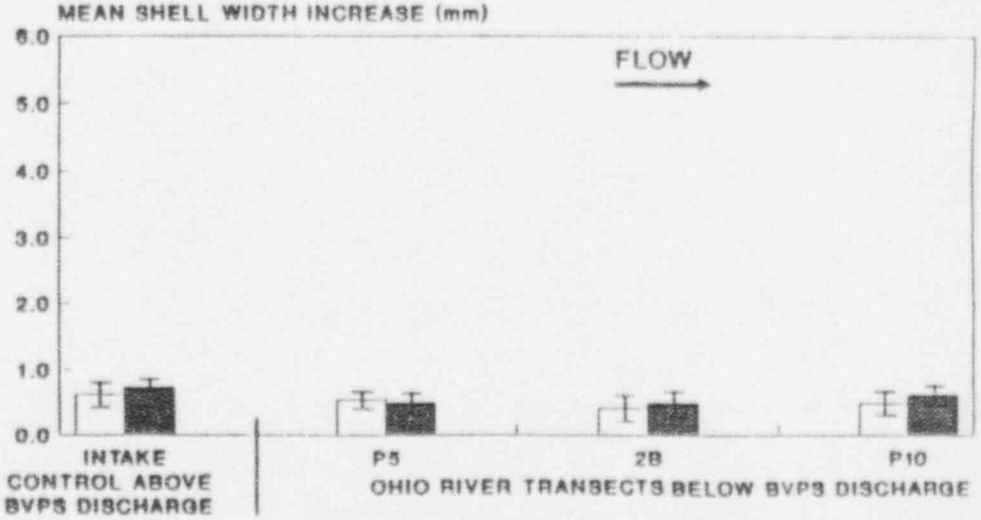
Ι -REPRESENTS STANDARD DEVIATION

TYPE OF TREATMENT

☐ AT BARGE SLIP DURING DOSING ■ AT STATION DURING DOSING



OCTOBER 23 TO DECEMBER 2, 1992 (40 DAYS)



OCTOBER 5 TO DECEMBER 2, 1992 (58 DAYS)

At Station P10, clam size was significantly larger for nondosed clams at the beginning and throughout the test (Table 8). Dosed clams had a significantly higher accumulative growth increment than nondosed clams at the end of the test.

3.3 Clam Growth from Subsampled Sets

There were several times when the mean width of 20 clams in one group was significantly greater than the other group at the start of a test (either 6/6 or 10/5/92). The questions addressed here are whether or not the larger clams were naturally beginning a decline in growth rate or if the initial (starting) mean clam size affected the final clam size results. To compensate, we analyzed the data according to clam shell size, specific growth increments before and after plant dosings, and accumulative growth increments. Another way was to attempt to reduce the "outliers" at the beginning of the test by taking 10 of the 20 clams closest to the mean for each station and following their growth rate through the test. Since each clam was individually marked and measured after each interval, we could identify the growth of every clam from beginning to end (resulting in 3200 individual measurements). These data and tables (1-8) are found in the Appendix.

In Table 1, clams at the Intake station were significantly smaller than the rest on Day 0. By reducing the variability initially from all four stations, mean clam size was no longer significantly different between station[illegible]ble 1-Appen.). No differences or significant trends were observed between data in Tabl[illegible]rsus that seen in Table 1-Appen., that is, the significant trends for clam size, growth increment and accumulative growth increment were the same in trimmed versus untrimmed data.

In Table 2 at the onset, mean width for clams at the Intake and P5 stations were significantly lower than the other two stations. After trimming the data, significant differences between sizes were removed (Table 2-Appen.). In Table 2, clams that were initially larger at Stations 2B and P10 remained significantly larger at the end of the test. Growth increments were not significantly different from 10/5/92 to the end of the test for the subsampled groups in Table 2-Appen. The most noteworthy result was that when clam sizes were not significantly different at the onset for 10 clams of similar initial size, no significant differences occurred throughout the test.

In Table 3, clam size and growth were compared between nondosed versus "dosed" clams at the Intake station. No significant differences between groups occurred at the beginning of the test or after the sets were trimmed to 10 per group. The same statistical trends observed in Table 3 were also found in Table 3-Appen.

In Table 4, an unusual situation at Station P5 was apparent when comparing the data to that of Table 4-Appen. Both the untrimmed and trimmed data had significant differences between clam sizes at the start, and the dosed clams were significantly smaller initially. Overall, clam size and the accumulative growth increment were not significantly different in the untrimmed and trimmed data at the end of the study.

Nondosed clams in Station 2B were significantly smaller at the onset of the study (Table 5), but this significance was removed in the trimmed data (Table 5-Appen.). At the end of the study, no significant differences were observed between clam size, growth increment and accumulative growth increment for the trimmed data while according to Table 5, the accumulative growth increment of 20 clams remained significantly lower for dosed clams at the end of the test.

Clam sizes at Station P10 were not significantly different between dosed and nondosed groups at the onset according to Table 6 and 6-Appen. The final results between both groups of clam data were the same. It appears that clam size at the beginning of the test did not have any inherent bias upon the data. In some cases, streamlining the groups to 10 clams of a consistent initial size made the results either easier to interpret or had no major influence upon the overall trends.

Data for the new clams placed in the bioboxes on October 5, 1992 were trimmed to 10 clams and reanalyzed (Table 7-Appen.). Neither nondosed nor dosed clams were significantly different between stations at the start of the test. The results for nondosed clams were generally the same as those for the untrimmed clams (Table 7). All three stations below the Intake station had significantly lower clam accumulative growth increment data. Hence, clams not exposed to CT-1:DT-1, but exposed to effluent conditions in general, had reduced growth with respect to the Intake group. The dosed clams were not significantly different in size between stations for untrimmed and trimmed groups. The results were the same for both groups. Growth increment and accumulative growth increment data were significantly reduced at all three stations below the Intake. Apparently, clam growth was impaired in Stations P5 and 2B during the 17 days after Unit 1 second dosing and after Unit 2 was dosed, when the colder, declining water temperatures in October-November 1992 did not allow the clams to recover in growth over time since winter river conditions in general retarded or eliminated clam growth.

No unusual trends were observed when clam size and growth of trimmed groups were compared between nondosed and dosed clams within each station (Table 8-Appen.). No significant differences occurred for any parameter between nondosed and dosed clams at the Intake station. Clam size was not significantly different at the onset of the test for nondosed and dosed clams at Station P5 and no significant differences occurred for accumulative growth increment at the end. The same general trends were observed for clams at Stations 2B and P10 except that clam growth was slightly higher in the dosed rather than the nondosed clams.

3.4 Potential for Thermal Influence

Four separate studies were carried out in October, 1992 to determine if the BVPS heated effluent would influence or bias clam growth in the first station (P5) below the discharge, and/or if it influenced the other two to a lesser degree. The question was to determine if potential thermal increase could possibly offset molluscicide impairment upon clam growth. Temperature measurements were taken at the surface and bottom of the river where the bioboxes were located.

The outfall or discharge temperature was always higher than the Intake surface temperature during the four sampling efforts in October 1992 (Table 9). Water temperatures across the river surface did not change appreciably between the Intake station through

Station P10. More importantly, water temperatures at the river bottom did not vary either between stations. For example, temperatures at the Intake station through P10 varied only 0.3°F at the surface and bottom on October 9, 1992. The greatest temperature range differential was 5°F at the surface of the Intake and P5 stations but only 0.4°F at the bottom on October 30, 1992. Other sampling efforts were similar to or less than those reported above. It was concluded that the effluent outfall discharge temperature was elevated at the discharge structure but was dissipated before reaching the first discharge station (P5) especially at the bottom of the river.

3.5 CT-1 Measurements in Outfall

Measurements of CT-1 were taken by the Chemistry Department of BVPS on June 23-24, 1992, October 6, 1992 and October 28-29, 1992 (Table 9 Appen). Cooling tower measurements ranged (starting to maximum concentration) from 8.4-13.9 mg/L on June 23, 1992 to 1.2-17.2 mg/L on October 6, 1992 and 5.9-11.5 mg/L on October 28, 1992. All CT-1 measurements were < 0.2 mg/L in the discharge for the three molluscicide dosing efforts.

3.6 Efficacy of CT-1 on *Corbicula* Control

Part of the BVPS *Corbicula* surveillance program involves investigating the colonization potential of juvenile *Corbicula* by placing empty bioboxes in the cooling towers. These bioboxes are left in place for five months after initial placement and are rotated on a monthly basis (one new biobox in, one 5 month period biobox out). These bioboxes are left in the cooling towers during the CT-1 dosing and therefore serve as indicators of CT-1 efficacy. In the June 1992 dosing of Unit 1 cooling tower, > 90% of the clams were eradicated in the bioboxes examined (Fig. 6). In the October 1992 dosing of Unit 1 cooling tower, a 95% kill was observed. The latter October, 1992 dosing of Unit 2 resulted in a 98-100% kill (Fig. 7). The CT-1 dosing of the plant was deemed successful in controlling *Corbicula* infestation.

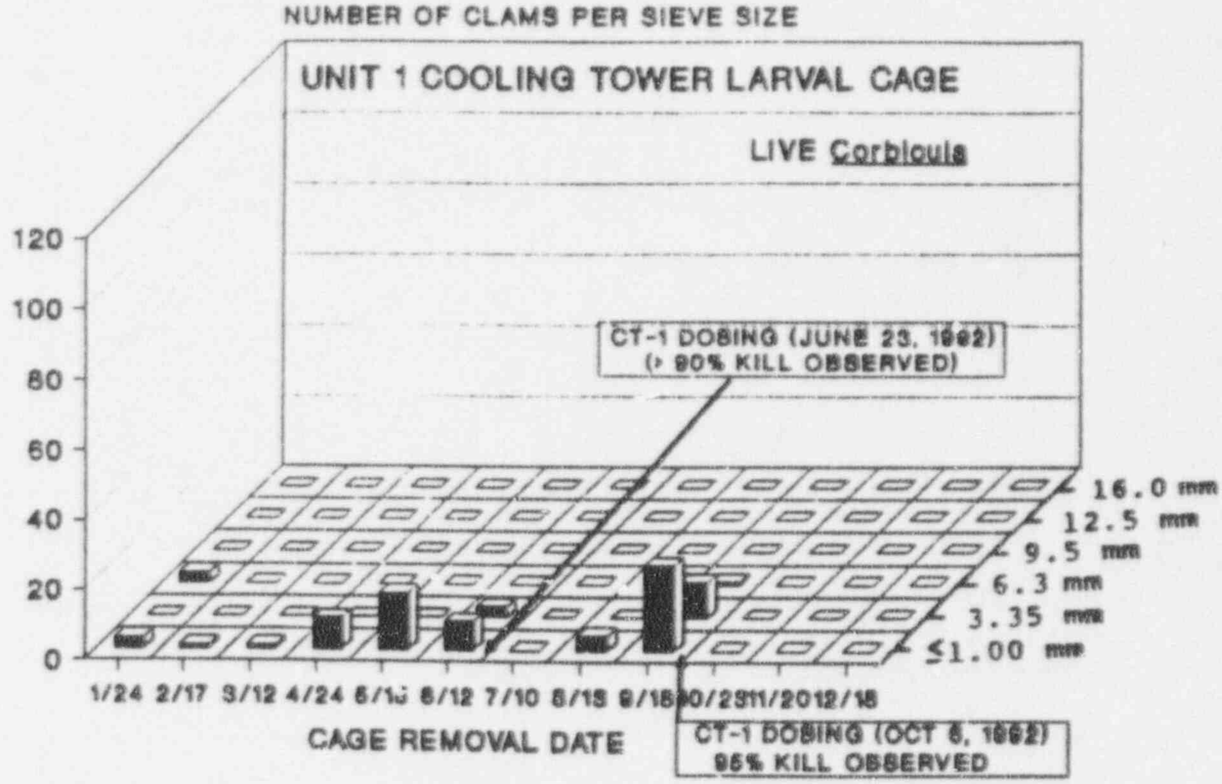


FIGURE 6

<u>Corbicula</u> LARVAL CAGE 1992 DATA - UNIT 1 COOLING TOWER

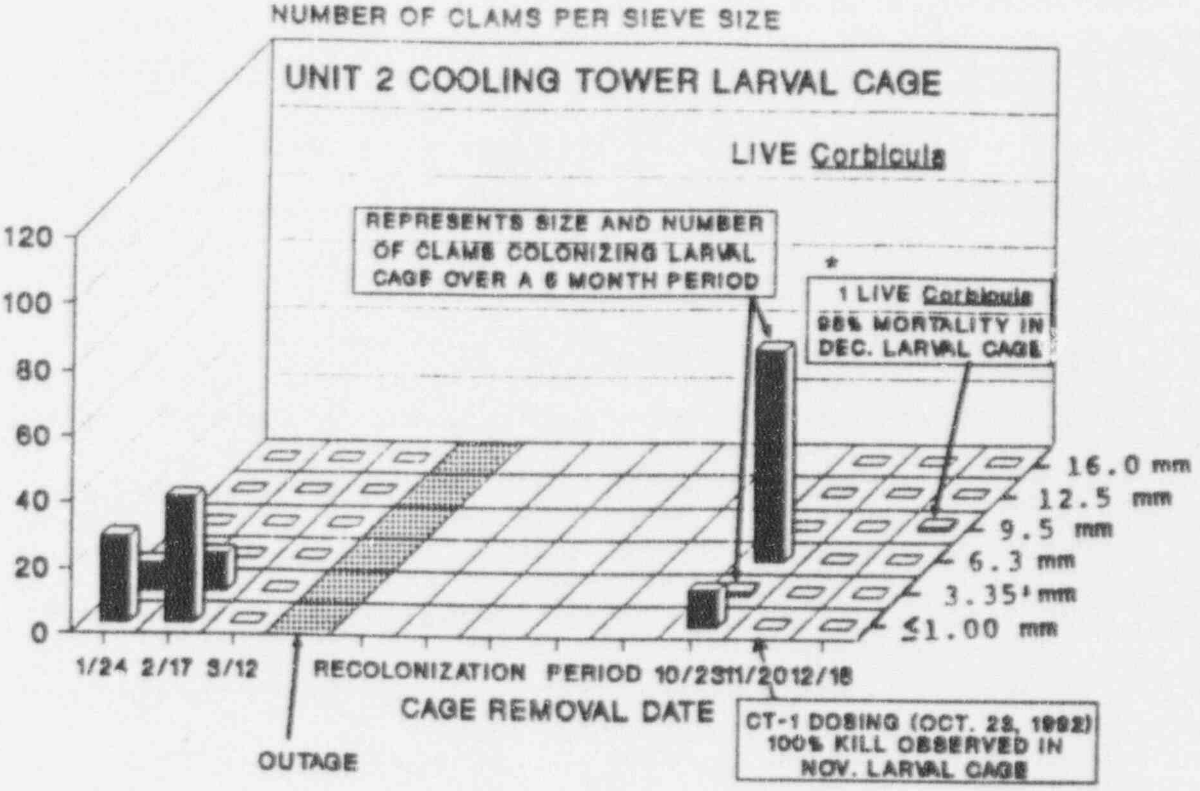


FIGURE 7

Corbicula LARVAL CAGE 1992 DATA - UNIT 2 COOLING TOWER

* PLEASE NOTE THAT THE 1 LIVE Corbicula COLLECTED IN THE DECEMBER LARVAL CAGE INDICATES THAT THERE WAS >90% KILL OBSERVED IN THE UNIT 2 COOLING TOWER. THIS IS BEING HIGHLIGHTED SINCE THIS REPRESENTS A DISCREPANCY FROM ALL OF THE NOVEMBER DATA (MORTALITY BAGS, RESERVOIR SCRAPER, AND LARVAL CAGE) THAT SHOWED 100% KILL IN THEIR RESPECTIVE SAMPLES.

3.7 *Corbicula* Surveillance Program

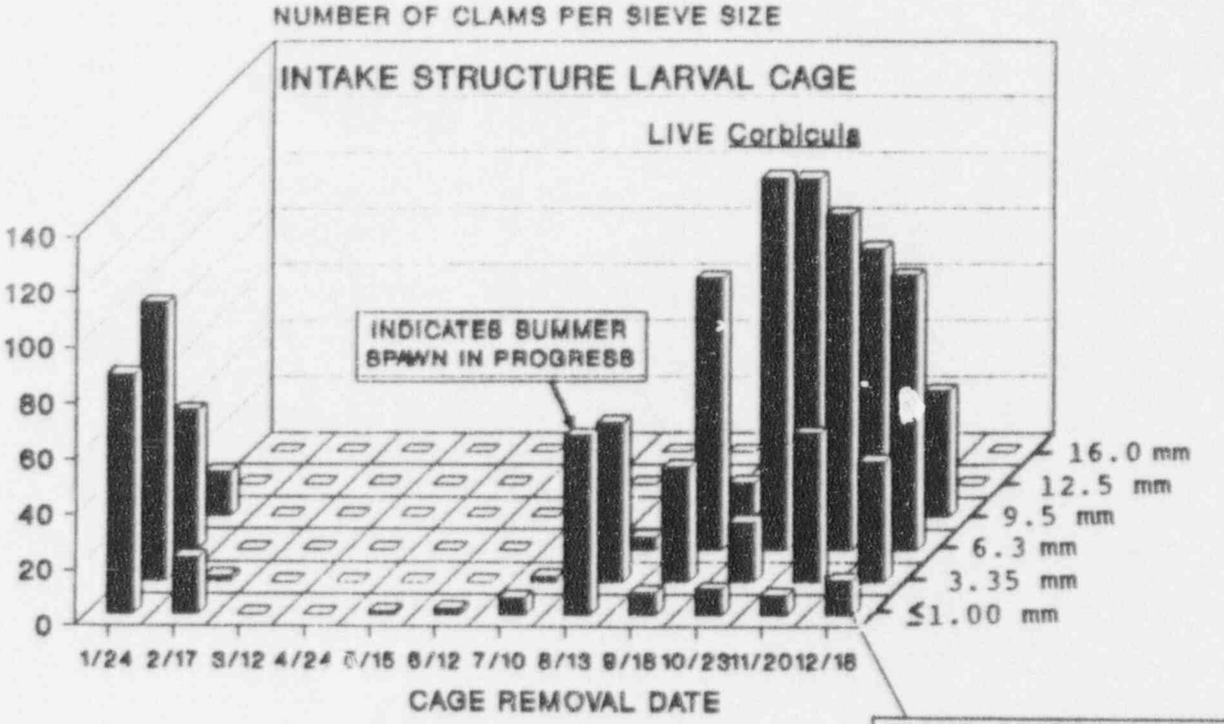
The three dosings in the plant during 1992 were developed on a critical need to control *Corbicula* infestation. *Corbicula* surveillance at BVPS was carried out by 1) investigating *Corbicula* colonization of empty larval cages housed in the Intake area, 2) analyzing *Corbicula* numbers impinged on the Intake structure travelling screens, and 3) examining monthly scrapings from the bottom sediment of Units 1 and 2 cooling towers.

At the Intake structure, an average of 197 clams per cage were collected in December (Fig. 8). The greatest numbers of clams found in the cages occurred in the October sampling effort. No larvae infiltrated the cages in March and April, and the marked increase in juvenile clams found by August 13, 1992 indicated that the summer spawn was in progress.

The number of *Corbicula* collected from the travelling screens was highest (nearly 400) in August-September, 1992 and then declined rapidly by October (Fig. 9). The greatest incidence of impinged clams occurred in 1989 with >12,000 clams collected for one month (September).

The number of live clams removed from the scraper samples of Unit 1 cooling tower were rare to nonexistent from August 27 through December 18, 1992 due to CT-1 dosing of the Unit 1 river water system on June 23 and October 6, 1992 (Fig. 10). In the Unit 2 cooling tower, clam numbers increased from August to September and peaked to over 2,000/sample by October 23, 1992 (Fig. 10). After dosing on October 28, 1992, live clams were basically eradicated (>90% kill) from the system.

Ohio River water temperature fluctuated throughout the year and was highest in the summer months of June through September (Fig. 11 and Appen 6.3). Coldest river water temperature occurred in January, February and December. River elevation fluctuated widely depending upon precipitation. The highest weekly river elevation reading was found on December 18, 1992. River elevation was lowest from early May through early July and again from mid August-September, 1992.



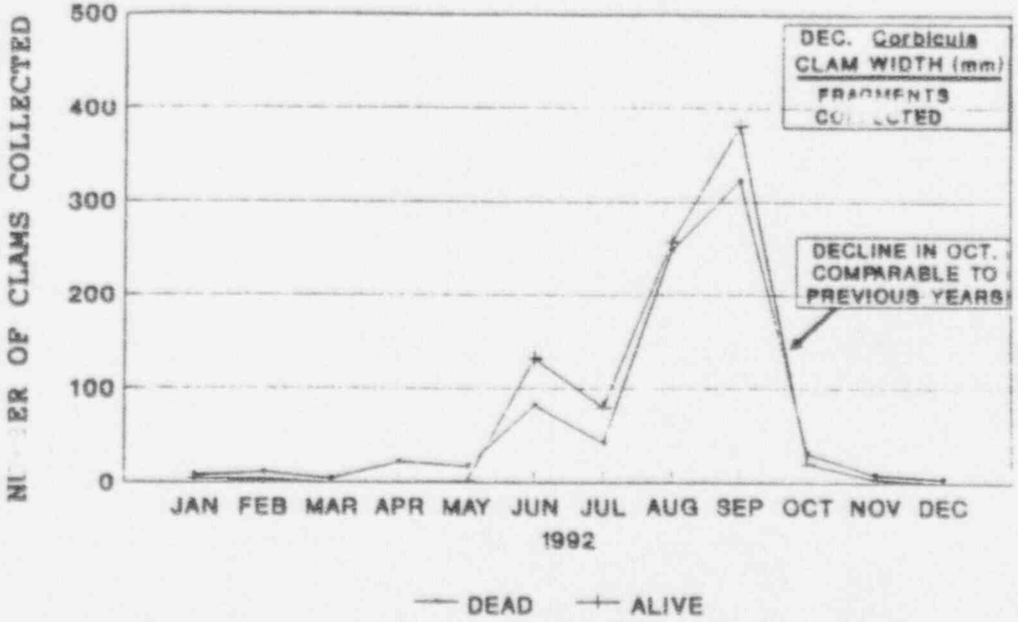
INDICATES SUMMER SPAWN IN PROGRESS

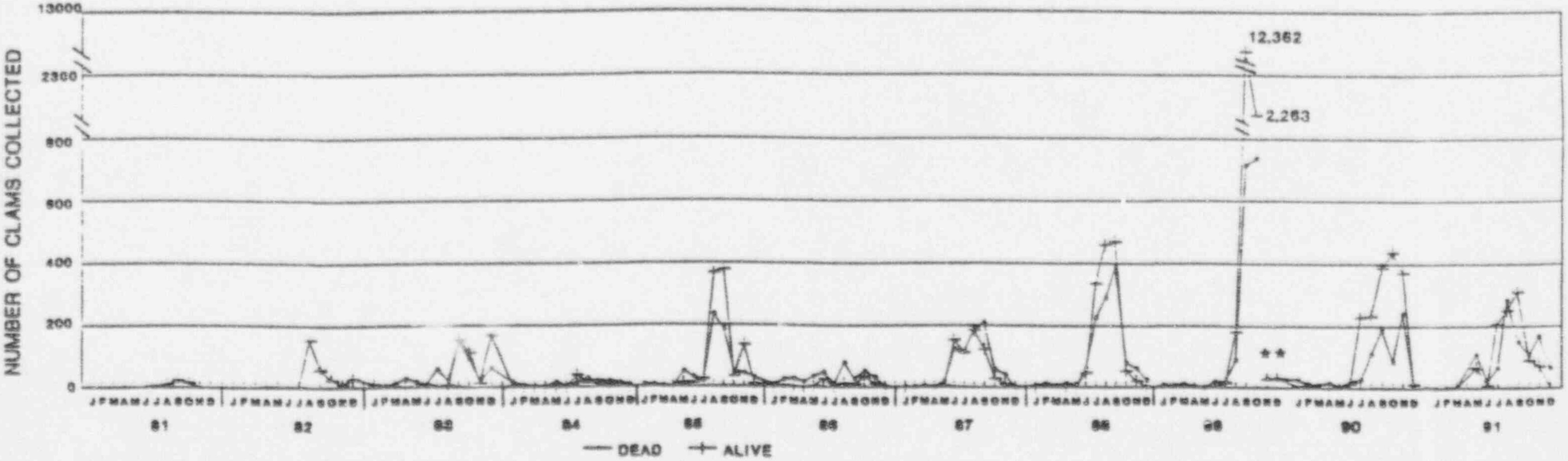
CLAMS PROBABLY ENTERED
EARLIER, BUT EXPERIENCE
MINIMAL GROWTH DUE TO
LOW RIVER TEMPERATURES.

FIGURE 8

Corbicula LARVAL CAGE 1992 DATA - INTAKE STRUCTURE

INTAKE STRUCTURE
BVPS

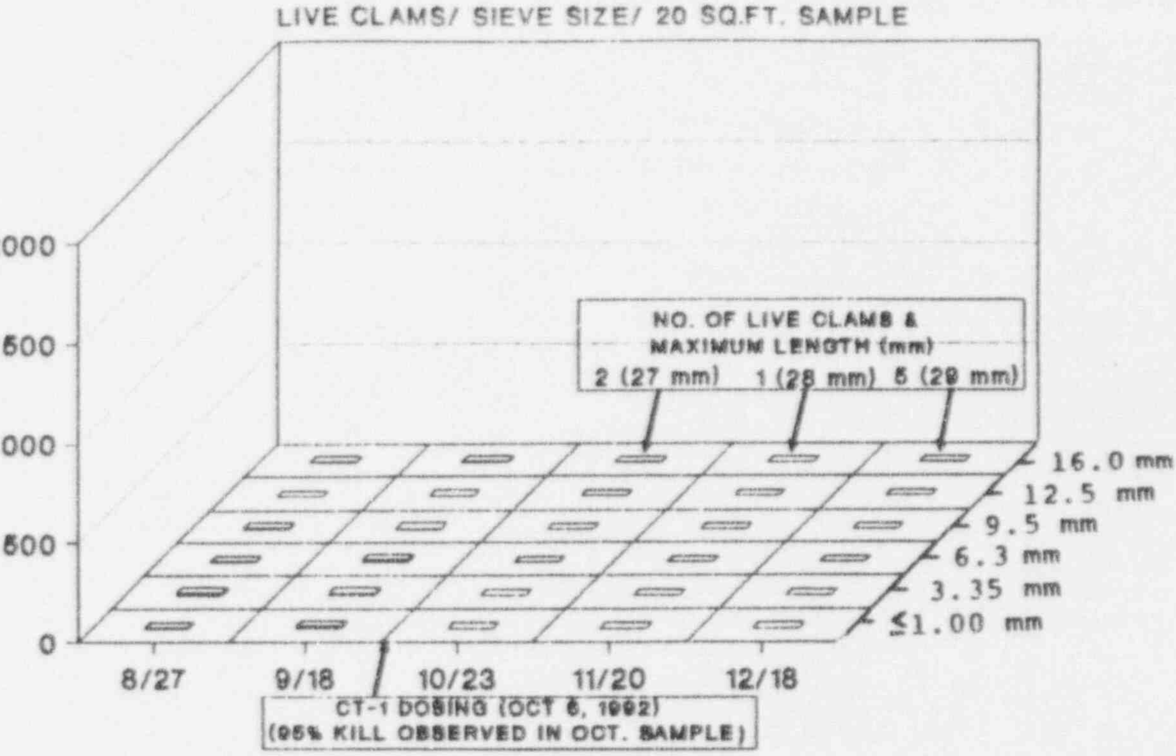




** DATA FOR NOVEMBER AND DECEMBER 1989 REPRESENTS ONLY ONE SAMPLING PERIOD FOR EACH MONTH DUE TO EITHER DIVING OR MAINTENANCE.

NUMBER OF Corbicula COLLECTED OFF TRAVELING SCREENS DURING THE IMPINGEMENT SURVEYS FOR 1981 THROUGH 1991 AND 1992 FOR MONTHS TO DATE

UNIT 1 COOLING TOWER - 1992
RESERVOIR SCRAPER SAMPLE DATA



UNIT 2 COOLING TOWER - 1992
RESERVOIR SCRAPER SAMPLE DATA

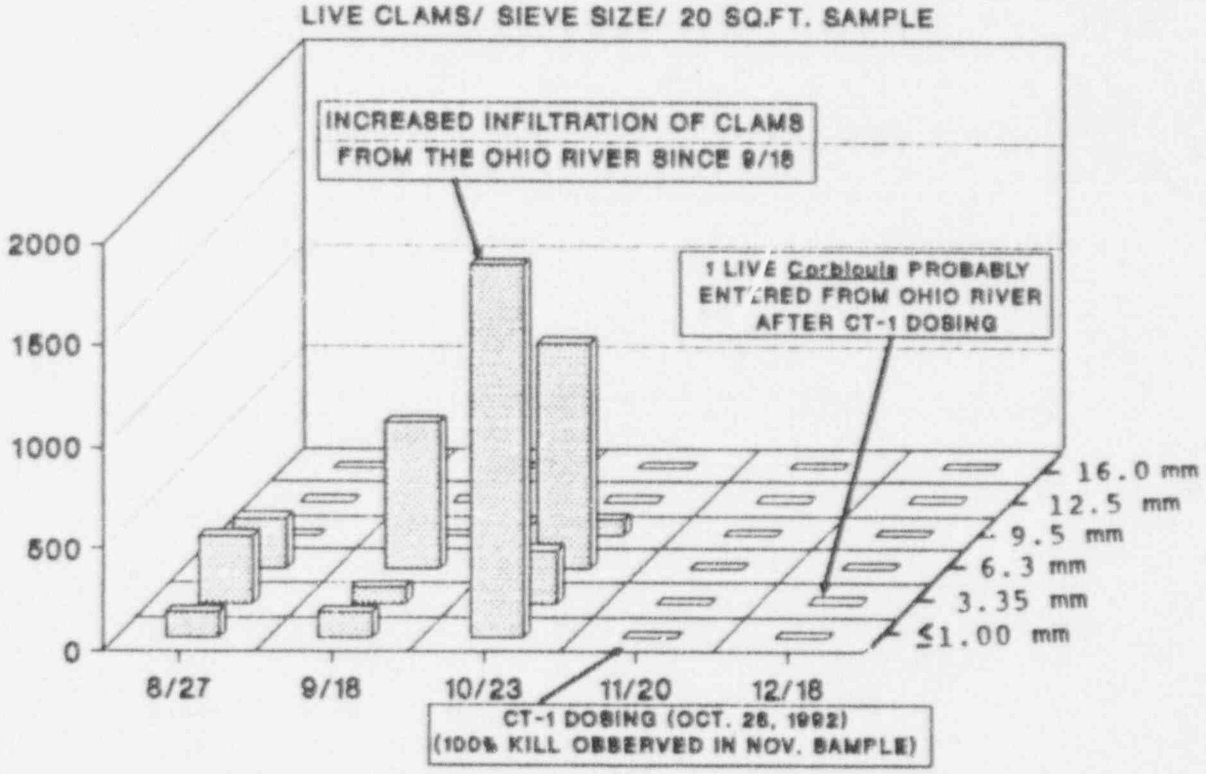


FIGURE 10

Corbicula DENSITIES AND SIZE DISTRIBUTION IN SCRAPER SAMPLES COLLECTED FROM BVPS COOLING TOWERS

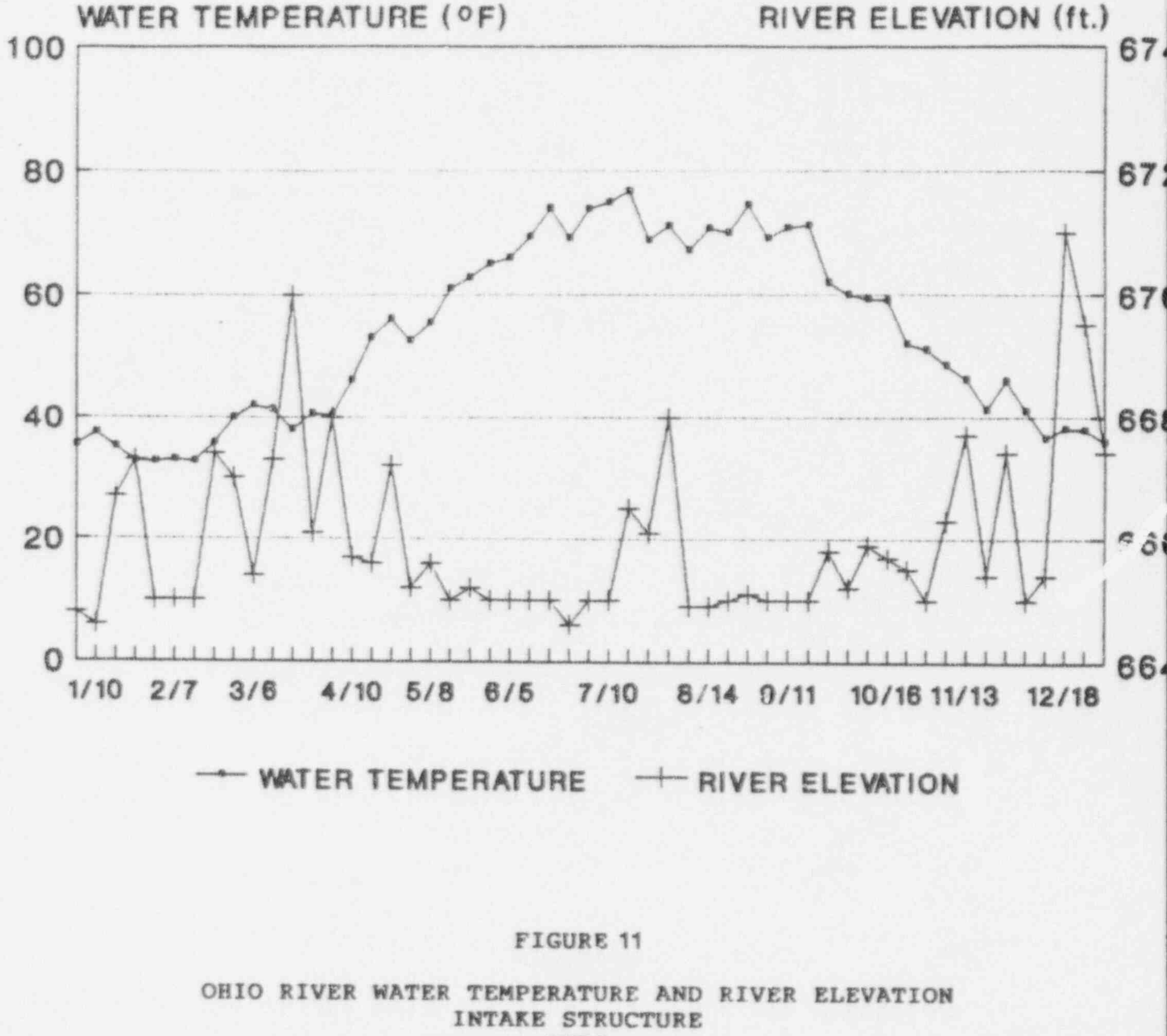


FIGURE 11

OHIO RIVER WATER TEMPERATURE AND RIVER ELEVATION
INTAKE STRUCTURE
BVPS

4.0 Summary

The efficacy of CT-1 upon *Corbicula* control in the plant was considered acceptable after each of the three dosings. *Corbicula* mortality ranged from >90 to 98-100% mortality in clams that had infiltrated bioboxes held in the cooling towers.

The clam size and growth increment data before and after the June 1992 dosing of Unit 1 through 8/20/92 and the second dosing in October, 1992 did not appear to cause any deleterious consequences to *Corbicula* held in bioboxes within the Ohio River receiving effluent below the Duquesne Light Company's Beaver Valley Power Station. Differences of 0.20 mm shell width can be significantly different for clams in dosed versus nondosed groups, intake versus effluent receiving stations, and for clams established at the beginning of a test at Day 0 or Day 16 before dosing, depending upon the length of time that measurements were obtained. Also, significant differences up to 0.38 mm in clam growth occurred for clams located at the Intake Station where clams did not experience any BVPS effluent or CT-1 exposure. Therefore, ecological consequences concerning growth impairment may occur at 0.40 mm, depending upon the initial relationship of dosed versus nondosed clam measurements and the time for clams to grow between measurements. Based upon these data, it was concluded that no ecological impairment occurred for clams held in the bioboxes during both dosings of Unit 1.

In the dosing of Unit 2, it was concluded that the declining river water temperature in latter October through early December 1992 prevented a valid assessment of *Corbicula* growth versus CT-1 influence. Thermal monitoring studies indicated that the thermal effluent of the plant had dissipated before reaching the clams in the bioboxes. Both sets of clams had reduced growth at all sampling stations and monthly growth increments of <0.10 mm were difficult to ascertain from lower detection limits of the Vernier calipers. Overall, the accumulative growth increment data base, which incorporates a larger portion of the total variability in a data set (ie, more time and interactions to access potential accumulative dosing response), provides the most relevant information. Hence, those clams which had a chance to demonstrate growth potential over a wide range of time under favorable temperature influencing conditions represent the best data base. No significant differences were found in the accumulative growth increment responses of these clams between the Intake and downstream stations that were exposed to three dosings (twice in Unit 1, once in Unit 2) and evaluated over a 162-day period of study.

5.0 Literature Cited

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Table 1. Mean width of *Corbicula* shells held in the "nondosed" group (clams located at refugium during the ~24 hr of plant dosing with CT-1:DT-1).

Station	Mean Clam Size (mm)	Significant Differences*	Growth Increment (mm)	Significant Differences*	Accumulative Growth Increment (mm)	
			Day 0 (6/6/92)			
Int	14.37	b	—		—	
P5	15.07	a	—		—	
2B	14.99	a	—		—	
P10	14.83	a	—		—	
			16 Days After River Acclimation, Prior to Dosing (6/22/92)			
Int	15.61	b	1.24	a	1.24	a
P5	16.23	a	1.24	a	1.24	a
2B	16.21	a	1.23	a	1.23	a
P10	15.99	a b	1.16	a	1.16	a
			30 Days After First Dosing (7/23/92)			
Int	17.32	b	1.72	a	2.99	a
P5	17.77	a	1.54	b	2.71	b
2B	17.88	a	1.67	a b	2.90	a b
P10	17.60	a b	1.61	a b	2.76	b
			58 Days After First Dosing (8/20/92)			
Int	18.24	b	0.92	a	3.92	a
P5	18.61	a	0.84	a	3.55	b
2B	18.83	a	0.94	a	3.84	a b
P10	18.50	a b	0.90	a	3.65	b
			104 Days After First Dosing (10/5/92)			
Int	20.33	a	2.12	a	6.04	a
P5	20.20	a	1.59	b	5.17	b
2B	20.33	a	1.50	b	5.34	b
P10	20.17	a	1.68	b	5.33	b
			122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)			
Int	20.49	a	0.16	a	6.20	a
P5	20.36	a	0.16	a	5.33	b
2B	20.47	a	0.14	a	5.48	b
P10	20.32	a	0.15	a	5.48	b
			162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)			
Int	20.56	a	0.07	a	6.27	a
P5	20.49	a	0.06	a	5.40	b
2B	20.54	a	0.07	a	5.55	b
P10	20.38	a	0.06	a	5.54	b

* Data with the same lower case letters are not significantly different from each other in this table and all tables hereafter.

Table 2. Mean width of *Corbicula* shells held in the "dosed" group (clams located at river stations throughout the ~24 hr of plant dosing with CT-1:DT-1).

Station	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant differences	Accumulative Growth Increments (mm)	
Day 0 (6/6/92)						
Int	14.13	b	—		—	
P5	14.50	b	—		—	
2B	15.88	a	—		—	
P10	15.35	a	—		—	
16 Days After River Acclimation Prior to Dosing (6/22/92)						
Int	15.11	b	0.98	a	0.98	a
P5	15.51	b	1.00	a	1.00	a
2B	16.73	a	0.85	b	0.85	b
P10	16.32	a	0.96	a	0.98	a
30 Days After First Dosing (7/23/92)						
Int	17.05	c	1.93	a	2.93	a
P5	17.43	b c	1.93	a	2.93	a
2B	18.40	a	1.67	b	2.52	b
P10	17.85	b	1.54	b	2.53	b
58 Days After First Dosing (8/20/92)						
Int	18.09	b	1.04	a	3.97	a
P5	18.26	b	0.83	b	3.77	a
2B	19.17	a	0.77	b	3.29	b
P10	18.75	a	0.89	b	3.43	b
104 Days After First Dosing (10/5/92)						
Int	19.65	b	1.74	a	5.70	a
P5	19.73	b	1.55	a b	5.12	b c
2B	20.53	a	1.37	b	4.66	c
P10	20.42	a	1.68	a	5.12	b c
122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)						
Int	19.83	b	0.17	a	5.88	a
P5	19.86	b	0.13	a b	5.45	a b
2B	20.64	a	0.11	b	4.77	c
P10	20.56	a	0.14	a b	5.25	b c
162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)						
Int	19.91	b	0.08	c	5.96	a
P5	19.98	b	0.12	a	5.56	a b
2B	20.71	a	0.07	c	4.84	c
P10	20.66	a	0.10	a b	5.36	b c

Table 3. Mean width of *Corbicula* shells held at the Intake Station (differences between nondosed vs dosed groups). Note that neither of these two clam groups experienced any effluent or molluscicide treatment.[1]

Clam Treatment[1]	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)	
Day 0 (6/6/92)						
Nondosed	14.37	a	—		—	
"Dosed"	14.13	a	—		—	
16 Days After River Acclimation (6/22/92)						
Nondosed	15.61	a	1.24	a	1.24	a
"Dosed"	15.11	b	0.98	b	0.98	b
30 Days After First Dosing (7/23/92)						
Nondosed	17.32	a	1.72	a	2.99	a
"Dosed"	17.05	a	1.93	b	2.93	a
58 Days After First Dosing (8/20/92)						
Nondosed	18.24	a	0.92	a	3.92	a
"Dosed"	18.09	a	1.04	b	3.97	a
104 Days After First Dosing, 1 Day Prior to Second Dosing (10/5/92)						
Nondosed	20.33	a	2.12	a	6.04	a
"Dosed"	19.65	b	1.74	b	5.70	b
122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)						
Nondosed	20.49	a	0.16	a	6.20	a
"Dosed"	19.83	b	0.17	a	5.88	b
162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)						
Nondosed	20.56	a	0.07	a	6.27	a
"Dosed"	19.91	b	0.08	a	5.96	b

Table 4. Mean width of *Corbicula* shells held at the P5 Station.

Clam Treatment	Mean Clam Size (mm)	Significant Difference	Growth Increments	Significant Differences	Accumulative Growth Increments (mm)
Day 0 (6/6/92)					
Nondosed	15.07	a	—		—
Dosed	14.50	b	—		—
16 Days After Acclimation (6/22/92)					
Nondosed	16.22	a	1.15	a	1.15 a
Dosed	15.51	b	1.01	b	1.01 b
30 Days After First Dosing (7/23/92)					
Nondosed	17.77	a	1.54	a	2.71 a
Dosed	17.43	a	1.93	b	2.93 a
58 Days After First Dosing (8/20/92)					
Nondosed	18.61	a	0.84	a	3.55 a
Dosed	18.26	b	0.83	a	3.77 a
104 Days After First Dosing, 1 Day Prior to Second Dosing (10/5/92)					
Nondosed	20.20	a	1.59	a	5.17 a
Dosed	19.73	a	1.55	a	5.32 a
122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)					
Nondosed	20.36	a	0.16	a	5.33 a
Dosed	19.86	b	0.13	a	5.45 a
162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)					
Nondosed	20.49	a	0.06	a	5.40 a
Dosed	19.98	b	0.12	b	5.56 a

Table 5. Mean width of *Corbicula* shells held at the 2B Station.

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
			Day 0 (6/6/92)		
Nondosed	14.99	a	—		—
Dosed	15.88	b	—		—
			16 Days After River Acclimation (6/22/92)		
Nondosed	16.21	a	1.23	a	1.23 a
Dosed	16.73	b	0.85	b	0.85 b
			30 Days After First Dosing (7/23/92)		
Nondosed	17.88	a	1.67	a	2.90 a
Dosed	18.40	b	1.67	a	2.52 b
			58 Days After Dosing (8/20/92)		
Nondosed	18.83	a	0.94	a	3.84 a
Dosed	19.17	a	0.77	b	3.29 b
			104 Days After First Dosing, 1 Day Prior to Second Dosing (10/5/92)		
Nondosed	20.33	a	1.50	a	5.34 a
Dosed	20.53	a	1.37	a	4.66 b
			122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)		
Nondosed	20.47	a	0.14	a	5.48 a
Dosed	20.64	a	0.11	a	4.77 b
			162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)		
Nondosed	20.54	a	0.07	a	5.55 a
Dosed	20.71	a	0.07	a	4.84 b

Table 6. Mean width of *Corbicula* shells held at the P10 Station.

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
Day 0 (6/6/92)					
Nondosed	14.83	a	—		—
Dosed	15.35	a	—		—
16 Days After River Acclimation (6/22/92)					
Nondosed	15.99	a	1.16	a	1.16 a
Dosed	16.31	a	0.96	b	0.96 b
30 Days After First Dosing (7/23/92)					
Nondosed	17.60	a	1.61	a	2.76 a
Dosed	17.85	a	1.54	a	2.53 a
58 Days After First Dosing (8/20/92)					
Nondosed	18.50	a	0.90	a	3.65 a
Dosed	18.75	a	0.89	a	3.43 a
104 Days After First Dosing, 1 Day Prior to Second Dosing (10/5/92)					
Nondosed	20.17	a	1.68	a	5.33 a
Dosed	20.42	a	1.68	a	5.13 a
122 Days After First Dosing, 17 Days After Second Dosing (10/23/92)					
Nondosed	20.32	a	0.15	a	5.48 a
Dosed	20.56	a	0.14	a	5.25 a
162 Days After First Dosing, 57 Days After Second Dosing, 35 Days After Third Dosing (12/2/92)					
Nondosed	20.38	a	0.06	a	5.54 a
Dosed	20.66	a	0.10	b	5.36 a

Table 7. Mean width of *Corbicula* shells held in the "nondosed" and dosed groups during the Unit 1 second dosing and dosing of Unit 2.

Station	Mean Clam Size (mm)	Significant Differences	Growth Increment	Significant Differences	Accumulative Growth Increments (mm)
Nondosed Clams, River Acclimation Since September 21, Day 0 (10/5/92)					
Int	14.92	b	—		—
P5	14.66	b	—		—
2B	14.99	b	—		—
P10	15.41	a	—		—
Nondosed Clams 17 Days After Unit 1 Second Dosing and Prior to Dosing Unit 2 (10/23/92)					
Int	15.39	b	0.47	a	—
P5	15.13	b	0.47	a	—
2B	15.34	b	0.36	b	—
P10	15.81	a	0.39	b	—
Nondosed clams 57 Days After Unit 1 Second Dosing (12/2/92)					
Int	15.55	b	0.16	a	0.63 a
P5	15.21	b	0.08	b	0.55 b
2B	15.42	b	0.08	b	0.44 b c
P10	15.90	a	0.10	b	0.49 c
Dosed Clams, Day 0 (10/5/92)					
Int	14.74	c	—		—
P5	15.13	a	—		—
2B	15.10	a b	—		—
P10	14.71	b c	—		—
Dosed Clams 17 Days After Unit 1 Second Dosing and Prior to Dosing Unit 2 (10/23/92)					
Int	15.23	a	0.55	a	—
P5	15.46	a	0.33	b	—
2B	15.42	a	0.32	b	—
P10	15.22	a	0.51	a	—
Dosed Clams 57 Days After Unit 1 Second Dosing (12/2/92)					
Int	15.46	a	0.17	a	0.72 a
P5	15.62	a	0.15	a	0.48 c
2B	15.88	a	0.16	a	0.48 c
P10	15.34	a	0.12	b	0.63 b

Table 8. Mean width of *Corbicula* shells held at the four stations (Intake, P5, 2B, P10) between "nondosed" and dosed groups during the Unit 1 second dosing and dosing of Unit 2 (dosing dates in Fig. 3).

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
Intake - Day 0					
Nondosed	14.92	a	—		—
Dosed	14.74	a	—		—
Intake - 17 Days After Unit 1 Second Dosing					
Nondosed	15.39	a	0.47	a	—
Dosed	15.29	a	0.55	a	—
Intake - 57 Days After Unit 1 Second Dosing					
Nondosed	15.55	a	0.16	a	0.63 a
Dosed	15.46	a	0.17	a	0.72 b
P5 - Day 0					
Nondosed	14.66	a	—		
Dosed	15.13	b	—		
P5 - 17 Days After Unit 1 Second Dosing River Acclimation					
Nondosed	15.13	a	0.47	a	—
Dosed	15.46	a	0.33	b	—
P5 - 57 Days After Unit 1 Second Dosing					
Nondosed	15.21	a	0.08	a	0.55 a
Dosed	15.62	b	0.15	b	0.49 b
2B - Day 0					
Nondosed	14.99	a	—		—
Dosed	15.10	a	—		—
2B - 17 Days After Unit 1 Second Dosing					
Nondosed	15.34	a	0.36	a	—
Dosed	15.43	a	0.32	a	—
2B - 57 Days After Unit 1 Second Dosing					
Nondosed	15.42	a	0.08	a	0.44 a
Dosed	15.58	a	0.16	b	0.48 a
P10 - Day 0					
Nondosed	15.41	a	—		—
Dosed	14.71	b	—		—
P10 - 17 Days After Unit 1 Second Dosing					
Nondosed	15.81	a	0.39	a	—
Dosed	15.22	b	0.51	b	—
P10 - 57 Days After Unit 1 Second Dosing					
Nondosed	15.90	a	0.10	a	0.49 a
Dosed	15.34	b	0.12	a	0.63 b

Table 9. Thermal dissipation of the BVPS discharge into the Ohio River receiving system.

Station	Water Temp °F	Depth ft	Time
		October 9, 1992	
Intake Surface (Sur)	59.5	1	0910
Bottom (Bot)	59.5	8	
Discharge	74.6	2	0905
P5 Sur	59.4	1	0857
Bot	59.4	6	
2B Sur	59.3	1	0855
Bot	59.3	9	
P10 Sur	59.2	1	0850
Bot	59.2	7	
		October 23, 1992	
Intake Sur	51.7	1	1543
Bot	51.6	6	
Discharge	66.6	2	1537
P5 Sur	51.7	1	1535
Bot	51.6	6	
2B Sur	51.6	1	1525
Bot	51.6	7	
P10 Sur	52.1	1	1520
Bot	52.0	6	
		October 26, 1992	
Intake Sur	50.0	1	1205
Bot	50.0	7	
Discharge	65.2	2	1202
P5 Sur	50.0	1	
Bot	50.0	6	1200
2B Sur	52.0	1	1157
Bot	51.0	5	
P10 Sur	50.0	1	1155
Bot	50.0	7	
		October 30, 1992	
Intake Sur	50.0	1	1600
Bot	50.0	5	
Discharge	62.6	2	1605
P5 Sur	55.0	1	1612
Bot	50.4	7	
2B Sur	51.1	1	1617
Bot	51.0	7	
P10 Sur	50.5	1	1621
Bot	50.6	6	

6.0 Appendix

6.1 Growth Data from Subsampled Groups of 10 Clams

6.2 Data from DLC Chemistry Department for CT-1 Measurements

6.3 Ohio River Flow (cfs) and Temperature (°F) New Cumberland Pool, 1992 BVPS)

6.1 Growth Data from Subsampled Groups of 10 Clams

Table 1 Appen. Mean width of *Corbicula* shells held in the "nondosed" group (clams located at refugium during the ~24 hr of plant dosing with CT-1:DT-1) subsampled group of 10 clams. (See Table 1 for more comprehensive description).

Station	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increment (mm)	
			Day 0 (6/6/92)			
Int	14.72	a	—		—	
P5	14.90	a	—		—	
2B	14.85	a	—		—	
P10	14.87	a	—		—	
			16 Days After River Acclimation (6/22/92)			
Int	15.91	a	1.18	a b	—	
P5	16.11	a	1.21	a b	—	
2B	16.21	a	1.28	a	—	
P10	15.97	a	1.10	b	—	
			30 Days After First Dosing (7/23/92)			
Int	17.61	a	1.71	a	2.85	a b
P5	17.66	a	1.55	b	3.03	b
2B	17.85	a	1.71	a	2.68	a
P10	17.56	a	1.59	a b	2.43	b
			58 Days After First Dosing (8/20/92)			
Int	18.54	a	0.93	a b	3.86	a b
P5	18.84	a	0.82	b	3.89	b c
2B	18.82	a	0.97	a	3.50	a
P10	18.39	a	0.84	b	3.30	c
			104 Days After First Dosing (10/5/92)			
Int	20.65	a	2.11	a	5.55	a
P5	20.06	a b	1.59	b	5.47	b
2B	20.40	a b	1.59	b	4.46	b
P10	20.02	b	1.63	b	5.00	b
			122 Days After First Dosing (10/23/92)			
Int	20.83	a	0.18	a	5.72	a
P5	20.22	a b	0.16	a	5.60	b
2B	20.36	a b	0.16	a	5.09	b
P10	20.14	b	0.12	a	5.12	b
			162 Days After First Dosing: (12/2/92)			
Int	20.91	a	0.07	a	5.81	a
P5	20.29	a b	0.06	a	5.72	b
2B	20.63	a b	0.07	a	5.14	b
P10	20.20	b	0.05	a	5.21	b

* Data with the same lower case letters are not significantly different from each other.

Table 2 Appen. *Mean* width of *Corbicula* shells held in the "dosed" group (clams located at river stations throughout the ~24 hr of plant dosing with CT-1/DT-1) <u>subsampled group of 10 clams</u> (per Table 1 Appen).

Station	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant differences ($\alpha = 0.05$)	Accumulative Growth Increments (mm)
<u>Day 0 (6/6/92)</u>					
Int	14.64	b c	—		—
P5	14.29	c	—		—
2B	15.17	a b	—		—
P10	15.24	a	—		—
<u>16 Days After River Acclimation (6/22/92)</u>					
Int	15.59	b	0.95	a	—
P5	15.32	b	1.04	a	—
2B	16.07	a	0.90	a	—
P10	16.18	a	0.95	a	—
<u>30 Days After First Dosing (7/23/92)</u>					
Int	17.49	a	1.90	a	2.85 a
P5	17.32	a	2.00	a	3.03 a
2B	17.84	a	1.77	a	2.68 a
P10	17.67	a	1.49	b	2.43 b
<u>58 Days After First Dosing (8/20/92)</u>					
Int	18.51	a	1.01	a	3.86 a
P5	18.18	a	0.86	b	3.89 a
2B	18.67	a	0.82	b	3.50 a
P10	18.54	a	0.87	b	3.30 a
<u>104 Days After First Dosing (10/5/92)</u>					
Int	20.19	a b	1.69	a	5.55 a
P5	19.76	b	1.57	a	5.47 a
2B	20.21	a b	1.46	a	4.96 a
P10	20.24	a	1.70	a	5.00 a
<u>122 Days After First Dosing (10/23/92)</u>					
Int	20.36	a	0.18	a	5.72 a
P5	19.89	a	0.13	a	5.60 a
2B	20.25	a	0.13	a	5.09 a
P10	20.36	a	0.12	a	5.12 a
<u>162 Days After First Dosing (12/2/92)</u>					
Int	20.45	a	0.08	b c	5.81 a
P5	20.01	a	0.13	a	5.72 a
2B	20.30	a	0.05	c	5.14 a
P10	20.45	a	0.09	a b	5.21 a

Table 3 Appen. Mean width of *Corbicula* shells held at the Intake Station (differences between nondosed vs dosed groups) subsampled group of 10 clams. Note that neither of these two clam groups experienced any effluent or molluscicide treatment.[1]

Clam Treatment[1]	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)	
Day 0 (6/6/92)						
Nondosed	14.72	a	—		—	
"Dosed"	14.64	a	—		—	
16 Days After River Acclimation						
Nondosed	15.90	a	1.18	a	—	
"Dosed"	15.59	a	0.95	b	—	
30 Days After First Dosing						
Nondosed	17.61	a	1.71	a	2.89	a
"Dosed"	17.49	a	1.90	b	2.85	a
58 Days After First Dosing						
Nondosed	18.54	a	0.93	a	3.82	a
"Dosed"	18.51	a	1.01	a	3.86	a
104 Days After First Dosing						
Nondosed	20.65	a	2.11	a	5.93	a
"Dosed"	20.19	a	1.68	b	5.55	b
122 Days After First Dosing						
Nondosed	20.84	a	0.18	a	6.12	a
"Dosed"	20.36	a	0.18	a	5.72	b
162 Days After First Dosing (12/2/92)						
Nondosed	20.91	a	0.07	a	6.19	a
"Dosed"	20.45	a	0.08	a	5.81	b

Table 4 Appen. Mean width of *Corbicula* shells held at the P5 Station - subsampled group of 10 clams.

Clam Treatment	Mean Clam Size (mm)	Significant Difference	Growth Increments	Significant Differences	Accumulative Growth Increments (mm)
Day 0					
Nondosed	14.90	a	—		—
Dosed	14.29	b	—		—
16 Days Aster River Acclimation					
Nondosed	16.11	a	1.21	a	—
Dosed	15.32	b	1.04	b	—
30 Days After First Dosing (7/23/92)					
Nondosed	17.66	a	1.55	a	2.76 a
Dosed	17.32	a	2.00	b	3.03 b
58 Days After First Dosing					
Nondosed	18.48	a	0.82	a	3.58 a
Dosed	18.18	a	0.86	a	3.89 b
104 Days After First Dosing (10/5/92)					
Nondosed	20.06	a	1.59	a	5.16 a
Dosed	19.76	a	1.57	a	5.47 a
122 Days After First Dosing (10/23/92)					
Nondosed	20.22	a	0.16	a	5.32 a
Dosed	19.89	a	0.13	a	5.60 a
162 Days After First Dosing (12/2/92)					
Nondosed	20.29	a	0.06	a	5.38 a
Dosed	20.01	a	0.13	b	5.22 a

Table 5 Appen. Mean width of *Corbicula* shells held at the 2B Station - subsampled group of 10 clams.

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
Day 0 (start)					
Nondosed	14.85	a	—		—
Dosed	15.17	a	—		—
16 Days After River Acclimation					
Nondosed	16.14	a	1.28	a	—
Dosed	16.07	a	0.90	b	—
30 Days After First Dosing (7/23/92)					
Nondosed	17.85	a	1.71	a	3.00 a
Dosed	17.84	a	1.77	a	2.86 a
58 Days After First Dosing (8/20/92)					
Nondosed	18.82	a	0.97	a	3.97 a
Dosed	18.67	a	0.82	a	3.50 a
104 Days After First Dosing (10/5/92)					
Nondosed	20.40	a	1.58	a	5.55 a
Dosed	20.12	a	1.46	a	4.96 a
122 Days After First Dosing (10/23/92)					
Nondosed	20.56	a	0.16	a	5.71 a
Dosed	20.25	a	0.13	a	5.09 a
162 Days After First Dosing (12/2/92)					
Nondosed	20.63	a	0.07	a	5.77 a
Dosed	20.30	a	0.05	a	5.14 a

Table 6 Appen. Mean width of *Corbicula* shells held at the P10 Station - subsampled group of 10 clams.

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
Day 0					
Nondosed	14.87	a	—		—
Dosed	15.24	a	—		—
16 Days After River Acclimation					
Nondosed	15.97	a	1.10	a	—
Dosed	16.18	a	0.95	a	—
30 Days After First Dosing (7/23/92)					
Nondosed	17.56	a	1.59	a	2.69 a
Dosed	17.67	a	1.49	a	2.43 a
58 Days After First Dosing (8/20/92)					
Nondosed	18.39	a	0.84	a	3.53 a
Dosed	18.54	a	0.87	a	3.30 a
104 Days After First Dosing (10/5/92)					
Nondosed	20.02	a	1.63	a	5.15 a
Dosed	20.24	a	1.70	a	5.00 a
122 Days After First Dosing (10/23/92)					
Nondosed	20.14	a	0.12	a	5.27 a
Dosed	20.36	a	0.12	a	5.12 a
162 Days After First Dosing (12/2/92)					
Nondosed	20.20	a	0.05	a	5.33 a
Dosed	20.45	a	0.09	b	5.21 a

Table 7 Appen. Mean width of *Corbicula* shells held in the "nondosed" and dosed groups during the Unit 1 second dosing and dosing of Unit 2 - subsampled group of 10 clams.

Station	Mean Clam Size (mm)	Significant Differences	Growth Increment	Significant Differences	Accumulative Growth Increments (mm)	
Nondosed Clams, River Acclimation Since September 21, Day 0 (10/5/92)						
Int	14.86	a	—		—	
P5	14.81	a	—		—	
2B	14.85	a	—		—	
P10	14.88	a	—		—	
Nondosed Clams 17 Days After Unit 1 Second Dosing and Prior to Dosing (10/23/92)						
Int	15.35	a	0.50	a	—	
P5	15.29	a	0.48	a	—	
2B	15.19	a	0.33	b	—	
P10	15.29	a	0.41	a	—	
Nondosed Clams 57 Days After Unit 1 Second Dosing (12/2/92)						
Int	15.49	a	0.14	a	0.65	a
P5	15.37	a	0.08	b	0.55	b
2B	15.27	a	0.09	b	0.42	c
P10	15.40	a	0.11	a b	0.52	b c
Dosed Clams, Day 0 (10/5/92)						
Int	14.87	a	—		—	
P5	14.87	a	—		—	
2B	14.86	a	—		—	
P10	14.87	a	—		—	
Dosed Clams 17 Days After Unit 1 Second Dosing (10/23/92)						
Int	15.41	a	0.54	a	—	
P5	15.24	a b	0.37	b	—	
2B	15.18	b	0.32	b	—	
P10	15.39	a	0.52	a	—	
Dosed Clams 57 Days After Unit 1 Second Dosing (12/2/92)						
Int	15.58	a	0.17	a b	0.71	a
P5	15.40	a b	0.16	a b	0.52	b
2B	15.35	b	0.17	a	0.49	b
P10	15.52	a b	0.13	b	0.65	a

Table 8 Appen. Mean width of *Corbicula* shells held at the four stations between nondosed and dosed groups during the Unit 1 second dosing and dosing of Unit 2 - subsampled group of 10 clams.

Clam Treatment	Mean Clam Size (mm)	Significant Differences	Growth Increment (mm)	Significant Differences	Accumulative Growth Increments (mm)
Intake - Day 0					
Nondosed	14.85	a	—		—
Dosed	14.87	a	—		—
Intake - 17 Days After Unit 1 Second Dosing					
Nondosed	15.35	a	0.50	a	—
Dosed	15.41	a	0.54	a	—
Intake - 57 Days After Unit 1 Second Dosing					
Nondosed	15.49	a	0.14	a	0.65 a
Dosed	15.58	a	0.17	a	0.71 a
P5 - Day 0					
Nondosed	14.81	a	—		
Dosed	14.87	a	—		
P5 - 17 Days After Unit 1 Second Dosing					
Nondosed	15.29	a	0.48	a	—
Dosed	15.24	a	0.37	b	—
P5 - 57 Days After Unit 1 Second Dosing					
Nondosed	15.37	a	0.08	a	0.55 a
Dosed	15.40	a	0.16	b	0.52 a
2B - Day 0					
Nondosed	14.86	a	—		—
Dosed	14.86	a	—		—
2B - 17 Days After Unit 1 Second Dosing					
Nondosed	15.19	a	0.33	a	—
Dosed	15.18	a	0.32	a	—
2B - 57 Days After Unit 1 Second Dosing					
Nondosed	15.27	a	0.09	a	0.42 a
Dosed	15.35	a	0.17	b	0.49 a
P10 - Day 0					
Nondosed	14.88	a	—		—
Dosed	14.87	a	—		—
P10 - 17 Days After Unit 1 Second Dosing					
Nondosed	15.29	a	0.41	a	—
Dosed	15.39	a	0.52	b	—
P10 - 57 Days After Unit 1 Second Dosing					
Nondosed	15.40	a	0.11	a	0.52 a
Dosed	15.52	a	0.13	a	0.65 b

6.2 Data from DLC Chemistry Department for CT-1 Measurements

Table 9 Appen. Communication by Mr. D. A. Orndorf, Chemistry Operations Director of Duquesne Light Company, to Mr. A. M. Dulick regarding *Corbicula* control application data for Unit 1 (6/23/92, 10/6/92 and 10/28/92). Three separate tables, each with a cover letter are included.

DUQUESNE LIGHT COMPANY
Chemistry Department

July 13,1992

Corbicula Control Application

A. M. Dulick:

On June 23, 1992, a clamicide application was performed on Beaver Valley Power Station Unit 1. Clamicide (CT-1) and detoxification (DT-1) introduction was initiated at approximately 1030 hours and the CT-1 was isolated at approximately 2130 hours. Detoxification of all plant systems including cooling tower, was complete by 0230 hours on June 24, 1992. The application resulted in turbine plant river water systems being exposed to >9 ppm clamicide for 9 hours, reactor plant river water systems exposed to >13 ppm for 10 hours or more and the cooling tower exposed to clamicide levels >8 ppm for about 11 hours. The above contact times coupled with a river water temperature during the application of 74°F led to a near 100% mortality rate for the test specimens; 18 out of 20 large clams within six days and 12 out of 14 small clams within four days.

During the application, 4605 pounds of CT-1 was used as well as 4787 pounds of clay for detoxification. An additional 2841 pounds of clay was used to complete the cooling tower detoxification after the in-plant systems were detoxified. This resulted in a clay to CT-1 ratio of 1.04/1 during the application and an overall ratio of 1.65/1.

D. A. Orndorf
Chemistry Operations Director

DAO/ijj

cc: T. P. Noonan
P. Sena
J. W. McIntire
V. J. Linnenbom
N. R. Tonet

UNIT 1 CLAMICIDE ADDITION
6/23/92

DATE	TIME	CCR	CCT	COOLING TOWER	CB-11 OUT	MAIN OUT
6/23/92	1115	13.9	5.4	8.4	<.2	<.2
6/23/92	1230	14.1	9.1	9.5	<.2	<.2
6/23/92	1340	14.6	17.3	8.9	<.2	<.2
6/23/92	1550			8.2	<.2	<.2
6/23/92	1640		21.2	10.5	<.2	<.2
6/23/92	1830	16.2		13.7	<.2	<.2
6/23/92	2000					<.2
6/23/92	2145	<.2	<.2	13.9	<.2	<.2
6/23/92	2300			5.7		<.2
6/24/92	0030					
6/24/92	0150			<.2		<.2

DUQUESNE LIGHT COMPANY
Chemistry Department

November 18, 1992

Corbicula Control Application

A. M. Dulick:

On October 6, 1992, a clamicide application was performed on Beaver Valley Power Station Unit 1. Clamicide (CT-1) and detoxification (DT-1) introduction was initiated at approximately 0630 hours and the CT-1 was isolated at approximately 2030 hours. Detoxification of all plant systems, including cooling tower, was complete by 2355 hours on October 6, 1992. The application resulted in turbine plant river water systems being exposed to > 22 ppm clamicide for 16 hours, reactor plant river water systems exposed to >13 ppm for 16 hours or more and the cooling tower exposed to clamicide levels >9 ppm for about 13 hours. The above contact times led to a 100% mortality rate for the test specimens within six days.

During the application, 5344 pounds of CT-1 was used as well as 5100 pounds of clay for detoxification. An additional 2791 pounds of clay was used to complete the cooling tower detoxification after the in-plant systems were detoxified. This resulted in a clay to CT-1 ratio of 0.95/1 during the application and an overall ratio of 1.47/1.

D. A. Orndorf
Chemistry Operations Director

DAO/ijj

cc: T. P. Noonan
P. Sena
J. W. McIntire
V. J. Linnenbom
N. R. Tonet

UNIT 1 CLAMICIDE ADDITION
10/6/92

DATE	TIME	CCR	CCT	COOLING TOWER	CB-11 OUT	MAIN OUT
10/6/92	0700	19.0	24.5	1.2	<.2	<.2
10/6/92	0830	21.4	24.0	9.0	<.2	<.2
10/6/92	0930	21.3	27.6	10.8	<.2	<.2
10/6/92	1100			11.7	<.2	<.2
10/6/92	1245	12.9	22.5	13.4	<.2	<.2
10/6/92	1430			18.4	<.2	<.2
10/6/92	1615	23.9	26.2	15.8	<.2	<.2
10/6/92	1800			16.6	<.2	<.2
10/6/92	1930			17.2	<.2	<.2
10/6/92	2030	15.5	26.4		<.2	
10/6/92	2135	<.2	<.2	9.8		<.2
10/6/92	2240			0.5		
10/6/92	2245					<.2
10/6/92	2300			<.2	<.2	

DUQUESNE LIGHT COMPANY
Chemistry Department

November 19, 1992

Corbicula Control Application

A. M. Dulick:

On October 28, 1992, a clamicide application was performed on Beaver Valley Power Station Unit 2. Clamicide (CT-1) and detoxification (DT-1) introduction was initiated at approximately 0600 hours and the CT-1 was isolated at approximately 2200 hours. Detoxification of all plant systems, including cooling tower, was complete by 0135 hours on October 29, 1992. The application resulted in turbine plant river water systems being exposed to >13 ppm clamicide for 16 hours, reactor plant river water systems exposed to >17 ppm for 16 hours or more and the cooling tower exposed to clamicide levels >8 ppm for abut 12 hours. The above contact times led to a 100% mortality rate for the test specimens within six days.

During the application, 5327 pounds of CT-1 was used as well as 6067 pounds of clay for detoxification. An additional 2272 pounds of clay was used to complete the cooing tower detoxification after the in-plant systems were detoxified. This resulted in a clay to CT-1 ratio of 1.14/1 during the application and an overall ratio of 1.56/1.

D. A. Orndorf
Chemistry Operations Director

DAO/ijj

cc: T. P. Noonan
P. Sena
J. W. McIntire
V. J. Linnenbom
N. R. Tonet

UNIT 2 CLAMICIDE ADDITION
10/28/92

DATE	TIME	A CCP	B CCP	CCS	COOLING TOWER	EOF OUT	MAIN OUT
10/28/92	0700	17.7	18.0	13.7		<.2	<.2
10/28/92	0800	19.7	17.7	13.8	5.9	<.2	<.2
10/28/92	0930			18.2	7.2	<.2	<.2
10/28/92	1100				8.1	<.2	<.2
10/28/92	1300				8.1	<.2	<.2
10/28/92	1530				9.8	<.2	<.2
10/28/92	1730				10.3	<.2	<.2
10/28/92	1930			21.3	10.8	<.2	<.2
10/28/92	2130				11.5	<.2	<.2
10/28/92	2230						
10/28/92	2245			1.7			
10/28/92	2330	<.2	<.2	<.2	0.78	<.2	<.2
10/29/92	0030				0.22		<.2
10/29/92	0100				<.2		

6.3 Ohio River Flow (cfs) and Temperature (°F) New Cumberland Pool, 1992 BVPS

OHIO RIVER FLOW (cfs) AND TEMPERATURE (°F) RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS FOR THE NEW CUMBERLAND POOL, 1992, BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow (cfs x 10^3)												
Monthly Maximum	77.5	86.7	113.3	87.5	52.4	17.0	91.5	93.8	106.6	35.7	86.1	126.1
Monthly Average	30.9	37.5	56.5	55.5	26.7	9.0	42.0	30.1	34.6	23.0	48.8	53.4
Monthly Minimum	14.5	9.6	32.8	29.1	8.2	4.1	4.1	6.5	10.6	10.1	11.8	14.7
Temperature (°F)												
Monthly Maximum	39	38	45	56	68	78	81	76	76	63	52	40
Monthly Average	36	34	40	51	61	74	79	73	71	58	47	38
Monthly Minimum	33	32	37	42	53	64	76	69	64	52	43	36

FLOWS ON DAYS OF CT-1 DOSING AT BVPS

DATE	NEW CUMBERLAND POOL (cfs)
Jun 23, 1992	7,100
Oct 6, 1992	26,100
Oct 28, 1992	16,000