

UTILITY Duquesne Light Co.

SITE Beaver Valley 1#2

ENCLOSURES Answers to Questions

- (1) Beaver Valley Unit 1 - Impingement /
Entrapment Monitoring Report OFE 8700 CW0629
- (2) 1/31/89 Observations of gizzard Shad. in
Discharge of BVPS. ~~Jan~~ Jan 12, 89
- (3) 1983 Annual Environment Report Non Radiological
Duquesne Light Unit 1
- (4) 1989 Annual Environmental Report
Units 1#2

WASTE MANAGEMENT QUESTIONS

A. Spent Fuel Questions:

1. Which of the following current techniques for at-reactor storage are you using and how?

A. Re-racking of spent fuel.
D. Longer fuel burnup.

2. Do you plan on continuing the use of these current techniques for at-reactor storage of spent fuel during the remaining time of your operating license or do you expect to change or modify them in some way?

Modify.

3. Which of the following techniques for at-reactor storage do you anticipate using until off-site spent fuel storage becomes available and how?

A. Re-racking of spent fuel.
C. Above ground dry storage.
D. Longer fuel burnup.
E. Rod Consolidation

4. Will the techniques described above be adequate for continued at-reactor storage of spent fuel for the operating lifetime of the plant, including a 20-year period of license renewal, or are you developing other plans?

Adequate

5. Do you anticipate the need to acquire additional land for the storage of spent-fuel for the operating lifetime of the plant, including a 20-year period of license renewal. If so, how much land? When would this acquisition occur? Where?

No.

6. Do you anticipate any additional construction activity on-site, or immediately adjacent to the power plant site, associated with the continued at-reactor storage of spent fuel for the operating lifetime of the plant, including a 20-year period of license renewal?

Yes.

7. If you answered yes to question 6, briefly describe this construction activity.

Building above ground dry storage facilities.

B. Low-level Radioactive Waste Management Questions:

1. Under the current scheme for LLRW disposal (i.e. LLRW Policy Amendments Act of 1985 and regional compacts) is there currently or will sufficient capacity for wastes generated during the license renewal period be available to your plant(s)? If so, what is the basis for this conclusion?

We have constructed a waste storage facility with sufficient capacity to store five years worth of BVPS waste.

2. If for any reason your plant(s) is/are denied access to a licensed disposal site for a short period of time, what plans do you have for continued LLRW disposal?

Our facility is already complete and available for storage.

3. In a couple of pages, please describe the specific methods of LLRW management currently utilized by your plant. What percentage of your current LLRW (by volume) is managed by:

- A. Waste compaction? 1%
- B. Waste segregation (through special controls or segregation at radiation check point)? 0
- C. Decontamination of wastes? 0
- D. Sorting of waste prior to shipment? 0
- E. Other? Commingled radioactive material is shipped offsite to vendors that segregate, compact, decontaminate, and incinerate the waste.

4. In a couple of pages, please describe the anticipated plans for LLRW management to be utilized by your plant(s) during the remainder of the operating license and through the license renewal term. What percentage of your anticipated waste (by volume) will be managed by:

- A. Waste compaction? 1%
- B. Waste segregation (through special controls or segregation at radiation check points)? 0
- C. Decontamination of wastes? 0
- D. Sorting of waste prior to shipment? 0
- E. Other? Same as Q.3

5. Do you anticipate the need to acquire additional land for the storage of LLRW for the operating lifetime of the plant, including a 20-year period of license renewal? If so, how much land? When would this acquisition occur? Where?

No

6. To provide information on the timing of future low-level waste streams, if you answered yes to question #5, over what periods of time are these activities contemplated? N/A

7. Do you anticipate any additional construction activity, on-site, or immediately adjacent to the power plant site, associated with temporary LLRW storage for the operating lifetime of the plant, including a 20-year period of license renewal?

Yes

8. If you answered yes to question 7, briefly describe this construction activity.

Storage areas for steam generator components.

9. To provide information on future low-level waste streams which may effect workforce levels, exposure, and waste compact planning, do you anticipate any major plant modifications or refurbishment that are likely to generate unusual volumes of low-level radioactive waste prior to, or during, the relicensing period for the plant? If so, please describe these activities. Also, what types of modifications do you anticipate to be necessary to achieve license renewal operation through a 20-year license renewal term?

Potential for reracking of the Unit 1 fuel pool.

C. Mixed Low-level Radioactive Waste Question:

1. If your plant generates mixed LLRW, how is it currently being stored and what plans do you have for managing this waste during the license renewal period?

AQUATIC RESOURCE QUESTIONS

1. Post-licensing modifications and/or changes in operations of intake and/or discharge systems may have altered the effects of the power plant on aquatic resources, or may have been made specifically to mitigate impacts that were not anticipated in the design of the plant. Describe any such modifications and/or operational changes to the condenser cooling water intake and discharge systems since the issuance of the Operating License.

There have been no post-licensing modifications in the operations of intake or discharge systems.

2. Summarize and describe (or provide documentation of) any known impacts on aquatic resources (e.g., fish kills, violations of discharge permit conditions) or National Pollutant Discharge Elimination System (NPDES) enforcement actions that have occurred since issuance of the Operating License. How have these been resolved or changed over time? (The response to this question should indicate whether impacts are ongoing or were the result of start-up problems that were subsequently resolved.)

Please see the attached 1983 Annual Environmental Report Non-Radiological Appendix A Report Concerning a Fish Die-Off and the Aquatic Systemic Corporation letter January 31, 1989 Observation of Gizzard Shad in Discharge of BVPS.

We are not aware of any enforcement actions taken by the regulatory agencies with respect to operations under the NPDES permit at BVPS. There are presently no patterns of noncompliance or unresolved compliance issues. However, there are a number of random incidences that occurred on occasion, but we do not believe any chronic problems exist.

In the past, chronic compliance problems existed with the Unit 1 sewage treatment plant (outfall 203). This system has been redesigned and upgraded with a Rotating Biological Contactor and the problems have been corrected.

3. Changes to the NPDES permit during operation of the plant could indicate whether water quality parameters were determined to have no significant impacts (and were dropped from monitoring requirements) or were subsequently raised as a water quality issue. Provide a brief summary of changes (and when they occurred) to the NPDES permit for the plant since issuance of the Operating License.

The NPDES permits (prior and current) have only contained Best Available Technology (BAT) effluent limitations and have never contained water quality based effluent limitations. Therefore, we are not aware of any significant impacts or unresolved water quality issues.

3. (Continued)

The station has had only two NPDES permits issued for the operations of the wastewater treatment systems. The first permit was issued on May 30, 1975 and the second permit was issued on November 26, 1984. An application to renew the NPDES was submitted to the Pennsylvania Department of Environmental resource on May 26, 1989. The Department has not yet acted on the application.

The only significant change between the first and second NPDES permit was the inclusion of the Unit 2 discharges (or outfalls) in the second permit.

4. An examination of trends in the effects on aquatic resources monitoring can indicate whether impacts have increased, decreased, or remained relatively stable during operation. Describe and summarize (or provide documentation of) results of monitoring of water quality and aquatic biota (e.g., related to NPDES permits, Environmental Technical Specifications, site-specific monitoring required by federal or state agencies). What trends are apparent over time?

Please see the attached 1989 Annual Environmental Report Non-Radiological Report Section II. Summary and Conclusions pages 8 through 12.

5. Summarize types and numbers (or provide documentation) of organisms entrained and impinged by the condenser cooling water system since issuance of the Operating License. Describe any seasonal patterns associated with entrainment and impingement. How has entrainment and impingement changed over time?

Please see the attached 1989 Annual Environmental Report Non-Radiological Report Section G Fish Impingement and Section H Plankton Entrainment. The only change with respect to entrainment and impingement overtime has been with the increased numbers of Corbicula. See Section I Corbicula and Figure V-I-7 of the referenced report.

6. Aquatic habitat enhancement or restoration efforts (e.g., anadromous fish runs) during operation may have enhanced the biological communities in the vicinity of the plant. Alternatively, degradation of habitat or water quality may have resulted in loss of biological resources near the site. Describe any changes to aquatic habitats (both enhancement and degradation) in the vicinity of the power plant since the issuance of the Operating License including those that may have resulted in different plant impacts than those initially predicted.

None.

7. Plant operations may have had positive, negative, or no impact on the use of aquatic resources by others. Harvest by commercial or recreational fishermen may be constrained by plant operation. Alternatively commercial harvesting may be relatively large compared with fish losses caused by the plant. Describe (or provide documentation for) other nearby uses of waters affected by cooling water system (e.g., swimming, boating annual harvest by commercial and recreational fisheries, and how these impacts have changed since issuance of the Operating License.

It has been observed that there has been increased recreational fishing in the area below the BVPS discharge through the years since operation of Unit #1 in 1976.

8. Describe other sources of impacts on aquatic resources (e.g., industrial discharges, other power plants, agricultural runoff) that could contribute to cumulative impacts. What are the relative contributions by percent of these sources, including the contributions due to the power plant, to overall water quality degradation and loss of aquatic biota?

There are no quantitative measurements of the cumulative impacts as related to activities upstream of the power plant. Oil and chemical spills, increased potential of hydroelectric facilities lowering the dissolved oxygen and the increased use of lawn herbicides and pesticides within the water shed has the potential for degrading overall water quality.

However, the loss of heavy industries in the Pittsburgh area and the improved water treatment plant operations in both municipal and industrial facilities have demonstrated an improved aquatic habitat as highlighted by the increased numbers of fish species. Reference Section E of the 1989 non-radiological report.

9. Provide a copy of your Section 316(a) and (b) Demonstration Report required by the Clean Water Act. What section 316(a) and (b) determinations have been made by the regulatory authorities?

None.

Beaver Valley utilizes cooling towers so the Section 315(a) did not apply to us. The Section 316(b) was accepted by the USEPA with no determinations. See the attached May 6, 1977 DLC letter to EPA with the 316(b) study and the June 15, 1977 USEPA letter to DLC approving the study.

SOCIOECONOMIC QUESTIONS FOR ALL UTILITIES

Various sources were utilized to obtain information concerning this survey. Our best estimate is based on information and records available.

1. To understand the importance of the plant and the degree of its socioeconomic impacts on the local region, estimate the number of permanent workers on-site for the most recent year for which data are available.

1255 Permanent (Nuclear Group Employee status Report)
357 Temporary Active Employees

2. To understand the importance of the plant to the local region, and how that has changed over time, estimate the average number of permanent workers on site, in five-year increments starting with the issuance of the plant's Operating License. If possible, provide this information for each unit at a plant site.

1989	3453	1984	2723
1988	3551	1983	2493
1987	3756	1982	2488
1986	2521	1981	1749
1985	<u>1776</u>	1980	<u>2432</u>
Average	3011.4	Average	2377
1st increment		2nd increment	

Plant operating license was issued to Unit 1 in 1976 and this information was not readily available beyond the 1980 year. This information was obtained by numbers of radiological badged employees.

3. To understand the potential impact of continued operation for an additional 20 years beyond the original licensing term, please provide for the following three cases:

- A) A typical planned outage: To best estimate this number, we will utilize the known Nuclear Group Permanent Strength 1255 and the average of the 3 largest outages by construction manpower requirements:

6 Refueling Outage ± 850 temporary
 1 Refueling Outage ± 584 temporary
 7 Refueling Outage ± 547 temporary

660 average temporary employees

Estimate for a typical planned outage - 1915

This estimate includes (current) permanent and temporary employees from past outages.

- B) An ISI outage: Because this type of outage work is now planned in increments over the course of several outages, the numbers above will be relatively constant. + 1915
- C) The largest single outage (in terms of numbers involved) that has occurred to date was the 6th Refueling Outage that involved an additional 850 temporary employees.

The goal of the Nuclear Group is to keep the length of Refueling outages to around 70 days.

4. To understand the plant's fiscal importance to specific jurisdictions, for 1980, 1985, and the latest year for which data are available, estimate the entire plant's taxable assessed value and the amount of taxes paid to the state and to each local taxing jurisdiction.

Assessed Value

80 - \$196.4 million (PURTA basis)
 85 - " 4 million (PURTA basis)
 90 - " 95 million (PURTA basis)
 " million (Local)

Taxes Paid*

State	80 - \$ 5.9 million	Local	80 - \$ 0 million
	85 - 8.9 million		85 - 0 million
	90 - 17.7 million		90 - 1 million

* Total - All owners



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION III

6TH AND WALNUT STREETS

PHILADELPHIA, PENNSYLVANIA 19106

Wheeling Field Office

303 Methodist Building, 11th & Chapline Streets
Wheeling, West Virginia 26003

June 15, 1977

Mr. Robert J. McAllister JUN 17 Recd
Structural Engineer
Duquesne Light
435 Sixth Avenue
Pittsburgh, Pennsylvania 15219


RE: Beaver Valley Power Station - Unit 1
NPDES - No. PA-0025615
Impingement/Entrainment Monitoring Report 316(b)

Dear Mr. McAllister:

We have received and reviewed your final impingement/entrainment monitoring report on your Beaver Valley Power Station - Unit No. 1 for 1976.

Based upon the data included in this document we do not feel that any modification of the intake structures at the Beaver Valley Power Station is necessary. We agree with the conclusion that the impingement/entrainment impact of the subject facility is not adversely affecting the balanced, indigenous communities of aquatic organisms in the Ohio River and therefore approve the study.

Sincerely yours,


James L. LaBuy
Aquatic Biologist
Wheeling Field Office



Duquesne Light

435 Sixth Avenue
Pittsburgh, Pennsylvania
15219

Jan
Send a copy
to Ed Brown
of Pa. Power
Self

(412) 471-4300

May 6, 1977

Mr. Stephen R. Wassersug, Director
Enforcement Division
U. S. Environmental Protection Agency
Region III
Sixth and Walnut Streets
Philadelphia, PA 19106

Beaver Valley Power Station - Unit 1
NPDES Permit No. PA 0025615
Impingement/Entrainment Monitoring Report
OFE 8700 CWO 629

Dear Mr. Wassersug:

On September 20, 1976 we submitted to you the semi-annual report for the Impingement/Entrainment Monitoring Program as required by the subject permit. We are herewith transmitting to you the final required report. This final report covers the entire year of 1976 as there was a change in reporting format by Duquesne's contractor.

We trust that this submittal fulfills the requirements of the subject permit. Should you have any questions, please contact us.

Very truly yours,

Robert J. McAllister
ROBERT J. McALLISTER
Structural Engineer

Attachment

cc: Mr. H. R. Preston - w/a

bcc: H. A. VanWassen
S. L. Pernick (3)
T. J. Munsch
F. J. Bissert
R. D. Scherer
R. L. Nelson
T. B. McAuliffe

DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
UNIT NO. 1

NPDES PERMIT NO. PA 0025615

REPORT OF
IMPINGEMENT/ENTRAINMENT MONITORING PROGRAM
FOR 1976

APRIL, 1977

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FISH IMPINGEMENT

A total of 9,102 fish were collected in 1976 (Table 1). The combined weight of the catch was 8,264 g (18.2 lbs). Eight families and 25 identifiable species were represented. No species classified as rare or endangered were taken. In addition, 483 crayfish, 343 clams, 83 leeches, and 20 dragonfly larvae were collected.

Emerald shiner was the most abundant species, accounting for 54% of the catch and 4,901 individuals (Table 1). Un-identifiable cyprinids, shiners, and minnows (those too badly damaged to identify) comprised 29% of the catch. Sand shiner, mimic shiner, bluntnose minnow, and carp made up an additional 9% of total. The combined collections of the carp-shiner family (Cyprinidae) accounted for 92% of the total catch and weighed 4,644 g (10.2 lbs). Channel catfish, the second most numerous species at a catch of 510 individuals weighing 1,548 g (3.4 lbs), constituted 6% of the total catch. The remaining 22 taxa represented only 2% of the total yield.

Of the total catch during 1976, 87% was taken during January and February (Table 2). After February, numbers of fish gradually declined to a low of five fish in June. From July to November, collections averaged seven fish per 24 hr period. Large numbers were caught again in October. The results indicate that large collections occur at water temperatures below 40°F.

Fluctuations in catch composition were small. Minnows and shiners were most abundant in the winter months but were collected throughout the year. Channel catfish occurred in 72% of the collections and were collected in all months.

Game species (sunfishes and some perches) were caught infrequently and no seasonal differences were apparent. Brown bullhead was the only abundant fish that exhibited a seasonal change in catch. This species was collected only in the summer.

Channel catfish was the most abundant non-forage species collected. The majority of channel catfish in the screen washings ranged in length from 45 to 265 mm (Table 1). Only four specimens larger than 120 mm were collected. Three of these larger fish were decomposed, indicating that they had been dead for some time. All of the channel catfish caught were less than two years old and more than 99% were

young-of-the-year. Ages were estimated from age-length relationships given in Carlander (1969). The only species for which mature adults were collected, as determined from length ranges given in Table 5.34 and data from Carlander (1969), were forage fish, mainly shiners, minnows, and gizzard shad.

On July 8, 1976, intake velocity at the trash bars was determined in each operating intake bay. A Marsh-McBirney Model 201 Portable Water Current Meter was used. Readings were taken at the water surface, middepth, and bottom at the middle and along the sides of the intake bay. Measurements in intake Bay A were less than 0.4 fps; most readings were between 0.25 and 0.3 fps. The total pumping capacity of this bay is 25,000 gpm. In Bay B (total pumping capacity 9,000 gpm) all readings were less than 0.35 fps. These measurements are similar to the maximum design flow velocity of 0.2 fps.

Almost half of the organisms in screen wash collections were taken from bays which were not operating during the 24-hr sampling period (Table 1). This situation may be caused by entrapment of organisms on the frames extending out from the screens. All of the traveling screens have frames extending 6 in. out from their face, running their horizontal length, and spaced every 2 ft along the vertical run. It is suspected that when the screens are rotated for washing, fish become trapped on the frame plates. This theory is supported by the large winter catch of emerald shiner. This shiner is a surface species (Trautman, 1957) and is sluggish during the cold winter months. Its surface habit and its slower response in cold water would make it more susceptible to entrapment. Additional support for this theory is the low number of large fish, since large fish would be able to escape entrapment on the frames. The majority of the large specimens that were collected were badly decomposed. These decayed specimens were dead for some time before collection and were probably dead before becoming impinged.

The results of weekly impingement collections during 1976 indicate that BVPS operations did not affect the fish populations of the Ohio River. Only 18.2 pounds of fish were collected in 1976, a negligible amount. This amount of fish is insignificant when compared to the 344 lbs of fish per acre estimated to inhabit the New Cumberland Pool (Preston, 1969). Also, 92% of the catch were cyprinids, a species that has high reproductive capabilities (Carlander, 1969) and would not be harmed by the loss of such a small number of individuals.

Almost half of the fish were taken in non-operating bays, bays which have zero intake velocity. Technically, these fish were not impinged but were rather entrapped.

River Fish Populations vs Impingement Collections

Shiners and minnows were numerically dominant in the river and the impingement catches (Table 3). Large numbers of emerald shiner, sand shiner, and bluntnose minnow occurred in both catches. Gizzard shad and channel catfish were also common in both collections. Carp, spotted bass, largemouth bass, yellow perch, and walleye, which were common in river collections, were collected in low numbers in screen washings. There were only slight differences in the river and screen catches because predominant species occurred in about the same proportions.

ICTHYOPLANKTON ENTRAINMENT
1976 INTAKE RESULTS

A total of 1,244 larvae, 6 eggs, 10 juveniles, and 135 adults were collected in the intake structure from April through July. At least 12 taxa, representing five families, were identified.

No fish eggs or larvae were collected in intake samples on April 15, the first entrainment survey of the 1976 study period (Table 4). River temperature was 54°F. On April 29 the river temperature had increased to 61°F and no eggs and 32 larvae (10.44/100m³) were collected. Most of the larvae were either walleye or sauger (Stizostedion sp.). On May 12, only one intake bay was operating and no eggs or larvae were collected. Thirty-nine larvae (13.05/100m³) and two eggs were collected on May 27, when the river temperature was 66°F. Numbers of larvae collected continued to increase and on June 10, 148 larvae (49.87/100m³) were collected. Two eggs were also collected. Cyprinids (minnows and shiners) accounted for the majority of the larvae on June 10. On June 24, 666 larvae (218.87/100m³) were collected and, as with the previous collection, the majority were cyprinids. The number of larvae declined to 237 (78.93/100m³) by July 8 (Table 5.38). A further decline was evident on July 22 when 122 larvae (40.58/100m³) were taken.

Cyprinids (minnows and shiners) accounted for 68 to 93% of the species collected. Gizzard shad (Dorosoma cepedianum), darters (Etheostoma sp.), sunfish (Centrarchidae), logperch (Percina caprodes), one juvenile channel darter (Percina copelandi), and one juvenile white sucker (Catostomus commersoni) were also collected.

The Commonwealth of Pennsylvania (1976) classifies the channel darter as "indeterminant: apparently threatened but insufficient data currently available on which to base a reliable assessment of status". Sauger is classified as "rare", however, positive identification could not be made as to whether the larvae caught were sauger or walleye. Walleye is not rare, endangered or indeterminant.

1976 River Transect Results

A total of 645 larvae, 195 eggs, and 13 juveniles were collected. Cyprinids (86%) and gizzard shad (8%) accounted for 94% of the total larvae collected along the river transect. Centrarchids, percids, and freshwater drum made up the remainder of the catch.

River transect samples collected during the same time period as the intake collections exhibited a temporal pattern similar to that of the entrainment samples. No eggs or larvae were collected on April 15 (Table 6). Three larvae and no eggs were collected on April 29 and no larvae and two eggs on May 12. By May 27, 40 larvae ($3.92/100\text{m}^3$) and five eggs were collected. On June 10, 42 larvae ($4.92/100\text{m}^3$) and 165 eggs were collected. The majority of eggs were tentatively identified as emerald shiner (Notropis atherinoides). Larval densities continued to increase: on June 24 they reached $16.34/100\text{m}^3$ and by July 8 they reached $27.76/100\text{m}^3$ (Table 7). After July 8, densities declined to 13.68 larvae/ 100m^3 .

Intake Spatial and Diel Trends

A spatial distributional pattern was apparent among the intake bays. Larvae were collected in all bays sampled throughout the period but densities were higher at intake Bay B than at Bays A, C, and D. Bay B yielded 54% of the larvae for the entire period. However, Bay B was sampled on the three dates when the highest number of larvae were collected. Species composition among the intake bays was not noticeably different.

A large difference between mean larval density values for the day and night samples indicated diurnal movement (Table 8). Night sampling yielded 83% of the larvae collected during the entire sampling period. The largest mean night larval density, collected on June 24 in intake Bay A, was $353.53/100\text{m}^3$ whereas during the day the highest density was $28.70/100\text{m}^3$. It is possible that the bright lights on the face of the intake structure and the work lights inside the intake bays attracted the larvae. Marcy (1976) showed similar results during day/night intake and river cross section sampling at the Connecticut Yankee Plant.

River Transect Spatial and Diel Trends

The river transect data showed little difference among the depths sampled at those stations having two or more depths. Mean larval densities were much higher along the north shoreline (Station 5) on the opposite shore from the BVPS than at other stations located along the transect. Approximately 43.4% of the total larvae were collected at Station 5 (Table 9).

No diurnal differences were noticeable along the river transect except at Station 5. Overall, 53% of the larvae were collected during the day compared to 48% collected during the night (Table 9). Densities at Station 5 were significantly higher during the day than at night.

Intake vs River Transect Comparison

Total mean density values from the intake and the river transect differed (Figure 1). The largest mean larval density for the intake was 218.87/100m³ (June 24) whereas the largest for the river transect was only 27.26/100m³ (July 8). 8).

Although densities differed, the species composition of intake and river transect samples remained similar. Cyprinids comprised 81% of the intake catch and 86% of the river transect catch; gizzard shad comprised 6% and 8%, respectively. Etheostoma sp. (darters) were found in both the intake samples (8%) and river transect samples (<1%).

Entrainment Losses

Calculation of the percentage of larvae entrained vs larvae in the river was based on the formula:

$$\text{Percent Entrained} = 100 \frac{N_i F_i}{N_r F_r} \text{ (Marcy, 1976)}$$

where N_i = average number of larvae per cubic meter in the intake, F_i = flow rate into the intake in m³/sec, N_r = average number of larvae per cubic meter in the river, and F_r = average flow rate (m³/sec) of the river past the plant. Intake flow rates were based on individual intake pump capacities in use on the sampling day. The river flow rates (monthly averages) were obtained from ORSANCO monthly reports. Several assumptions were made:

- 1) ichthyoplankton densities were uniform throughout the sampling site.
- 2) spawning for each species occurred continuously during the spawning season.
- 3) ichthyoplankton populations near the intake were not depleted but were repopulated constantly.
- 4) the flow of the river was uni-directional and the larvae passed by the plant only once.

The percentage of fish larvae entrained at the intake vs those passing by the plant is:

	<u>Based on Mean Monthly River Flow</u>	<u>Based on Minimum Monthly River Flow</u>
April 15, 1976	0	0
April 29, 1976	6.33	15.70
May 12, 1976	0	0
May 27, 1976	0.92	1.54
June 10, 1976	3.76	5.65
June 24, 1976	4.95	7.43
July 8, 1976	0.85	1.47
July 22, 1976	0.86	1.49

The maximum percentage of eggs and larvae is entrained during minimum flow.

The largest estimated percent of larvae entrained (mean and minimum flow on April 29) was probably not characteristic due to the relatively few larvae that were collected in the river. The other mean values, ranging from 0.85 to 4.95%, are comparable to results reported by Marcy (1976) at the Connecticut Yankee Plant (mean 4%; range 1.7-5.8%) and Voigtlander (unpublished) at the Browns Ferry Nuclear Plant (range 0.93-2.81%). At minimum low river flow (5,000 cfs), about 1.2% of the flow would be drawn into the power station. Calculated entrainment losses were similar to predicted losses. Entrainment losses are judged to be negligible.

PHYTOPLANKTON ENTRAINMENT

In general, the composition and quantities of phytoplankton entrained were similar to those of the river samples. The following paragraphs discuss observed differences.

Monthly mean phytoplankton densities were slightly higher in river samples than in entrainment samples in 10 of the 12 months sampled (Table 10). The only large differences were among the green algae in May, June, and July. The flagellated algae, especially the cryptophytes and dinoflagellates, were more abundant in the river while diatoms had similar densities in both the river and entrainment samples. The small differences observed between entrained and river phytoplankton were probably related to shore effects. The shore zone, where substrate, light and other requirements are more readily available than in open waters, would be more favorable to the production of periphytic species. Growth conditions for true planktonic species would be best in the main flow of the river. Since the BVPS intake structure is a flush-to-shore design, periphytic species are more likely to be taken into the plant than are planktonic species.

In January, the periphytic diatoms Melosira varians and species of Navicula and Nitzschia were more abundant in entrainment samples than in river samples. In March, the green alga Chlamydomonas, which is indistinguishable from zoospores of periphytic green algae, was again more abundant in entrainment samples. Densities of most species in April were slightly lower in the river samples than in the entrainment samples. In May, the cryptophyte Rhodomonas minuta and most species of green algae were more abundant in the river while diatoms were more abundant in entrainment samples. The greatest difference between entrainment and river, especially among cryptophytes and green algae, occurred in June. From July through December, differences were similar to those observed previously but were considerably smaller.

Species whose mean densities in 1976 were noticeably higher in the river samples than in entrainment samples included the green algae Chlamydomonas snowii, Ankistrodesmus convolutus, and Micractinium pusillum and the cryptophyte Rhodomonas minuta. Differences were most noticeable in May and June. A number of diatom taxa were slightly more abundant in entrainment samples than in river samples, but large differences were not observed. A few colonial species, such as the blue-green alga Microcystis aeruginosa, showed differences in densities that were due to only a few, but many-celled, colonies.

...tion of phytoplankton densities were small. The
of diel variation is expected since few phytoplankters
capable of more than the slowest movement and diurnal
... are unlikely. Occasional high densities of
... phytoplankton seemed to be associated with samples
... high ... normal suspended solids, possibly
... bottom sediment. Dying phytoplankters that settle out
... water column are commonly found in high densities at
... water-mud interface.

Entrainment

Entrainment losses, based on BVPS withdrawal ... of the
river flow during minimum low river flow of 5,000 cfs, are
judged to be negligible.

ZOOPLANKTON ENTRAINMENT

Species occurring in the entrainment samples were similar to those found in the river (Table 11). Mean zooplankton densities and group percent composition data for each month agree closely with data for the river transects. Zooplankton densities were low (<400/l) from January through March. Seasonal peak densities of 5,336 and 7,093 organisms/l were reached in April and June. May densities were only 2,905 organisms/l. Densities decreased thereafter to less than 4,000 organisms/l from July through September and less than 500 organisms/l for the remainder of 1976.

Protozoa composed more than 80% or more of all organisms in all months except June through September. Rotifers were abundant in the first months, composing as much as 88 and 70% of the zooplankton in June and September, respectively. Abundant taxa in entrainment and river samples were similar throughout 1976.

Diel Trends

Diurnal fluctuations in total zooplankton densities were small during all months of the study. The fluctuations which did occur followed no definite pattern and probably reflect slight differences in river populations passing the intake structure. Variations among zooplankton densities collected diurnally were no greater than those observed among the different river stations on a given date.

In April Vorticella microstoma was considerably less abundant at the intake bays (<5000/l) than at all the river transects (>10,000/l); however, this was likely a result of differences in current velocity, turbulence, etc. at the intake bay region.

Conclusions

Entrainment losses, based on BVPS withdrawing 1.2% of the river flow during minimum low river flow of 5,000 cfs, are judged to be negligible.

TABLE 1

SUMMARY OF FISHES COLLECTED ON THE TRAVELING SCREENS AT BVPS
JANUARY THROUGH DECEMBER 1976

Taxa	Number	Percent Frequency of Occurrence	Percent Composition *	Number and Weight (g) of Fish Collected								Length Range (mm)
				Operating ^(a)				Non-operating ^(b)				
				Alive ^(c)		Dead ^(d)		Alive		Dead		
Number	Weight	Number	Weight	Number	Weight	Number	Weight					
Gizzard shad	93	28	1	1	6.5	78	1314.4			14	180.7	30-265
Carp	4	8	<1	1	4.8	2	62.5			1	3.5	67-170
Emerald shiner	4901	45	54	93	65.4	3579	2214.6	123	79.8	1106	670.9	25-96
Sand shiner	453	13	5	25	20.5	202	134.8	42	26.0	184	84.3	23-77
Mimic shiner	166	23	2	3	1.9	124	76.8			39	20.7	30-75
Bluntnose minnow	206	34	2	19	15.4	63	41.0	21	22.4	103	63.6	21-45
Unidentified cyprinids	2635	45	29			1108	496.5			1497	558.0	
White sucker	2	2	<1					1	2.1	1	2.7	62-65
White catfish	26	23	<1	1	2.3	5	15.2	16	37.7	4	6.2	55-75
Yellow bullhead	1	2	<1					1	13.4			105
Brown bullhead	21	19	<1	6	10.6	7	102.6	8	18.5			11-191
Channel catfish	510	72	5	69	193.5	187	664.6	186	526.1	68	153.4	45-265
Stoneroller	2	2	<1	1	6.8	1	8.3					93-110
Unidentified catfish	12	15	<1			2	2.9			10	23.2	35-75
Trout-perch	1	2	<1			1	1.4					71
Banded killifish	1	2	<1			1	6.8					65
Rock bass	4	8	<1					3	9.5	1	5.4	32-67
Green sunfish	12	8	<1	9	24.1	1	11.8	2	6.4			42-100
Pumpkinseed	22	30	<1	7	27.1	2	12.0	10	54.7			30-95
Bluegill	5	9	<1	2	3.0			2	4.8			42-57
Smallmouth bass	1	2	<1					1	12.3			103
Spotted bass	1	2	<1					1	30.6			175
White crappie	4	8	<1			2	3.5			2	28.4	40-139
Unidentified sunfish	5	8	<1			4	4.6			1	0.4	28-55
Johnny darter	5	8	<1			4	3.7	1	1.0			43-53
Unidentified darter	1	2	<1							1	1.0	33
Yellow perch	3	6	<1			2	25.1			1	3.6	75-111
Logperch	4	8	<1			1	1.0	1	1.0	2	1.9	54-65
Walleye	1	2	<1							1	4.5	80
Total Number	9102			237		5409		420		3036		
Percent of Total Number				2.6		59.4		4.6		33.4		
Weight					381.9		5205.1		846.3		1830.4	
Percent of Total Weight					4.6		63.0		10.2		22.1	

(a) Intake bays that had intake pumps operating in the 24 hr sampling period

(b) Bays that had no pumps operating during the sampling period

(c) Reactive to external stimuli, returned to river

(d) Unreactive to stimuli or partially decayed

TABLE 2

RIVER CONDITIONS SUMMARY OF FISHES COLLECTED ON
THE TRAVELING SCREENS, BY DATE
JANUARY THROUGH DECEMBER 1976
BVPS

Date	Month	Day	Number Collected	Percent	Number of Fish Collected (b)				Intake Bays				Intake Water Temp. °F	River Elevation Above Mean Sea Level
					Downfall		Newt, Strick (c)		Strickline					
					Alive (d)	Dead (e)	Alive	Dead	A	B	C	D		
January		2	714	8	10	595	21	88	X				40.5	673.0
		9	222	2	18	80	21	102	X	X			55.0	668.0
		18	819	8	79	347	35	318	X	X			37.2	668.5
		23	911	10	14	709	67	622	X				34.5	666.0
		30	3145	23	7	3412	38	848	X				36.5	470.0
February		6	1017	11	7	500	41	469	X				35.4	666.5
		13	674	7	4	175	64	431	X				39.0	668.5
		20	269	3	0	269	0	0		X	X		45.0	667.0
		27	161	2	4	128	1	28	X	X	X		42.5	671.5
March		8	87	1	3	49	0	26	X	X			47.0	669.0
		12	179	2	0	116	0	42	X				44.0	666.5
		19	41	<1	0	17	4	23	X				41.5	667.1
		26	81	1	1	80	0	0	X				48.9	667.5
April		2	13	<1	1	7	1	4	X		X		52.7	668.0
		9	12	<1	0	9	0	2	X				52.4	668.0
		16	2	<1	0	1	0	1	X				54.8	666.0
		23	1	<1	0	1	0	0	X	X	X		54.8	665.7
		30	2	<1	0	0	2	0	X		X		53.5	666.0
May		7	1	<1	0	1	0	0	X				57.0	666.0
		14	1	<1	0	0	1	0	X				60.0	665.5
		21	4	<1	1	3	0	0	X		X		58.0	666.0
		28	1	<1	0	0	1	0	X		X		59.2	665.5
June		4	9	0	0	0	0	0	X	X			60.0	665.5
		11	0	0	0	0	0	0	X	X			61.5	665.5
		18	0	0	0	0	0	0	X	X			76.8	665.5
		25	5	<1	1	3	0	1	X	X			77.0	666.0
July		2	4	<1	0	3	1	0	X	X			77.0	666.0
		9	10	<1	0	5	2	3	X	X			71.0	666.0
		16	3	<1	1	1	1	0	X	X			75.5	665.5
		23	9	<1	1	3	1	1	X	X	X		75.9	665.8
		30	10	<1	0	7	1	2	X	X	X		77.3	665.5
August		6	7	<1	1	5	1	0	X	X	X		75.3	665.5
		13	5	<1	1	3	1	0	X	X	X		74.0	665.5
		20	12	<1	0	5	5	2	X	X			71.8	665.5
		27	13	<1	2	10	0	1	X	X			76.9	665.5
September		3	5	<1	1	3	0	2	X	X			75.0	665.7
		10	3	<1	0	0	1	0	X	X	X		72.5	666.0
		17	4	<1	0	2	2	0	X	X			74.0	665.0
		25	4	<1	1	3	2	0	X		X		70.0	665.8
October		1	1	<1	0	0	0	1	X	X			67.5	665.8
		8	2	<1	1	1	0	0	X	X	X		68.5	665.9
		15	20	<1	9	11	0	0	X	X	X		58.6	667.0
		22	6	<1	0	2	2	0	X		X		53.5	666.0
		29	14	<1	1	4	4	1	X		X		50.5	667.7
November		5	4	<1	0	4	0	0	X		X		48.7	667.0
		12	3	<1	0	0	1	1	X				45.0	665.6
		19	3	<1	1	1	1	0	X	X			44.0	666.0
		26	10	<1	0	9	1	0	X				43.9	666.0
December		3	4	<1	0	3	3	1	X	X	X		41.0	666.2
		10	62	1	41	22	11	5	X	X			38.1	667.2
		17	236	2	8	182	4	4	X		X		39.2	666.1
		24	129	1	24	49	16	41	X	X	X		34.5	666.2
		31	140	2	17	47	25	71	X		X		35.0	665.8
Total			9102		237	5409	420	1016						
Percent					2.6	59.4	4.6	11.4						

(a) Intake bays that had intake pumps operating in the 24 hr sampling period

(b) Bays that had no pumps operating during the sampling period

(c) Reactive to external stimuli, returned to river

(d) Unreactive to stimuli or partly decayed

TABLE 3

COMPARISON OF FISHES COLLECTED IN THE NEW CUMBERLAND
POOL OF THE OHIO RIVER AND FISHES COLLECTED ON THE
TRAVELING SCREENS OF THE BVPS
JANUARY THROUGH DECEMBER 1976

Taxa	Total Number of Fishes Collected		Percent Composition of Fishes Collected	
	River	Traveling Screens	River	Traveling Screens
Longnose gar	2	0	<1	0
Gizzard shad	10	93	1	1
Coldfish	2	0	<1	0
Carp	12	4	1	<1
Emerald shiner	81	4,901	10	54
Spotfin shiner	35	0	4	0
Sand shiner	302	453	36	5
Mimic shiner	12	166	1	2
Bluntnose minnow	272	206	33	2
Creek chub	1	0	<1	0
Unidentified cyprinids	0	2,635	0	29
Quillback	2	0	<1	
White sucker	0	2	0	<1
Yellow bullhead	1	1	<1	<1
Brown bullhead	3	21	<1	<1
White catfish	1	26	<1	<1
Channel catfish	16	510	2	6
Stonecat	0	2	0	<1
Unidentified catfish	0	12	0	<1
Trout-perch	0	1	0	<1
Barbed minnow	0	1	0	<1
Rock bass	3	4	<1	<1
Golden sunfish	1	12	<1	<1
Pumpkinseed	3	22	<1	<1
Bluegill	3	5	<1	<1
Smallmouth bass	6	1	<1	<1
Spotted bass	17	1	2	<1
Largemouth bass	12	0	1	0
White crappie	2	4	<1	<1
Black crappie	3	0	<1	0
Unidentified sunfish	0	5	0	<1
Johnny darter	2	5	<1	<1
Yellow perch	24	3	3	<1
Walleye	9	1	1	<1
Logperch	0	4	0	<1
Unidentified darter	0	1	0	<1
Total	837	9,102		

TABLE 4

ADULT FISH, FISH EGGS AND LARVAE (per 100m³) COLLECTED
IN THE BVPS INTAKE WITH A 1 m, 505 MICRON MESH
PLANKTON NET
APRIL-JUNE 1976
BVPS

	Intake Bays								Combined (12)	
	Bay 1		Bay 2		Bay 3		Bay 4			
	Vol.	Filter	Vol.	Filter	Vol.	Filter	Vol.	Filter		
April 13, 1976										
Vol. of water filtered (m ³)	74.43	74.43	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	131.70	
No. of adults	67	31							121	
Density (12)	0	0							0	
Adults										
<i>Morone chrysops</i> (16)	90.01	43.33							77.63	
<i>Morone chrysops</i> (10)	0	2.41							1.39	
April 29, 1976										
Vol. of water filtered (m ³)	74.43	74.43	NOT SAMPLED	74.43	74.43	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	104.40	
No. of larvae collected	1	17		2	11				32	
No. of adults collected	0	0		7	3				10	
Density	1.30	22.18		2.61	15.44				10.44	
Larvae										
<i>Morone chrysops</i> (10)	0	0		4.32	1.91				2.61	
<i>Morone chrysops</i> (10)	0	0		2.41	0				0.43	
<i>Morone chrysops</i> (10)	0	0		0	1.30				0.33	
<i>Morone chrysops</i> (10)	0	0		0	1.30				0.33	
<i>Morone chrysops</i> (10)	1.30	22.18		2.61	10.43				7.14	
Unidentified larvae	0	0		0	2.41				0.43	
May 17, 1976										
Vol. of water filtered (m ³)	74.43	74.43	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	131.70	
No. of larvae collected	0	0							0	
Density	0	0							0	
May 27, 1976										
Vol. of water filtered (m ³)	74.43	74.43	NOT SAMPLED	NOT SAMPLED	74.43	74.43	NOT SAMPLED	NOT SAMPLED	131.70	
No. of larvae collected	2	24			2	2			31	
No. of eggs collected	1	0			1	0			2	
Density	4.82	43.53			2.68	0			11.03	
Larvae										
<i>Dorosoma cepedianum</i> (EL) (2)	1.34	1.34			1.34	0			1.00	
Cyprinidae (unidentified) (EL) (1)	1.34	1.34			0	0			0.47	
Cyprinidae (unidentified) (EL)	0	0			1.34	0			2.34	
Cyprinidae (EL)	0	0			0	0			0	
<i>Stenotomus</i> sp. (EL) (4)	0	32.13			0	0			0	
<i>Pimephales</i> (EL)	1.34	1.34			0	0			0.67	
Eggs										
Egg chorion	1.34	0			1.34	0			0.67	
June 10, 1976										
Vol. of water filtered (m ³)	74.43	74.43	74.43	74.43	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	131.70	
No. of larvae collected	1	5	0	131					147	
No. of eggs collected	1	0	0	1					2	
No. of juveniles collected	1	0	0	1					2	
No. of adults collected	0	0	0	2					2	
Density	2.68	12.03	1.34	179.41					40.07	
Larvae										
<i>Dorosoma cepedianum</i> (TL)	0	0	0	1.34					0.33	
<i>Dorosoma cepedianum</i> (EL)	0	0	0	1.34					0.33	
<i>Dorosoma cepedianum</i> (EL) (4)	0	0	0	14.73					3.68	
Cyprinidae (unidentified) (TL)	0	1.34	0	45.40					16.75	
Cyprinidae (unidentified) (EL)	1.34	10.21	0	52.22					16.75	
Cyprinidae (unidentified) (EL)	0	0	1.34	0					0.71	
<i>Morone chrysops</i> (10)	0	0	0	1.34					0.33	
<i>Morone chrysops</i> (10)	0	0	0	3.68					0.97	
<i>Morone chrysops</i> (10)	1.34	0	0	0					0.33	
<i>Morone chrysops</i> (10)	0	0	1.34	30.43					10.04	
<i>Morone chrysops</i> (10)	0	0	0	1.34					0.33	
Unidentified larvae	0	0	0	4.01					1.00	
Eggs										
Dead Eggs (unfertilized)	1.34	0	0	1.34					0.67	
June 24, 1976										
Vol. of water filtered (m ³)	74.43	74.43	74.43	74.43	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	NOT SAMPLED	104.40	
No. of larvae collected	12	271	132	241					644	
No. of eggs collected	1	0	0	1					2	
No. of juveniles collected	1	0	0	2					3	
Density	1.70	351.53	173.21	317.03					217.87	
Larvae										
<i>Dorosoma cepedianum</i> (EL)	3.22	3.41	10.44	5.22					5.67	
<i>Dorosoma cepedianum</i> (EL)	0	1.91	0	10.44					3.4	
Cyprinidae (unidentified) (TL)	1.34	0	0	11.03					1.1	
Cyprinidae (unidentified) (TL)	10.67	315.70	150.87	320.47	NOT SAMPLED	NOT SAMPLED			174.50	
Cyprinidae (unidentified) (EL)	0	19.57	9.13	16.33					16.31	
Cyprinidae (unidentified) (EL)	0	1.30	1.30	3.22					1.96	
<i>Lepomis macrochirus</i> (EL)	0	0	13.0	0					0.33	
<i>Lepomis macrochirus</i> (EL)	0	1.30	0	0					0.33	
<i>Lepomis macrochirus</i> (EL)	0	0	0	1.30					0.33	
<i>Lepomis macrochirus</i> (EL)	0	4.53	0	20.70					0.33	
<i>Lepomis macrochirus</i> (EL)	0	1.91	0	7.41					0.33	
<i>Lepomis macrochirus</i> (EL)	0	0	0	1.30					0.33	
Unidentified larvae	1.30	0	0	1.30					0.33	
Eggs										
Egg chorion	1.30	0	0	1.30					0.65	

- (1) - On the collecting date, only the bays with the pumps operating were sampled.
 (2) - TL hatched specimens in which yolk and/or oil globules are present.
 (3) - EL specimens in which yolk and/or oil globules are not present.
 (4) - EL specimens in which fin rays and spine elements of the dorsal and anal fins are present and the number of fin rays and spine elements are not present.
 (5) - J specimens in which the proximal adult number of fin rays are present in all fins and specimens have developed body shape and pigmentation of adult.
 (6) - 0 Fishes one year or more from hatching.
 (7) - Lack of adequate taxonomic information for tentative identification.
 (8) - Destroyed or deteriorated.
 (9) - Several species of *Morone* (*M. chrysops*, *M. punctata*, *M. saxatilis*, *M. saxatilis*, *M. saxatilis*, *M. saxatilis*, *M. saxatilis*) and *Pimephales* sp. (*P. promelas* and *P. promelas*) found in eggs. Identification is tentative.
 (10) - *Morone chrysops* sp. found in the eggs includes *M. saxatilis* and *M. saxatilis*.
 (11) - Tentatively identified as *Morone saxatilis* probably also common *Morone* in area after *M. saxatilis*.
 (12) - Includes larvae (TL, EL, J) and juveniles. Excludes of adults and eggs. Totals may not be equal to the sum of the individual values since the larvae were counted off.
 (13) - Identification tentative. *M. saxatilis* and *M. saxatilis* similar during TL and EL stages.

TABLE 5

ADULT FISH, JUVENILES AND FISH LARVAE (per 100m³) COLLECTED
IN THE BVPS INTAKE WITH A 1 m, 505 MICRON MESH PLANKTON NET
JULY 1976
BVPS

	Intake Bays								Combined ⁹
	Bay A		Bay B		Bay C		Bay D		
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	
July 8, 1976									
Vol. of water filtered (m ³)	76.65	76.65	76.65	76.65	NOT SAMPLED ¹		NOT SAMPLED		306.6
No. of larvae collected	8	72	20	137					237
No. of juveniles collected	2	0	0	3					5
No. of adults collected	0	2	0	0					2
Density ⁹	13.05	93.93	26.09	181.63					76.93
Larvae									
<i>Menidia menidia</i> (EL) ³	2.41	9.13	1.30	20.87					6.40
<i>Menidia menidia</i> (L) ⁴	0	0	0	2.41					0.45
Cyprinidae (unidentified) (TL) ²	0	3.91	3.41	2.41					1.18
Cyprinidae (unidentified) (EL) ⁴	7.43	16.97	20.17	131.77					29.34
Cyprinidae (unidentified) (LL)	0	1.30	1.30	3.41					1.61
<i>Leiostomus</i> sp. (EL) ⁷	0	0	0	2.41					0.45
<i>Leiostomus</i> sp. (LL)	0	0	0	4.32					1.63
<i>Stenotomus</i> sp. (ML) ⁸	0	0	0	2.91					0.90
<i>Stenotomus</i> sp. (LL)	0	1.30	0	1.30					0.45
Unidentifiable ¹⁰	0	1.30	0	2.41					0.90
Juveniles									
<i>Menidia menidia</i>	0	0	0	2.41					0.45
<i>Leiostomus</i> sp.	0	0	0	1.30					0.31
<i>Stenotomus</i> sp.	2.41	0	0	0					0.45
Adults									
<i>Menidia menidia</i>	0	2.41	0	0					0.45
July 21, 1976									
Vol. of water filtered (m ³)	75.78	75.78	NOT SAMPLED		NOT SAMPLED		75.78	75.78	301.12
No. of larvae collected	10	90					4	18	122
No. of juveniles	0	1					0	0	1
Density	13.20	120.08					3.38	23.75	40.58
Larvae									
<i>Menidia menidia</i> (EL)	0	2.44					0	0	0.46
Cyprinidae (unidentified) (TL)	0	7.92					0	0	1.25
Cyprinidae (unidentified) (EL)	11.88	101.93					3.96	21.11	34.97
Cyprinidae (unidentified) (LL)	0	1.32					0	0	0.31
<i>Leiostomus</i> sp. (EL)	0	0					1.12	2.64	0.99
<i>Leiostomus</i> sp. (LL)	1.32	1.32					0	0	0.46
Unidentifiable	0	2.44					0	0	0.46
Juveniles									
<i>Leiostomus</i> sp.	0	1.32					0	0	0.31

(1) On the collecting date, only the bays with the pumps operating were sampled.

(2) TL - Retained specimens in which yolk and/or oil globules are present.

(3) EL - Specimens in which yolk and/or oil globules are not apparent and in which fin rays and spiny elements are not present.

(4) LL - Specimens in which fin rays and spiny elements of the dorsal and anal fins approximate the number found in adults.

(5) J - Specimens in which the approximate adult number of fin elements are apparent in all fins and specimens have developed body shape and pigmentation of adult.

(6) Several species of *Leiostomus* (*L. xanthurus*, *L. spilopterus*, *L. atrinoides*, *L. volucellus*) and *Pomoxis* (*P. notatus* and *P. grandis*) found in area. Identification is tentative.

(7) Several species of *Leiostomus* found in the study area (*L. xanthurus*, *L. gibbosus*, *L. atlanticus*, *L. merrilli*). Identification tentative.

(8) Probably *Leiostomus xanthurus* or *L. blennioides*.

(9) Includes only larvae and juveniles. Exclusive of eggs and adults. Total may not be equal to the sum of the individual values since the values were rounded off.

(10) Destroyed or deteriorated.

TABLE 6

FISH EGGS AND LARVAE (per 100 m³) COLLECTED AT THE ENTRAINMENT RIVER TRANSECT WITH A 1 m, 505 MICRON MESH PLANKTON NET APRIL-JUNE 1976 BVPS

	ENTRAINMENT TRANSECT SAMPLING STATIONS												Combined ⁽¹⁾	
	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6			
	DEP.	SIGMA-T	DEP.	SIGMA-T	DEP.	SIGMA-T	DEP.	SIGMA-T	DEP.	SIGMA-T	DEP.	SIGMA-T		
April 15, 1976														
Vol. water filtered (m ³)	34.24	34.81	101.85	11.35	114.47	101.74	39.17	38.80	9.88	10.11	350.28		550.28	
No. larvae collected	0	0	1	0	0	0	0	0	0	0	0	0	1	
No. eggs collected	0	0	0	1	0	0	0	0	0	0	0	0	1	
Density	0	0	0	0	0	0	0	0	0	0	0	0	0	
April 22, 1976														
Vol. water filtered (m ³)	49.43	81.45	125.71	36.37	162.04	118.14	99.99	70.91	51.58	62.22	873.41		1073.41	
No. larvae collected	0	1	0	1	0	0	0	0	0	0	0	0	2	
No. eggs collected	0	0	0	0	0	0	0	0	0	0	0	0	0	
No. adults collected	0	1	0	0	0	0	0	0	0	0	0	0	1	
Density	0	1.20	0	1.04	0.61	0	0	0	0	0	0	0	0.31	
Larvae														
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	1.04	0	0	0	0	0	0	0	0	0	1.10
<i>Stenobothrus leucostictus</i> (TL)	0	1.20	0	0	0	0	0	0	0	0	0	0	0	1.10
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0.61	0	0	0	0	0	0	0	0	1.10
<i>Stenobothrus leucostictus</i> (TL)	0	1.20	0	0	0	0	0	0	0	0	0	0	0	1.10
May 11, 1976														
Vol. water filtered (m ³)	79.78	87.82	72.78	101.04	121.24	142.18	78.89	90.70	17.90	47.17	886.74		1086.74	
No. larvae collected	0	0	0	0	0	0	0	0	0	0	0	0	0	
No. eggs collected	0	0	2	0	0	0	0	0	0	0	0	0	2	
Density	0	0	0	0	0	0	0	0	0	0	0	0	0	
May 13, 1976														
Vol. water filtered	92.84	102.88	92.28	109.76	142.45	167.30	114.93	94.71	51.12	55.54	1,070.73		1,270.73	
No. larvae collected	0	11	2	3	0	4	0	3	0	0	0	0	10	
No. eggs collected	0	0	2	0	1	0	0	2	0	0	0	0	5	
No. adults collected	0	1	0	0	0	0	0	0	0	0	0	0	1	
Density	0	10.89	2.17	4.31	0	3.43	0	3.28	0	22.40	0	0	3.91	
Larvae														
<i>Stenobothrus leucostictus</i> (TL)	0	0.97	0	1.91	0	0.61	0	0	0	0	0	0	0	0.24
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0.61	0	1.04	0	0	0	0	0	0.10
<i>Cyprinidae</i> (unidentified) (TL)	0	4.46	7.17	1.82	0	2.22	0	1.04	0	0	0	0	0	3.44
<i>Cyprinidae</i> (unidentified) (TL)	0	1.85	0	0	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	1.94	0	0	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	0.97	0	0	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	0.97	0	0	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	1.94	0	0.91	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.10
<i>Stenobothrus leucostictus</i> (TL)	0	0.97	0	0	0	0	0	0	0	1.80	0	0	0	0.10
Eggs														
egg chorion	0	0	2.17	0	0	0	0	2.17	0	0	0	0	0	0.10
unidentified egg	0	0	0	0	0.70	0	0	0	0	0	0	0	0	0.10
June 10, 1976														
Vol. water filtered (m ³)	79.19	74.55	40.58	82.24	230.23	108.69	104.00	80.13	52.70	30.77	892.56		1,092.56	
No. larvae collected	0	12	3	3	4	2	2	1	1	4	0	0	27	
No. eggs collected	0	0	2	0	2	183	0	21	0	1	0	0	187	
Density	0	16.09	3.72	4.00	3.99	3.74	2.68	4.41	1.90	10.32	0	0	2.92	
Larvae														
<i>Stenobothrus leucostictus</i> (TL)	0	2.68	0	0	0	0	0	0	0	0	0	0	0	0.23
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0.94	0	2.31	0	0	0	0	0	0.15
<i>Cyprinidae</i> (unidentified) (TL)	0	0	0	1.20	0.67	1.87	0	1.11	0	0	0	0	0	1.05
<i>Cyprinidae</i> (unidentified) (TL)	0	10.72	3.48	1.69	1.32	0.94	0	0	0	0	0	0	0	3.11
<i>Cyprinidae</i> (unidentified) (TL)	0	0	0	0	0	0	0	1.80	0	0	0	0	0	0.11
<i>Cyprinidae</i> (unidentified) (TL)	0	1.84	0	0	1.32	0	0	1.11	0	0	0	0	0	0.11
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	2.20	0.67	0	0	0	0	0	0	0	0	0.11
<i>Stenobothrus leucostictus</i> (TL)	0	1.94	1.24	0	0	0	0	0	0	0	0	0	0	0.23
Eggs														
Viable eggs (unidentified)	0	0	0	0	0	0	0	3.32	0	0	0	0	0	0.23
Viable eggs (unidentified)	0	0	1.24	0	2.31	134.14	0	31.10	0	7.54	0	0	0	12.14
Dead eggs	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11
Egg chorion	0	0	1.24	0	0	0.94	0	0	0	0	0	0	0	0.23
June 20, 1976														
Vol. water filtered	74.36	117.69	100.64	91.23	172.67	174.55	74.12	89.07	54.78	55.30	1,026.12		1,226.12	
No. larvae collected	19	0	10	4	11	0	0	2	0	0	0	0	141	
No. eggs collected	0	0	0	1	0	0	0	0	0	0	0	0	1	
No. adults collected	0	1	0	0	0	0	0	0	0	0	0	0	1	
Density	26.82	1.99	9.92	4.25	4.36	7.26	3.27	3.15	177.95	43.67	0	0	15.34	
Larvae														
<i>Stenobothrus leucostictus</i> (TL)	0	1.77	0	1.09	1.14	1.70	0	0	0	0	0	0	0	1.07
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0.17	0	0	0	0	0	0	0	0.10
<i>Cyprinidae</i> (unidentified) (TL)	0	1.77	1.70	1.09	1.14	1.40	0	1.11	0	0	0	0	0	1.36
<i>Cyprinidae</i> (unidentified) (TL)	0	1.84	7.91	3.17	4.05	0.17	4.37	1.11	127.13	75.41	0	0	0	11.1
<i>Cyprinidae</i> (unidentified) (TL)	0	0.99	0	0	0	0	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	0	0.99	0	0	0	0	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	0	0.99	0	0	0	0	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.19
<i>Stenobothrus leucostictus</i> (TL)	2.61	0	0	0	0	0	0	0	0	1.84	0	0	0	0.10
Eggs														
Viable	0	0	0	1.09	0	4.13	0	0	0	0	0	0	0	0.46

(1) TL - Attached eggs have a vitelline yolk and/or oil globules and present.
 (2) TL - Specimens in which the vitelline yolk and/or oil globules are present and in which the egg and yolk elements are not present.
 (3) L - Specimens in which the egg and yolk elements of the overall egg and yolk elements are not present.
 (4) U - Specimens in which the vitelline yolk number of the elements are present in all fish and specimens have developed approximate body shape and pigmentation of adult.
 (5) D - Fishes were part of egg mass collection.
 (6) D - Fishes were part of egg mass collection.
 (7) D - Fishes were part of egg mass collection.
 (8) D - Fishes were part of egg mass collection.
 (9) D - Fishes were part of egg mass collection.
 (10) D - Fishes were part of egg mass collection.
 (11) D - Fishes were part of egg mass collection.
 (12) D - Fishes were part of egg mass collection.
 (13) D - Fishes were part of egg mass collection.
 (14) D - Fishes were part of egg mass collection.
 (15) D - Fishes were part of egg mass collection.
 (16) D - Fishes were part of egg mass collection.
 (17) D - Fishes were part of egg mass collection.
 (18) D - Fishes were part of egg mass collection.
 (19) D - Fishes were part of egg mass collection.
 (20) D - Fishes were part of egg mass collection.

TABLE 7

JUVENILE FISH AND FISH EGGS AND LARVAE (per 100m³) COLLECTED
AT THE ENTRAINMENT RIVER TRANSECT WITH A 0.5 m, 505 MICRON
MESH PLANKTON NET
JULY 1976
BVPS

	Entrainment Transect Sampling Stations										Combined (10)
	St. 1		St. 2		St. 3		St. 4		St. 5		
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
July 8, 1976											
Vol. of water filtered (m ³)	72.40	108.42	70.01	91.37	149.39	164.98	99.41	98.01	58.14	60.95	1061.49
No. of larvae collected	30	41	4	12	18	10	14	7	45	64	270
No. of juveniles collected	0	0	0	2	0	1	0	0	0	0	3
No. of eggs collected	0	0	0	0	0	6	0	1	0	0	7
Density (10 ³)	42.52	58.11	5.11	13.22	9.44	6.67	14.05	12.24	77.40	10.90	27.24
Larvae											
<i>Desmognathus crassicauda</i> (TL) (11)	0	0	0	0	1.77	0	0	0	0	0	0.30
<i>Desmognathus sibilans</i> (EL) (12)	5.51	3.77	0	1.09	1.20	0	0	2.04	4.88	11.44	1.40
Cyprinidae (unidentified) (XL) (13)	0	0.92	1.28	0	0	0.41	0	0	0	18.05	1.40
Cyprinidae (unidentified) (EL) (13)	34.44	47.54	3.84	7.64	8.49	4.85	12.05	0.14	70.32	44.91	20.87
Cyprinidae (unidentified) (EL) (13)	0	4.81	0	0	0	0	0	0	0	3.28	0.70
<i>Leuciscus</i> sp. (EL) (14)	1.28	0	0	1.09	0	0	0	0	0	0	0.20
<i>Leuciscus</i> sp. (EL) (14)	0	0	0	0	0	0	0	1.03	0	3.28	0.30
<i>Phoxinotus</i> sp. (EL) (15)	0	1.84	0	1.09	0	0	0	0	0	0	0.30
<i>Aplocheilichthys</i> (TL) (16)	0	0	0	0	0	0.41	0	0	0	0	0.10
Unidentified TL (16)	4	0	0	2.19	0	0	2.11	0	0	0	0.40
Juveniles (14)											
<i>Notropis albicinctus</i>	0	0	0	1.09	0	0	0	0	0	0	0.10
<i>Notropis punctatus</i>	0	0	0	1.09	0	0.41	0	0	0	0	0.20
Eggs											
<i>Notropis albicinctus</i> (18)	0	0	0	0	0	3.44	0	1.03	0	0	0.70
July 21, 1976											
Vol. of water filtered (m ³)	92.35	81.14	48.43	101.90	145.24	188.13	79.49	81.84	44.00	54.14	864.70
No. of larvae collected	23	7	10	1	10	6	4	2	54	10	125
No. of juveniles collected	7	0	0	0	0	0	0	0	0	0	7
No. of eggs collected	0	0	0	0	1	1	5	0	0	0	7
Density	29.48	5.70	11.31	0.98	6.89	3.21	7.55	2.19	122.71	18.45	13.68
Larvae											
Cyprinidae (unidentified) (TL)	1.08	0	3.28	0	0	1.10	1.20	0	97.77	0	5.10
Cyprinidae (unidentified) (EL)	21.64	3.70	4.79	0.98	4.86	2.15	4.29	2.18	15.00	12.92	7.15
Unidentified (TL)	0	0	1.13	0	0	0	0	0	0	0	0.10
Unidentified (EL)	3.14	0	1.13	0	0	0	0	0	0	5.54	0.42
Juveniles											
<i>Notropis albicinctus</i>	3.25	0	0	0	0	0	0	0	0	0	0.31
<i>Notropis punctatus</i>	4.23	0	0	0	0	0	0	0	0	0	0.41
Eggs											
<i>Notropis albicinctus</i>	0	0	0	0	0.42	0.34	4.79	0	0	0	0.73

(11) TL - Retained specimens in which yolk and/or oil globules are present.

(12) EL - Specimens in which yolk and/or oil globules are not apparent and in which fin rays and spiny elements are not present.

(13) XL - Specimens in which the eyes and spiny elements of the dorsal and anal fins approximate the number found in adults.

(14) Specimens in which the approximately adult number of fin elements are apparent in all fins and specimens have developed the body shape and pigmentation of the adult.

(15) Several species of *Leuciscus* (*L. cinctus*, *L. spilargenteus*, *L. diabolus*, *L. microlepis*) and *Pimephales* (*P. notropis* and *P. promelas*) found in area, identification is tentative.

(16) Several species of *Aplocheilichthys* found in area (*A. grandis*, *A. fluviatilis*, *A. mexicanus*, *A. nebulosus*). Identification tentative.

(17) Presumably *Leuciscus* sp. or *L. cinctus*.

(18) Only one type of egg collected. Tentatively identified as *Notropis albicinctus*.

(19) Destroyed or deteriorated.

(20) Includes only larvae and juveniles. Total may not be equal to the sum of the individual values since the values were rounded off.

TABLE 8

ENTRAINMENT PROGRAM (INTAKE) - SPATIAL DISTRIBUTION
 MEAN NUMBER OF FISH LARVAE PER HUNDRED CUBIC METERS
 OF WATER SAMPLED IN OPERATING BAYS

BVPS

APRIL - JULY 1976

	Bay A		Bay B		Bay C		Bay D		Combined ^(a)
	Day	Night	Day	Night	Day	Night	Day	Night	
April 15, 1976	0	0	-(b)	-	-	-	-	-	-
April 29, 1976	1.30	22.18	-	-	2.61	15.66	-	-	10.44
May 12, 1976	0	0	-	-	-	-	-	-	0
May 27, 1976	4.02	45.52	-	-	-	-	2.68	0	13.05
June 10, 1976	2.68	12.05	5.36	179.41	-	-	-	-	49.88
June 24, 1976	28.70	353.53	172.20	317.03	-	-	-	-	217.87
July 8, 1976	13.05	93.93	26.09	182.65	-	-	-	-	78.93
July 22, 1976	13.20	120.08	-	-	-	-	5.28	23.75	40.18
TOTALS	62.95	647.29	203.65	679.09	2.61	15.66	7.96	23.75	

TABLE 9

SPATIAL DISTRIBUTION OF ICHTHYOPLANKTON (MEAN NUMBER/100m³) AT
THE ENTRAINMENT RIVER TRANSECT
APRIL-JUNE, 1976
BVPS

	No. 1		No. 2		No. 3		No. 4		No. 5		Combined ^(a)
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
April 15, 1976	0	0	0	0	0	0	0	0	0	0	0
April 29, 1976	0	1.20	0	1.04	0.61	0	0	0	0	0	0.28
May 12, 1976	0	0	0	0	0	0	0	0	0	0	0
May 27, 1976	0	10.69	2.17	4.55	0	2.45	0	5.28	0	23.40	3.92
June 10, 1976	0	16.10	3.72	6.00	3.99	3.74	2.88	4.43	1.90	10.32	4.92
June 24, 1976	24.82	7.99	9.92	4.35	6.36	7.36	6.37	2.25	128.96	40.47	16.34
July 8, 1976	41.32	58.11	5.13	15.32	9.44	6.67	14.05	12.24	71.40	105.00	7.26
July 22, 1976	32.48	3.70	11.31	0.98	6.88	3.22	7.55	2.18	122.73	18.46	13.60
TOTAL	98.62	97.79	32.25	32.24	27.28	23.44	30.85	26.38	330.99	197.65	

(a) Individual values rounded off. Totals may not be equal to the sum of the individual values.

FIGURE 1

COMPARISON OF MEAN LARVAE DENSITIES FOR THE
INTAKE AND RIVER TRANSECT SAMPLES
BVPS (1976)

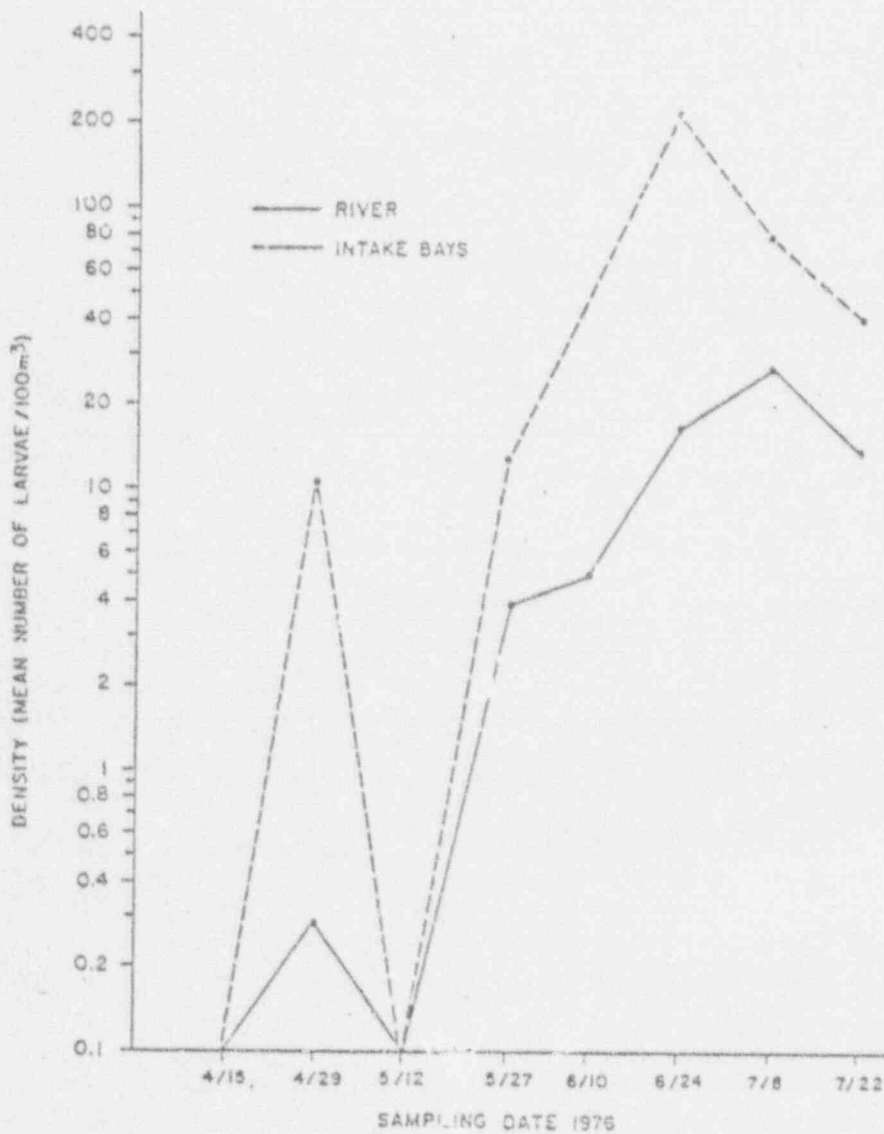


TABLE 10

PHYTOPLANKTON DENSITIES AND PERCENT COMPOSITION IN
ENTRAINMENT AND RIVER SAMPLES
MEAN OF ALL SAMPLES
JANUARY - DECEMBER 1976
BVPS

Entrainment

Group	Sampling Date												Σ
	1/18	1/21	1/28	2/7	2/11	2/18	2/22	2/27	3/12	10/18	11/2	12/1	
Cyanophyta cells/ml %	38 13	8 2	6 2	81 2	210 1	155 1	212 2	892 6	133 1	40 2	48 7	20 5	154 2
Chlorophyta cells/ml %	35 12	15 4	62 17	1,147 36	8,019 56	10,932 73	5,327 48	6,243 45	8,088 42	623 37	134 20	22 5	3,287 55
Euglenophyta cells/ml %	1 0	0 0	1 0	5 0	1 0	3 0	3 0	2 0	5 0	0 0	2 0	1 0	2 0
Pyrrhophyta cells/ml %	0 0	0 0	1 0	2 0	7 0	14 0	16 0	47 0	13 0	0 0	1 0	0 0	8 0
Cryptophyta cells/ml %	6 2	6 2	17 5	472 13	748 5	549 4	366 3	697 5	418 3	101 6	43 6	9 2	286 5
Chrysophyta cells/ml %	205 70	213 84	123 33	1,147 35	4,945 32	2,864 19	4,394 40	5,650 41	4,113 32	581 34	338 49	353 84	2,502 33
Microflagellates cells/ml %	8 3	20 6	159 43	373 12	861 6	487 3	706 6	395 3	270 2	359 21	117 17	13 3	314 5
Total cells/ml	283	347	349	3,341	14,390	15,004	11,023	13,920	13,041	1,704	861	418	

River

Group	Sampling Date												Σ
	1/18	1/24	1/28	2/7	2/15	2/27	2/28	3/27	3/31	10/18	11/1	12/1	
Cyanophyta cells/ml %	103 29	12 4	28 6	68 2	146 2	101 0	166 1	801 5	75 1	94 4	101 10	54 9	162 2
Chlorophyta cells/ml %	38 16	34 11	41 8	566 33	12,457 66	18,180 77	7,519 58	7,226 46	8,174 62	920 42	335 33	63 11	4,671 61
Euglenophyta cells/ml %	0 0	0 0	1 0	4 0	3 0	5 0	8 0	11 0	1 0	3 0	3 0	1 0	5 0
Pyrrhophyta cells/ml %	1 0	0 0	2 0	10 0	15 0	27 0	4 0	75 0	11 0	1 0	2 0	1 0	10 0
Cryptophyta cells/ml %	11 3	4 1	27 5	282 10	1,757 9	935 4	289 2	774 5	463 4	94 4	58 4	20 3	393 5
Chrysophyta cells/ml %	157 44	245 79	309 62	1,045 19	2,562 19	4,090 17	4,055 31	4,283 39	4,010 31	878 31	354 35	425 71	2,102 27
Microflagellates cells/ml %	27 5	16 5	95 19	320 12	443 3	378 2	874 7	793 5	318 1	393 18	156 16	37 6	347 5
Total cells/ml	357	311	502	2,725	18,783	23,694	13,016	14,042	17,651	2,184	959	600	

TABLE 11

ZOOPLANKTON DENSITIES AND PERCENT COMPOSITION
 JANUARY - DECEMBER 1976
 BVPS

Entrainment

Sampling Date	Total Zooplankton	Protozoa		Rotifera		Crustacea and Others	
	Number/l	Number/l	%	Number/l	%	Number/l	%
January 19, 1976	320	256	80	56	18	8	2
February 23, 1976	289	258	89	31	11	1	<1
March 19, 1976	349	308	89	40	11	1	<1
April 29, 1976	5,136	4,978	91	455	9	4	<1
May 27, 1976	2,905	2,408	83	487	17	10	<1
June 17, 1976	7,091	741	10	6,254	88	98	1
July 13-14, 1976	1,705	2,286	62	1,375	37	44	1
August 17-18, 1976	3,178	1,765	56	1,404	44	9	<1
September 22-23, 1976	3,655	1,050	29	2,590	70	5	1
October 19-20, 1976	485	420	87	63	13	1	<1
November 9-10, 1976	396	347	88	47	12	2	<1
December 9-10, 1976	401	352	88	47	12	2	<1

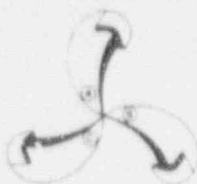
River

Sampling Date	Total Zooplankton	Protozoa		Rotifera		Crustacea and Others	
	Number/l	Number/l	%	Number/l	%	Number/l	%
January 20	327	276	85	48	15	2	1
February 24	311	274	88	36	12	1	<1
March 19	347	305	88	38	11	5	1
April 28	10,948	10,774	98	169	2	4	<1
May 26	2,516	1,699	67	808	32	10	<1
June 17	5,711	706	12	4,664	85	1	2
July 13	3,344	1,903	57	1,398	42	43	1
August 18	3,296	1,676	51	1,597	48	23	1
September 22	3,521	808	23	2,643	75	69	2
October 19	518	425	82	89	17	3	1
November 9	446	396	89	48	11	2	<1
December 9	557	492	85	78	14	8	1

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AQUATIC
SYSTEMS
CORPORATION



PO BOX 15390
PITTSBURGH, PA 15237
412-367-1600

31 January 1989

To: Wayne McIntire
Duquesne Light Company
Nuclear Safety and Licensing Dept.
P.O. Box 4
Shippingport, PA 15077

From: Robert Shema (ASC)
Greg Styborski (ASC)

Subj: Observation of gizzard shad (Dorosoma cepedianum)
in Discharge of BVPS
12 January 1989

At approximately 1115 on 12 January 1989, ASC received a telephone message from Wayne McIntire (DLCo) that there had been reports of 20 to 30 dead fish floating and/or on the shore in the discharge area. At 1125 Shema talked to William Wirth and informed him that we were collecting our equipment (boat, water meters, etc.) and were leaving within the next few minutes.

At 1245 we arrived at the discharge and talked with the foreman in charge of the road construction as to our intention of taking some physical/chemical measurements of the discharge. We also observed four (4) anglers and inquired what types of fish they were catching. It appeared that white bass (Morone chrysops) were being caught on a regular basis. No other game fish was mentioned as being caught that day.

We walked the entire shoreline around the discharge and observed and collected gizzard shad. On the north shore of the discharge there were 27 gizzard shad. Their age class was approximately 1 year. On the west end near the newly constructed road there were approximately 60 very small fish. However, from their position in the stones, it appeared that these fish were land-locked whenever the water elevation was up approximately 1 foot. When the river elevation receded, these fish were left exposed on the stones with no water around them. The larger fish however, were either floating or near the water line. Twenty (20) fish (10 from each age class) were collected and returned to the laboratory for examination.

In the lab the fish's length (total length) and weight (grams) were recorded along with a notation as to the color of the fish's gills (white, pink, or red). This was done to try to estimate when the fish died. Since all the gills showed at least some pink, the fish probably died within the last few days. Since the discharge was inspected on the previous Friday

as part of our routine observation, we are confident that the deaths occurred sometime within the last week. In addition, since there were variations between color (white-pink, pink, and red-pink), we can assume that the fish did not die all at the same time. Please see attached data sheet.

The water temperature and dissolved oxygen (D.O.) were measured at the discharge and near the intake structure. The results are provided in the following Table.

TABLE

	<u>Temp °F</u>	<u>D.O. Saturation</u>	<u>D.O. Measured</u>
Intake	38.7	13.35 mg/l	14.6 mg/l
Discharge	76.1	8.45 mg/l	8.6 mg/l

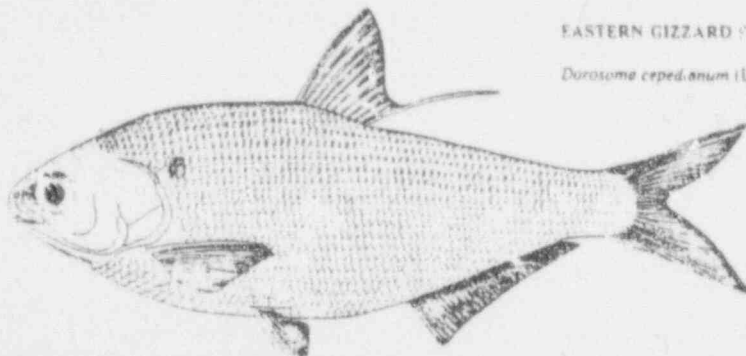
Barometric Pressure 29.95 and falling.

Realizing that the dissolved oxygen was above saturation, this alerted us to look for signs of "popeye or gas bubble disease" in the fish. Although no signs were visible, diffusion of the gases could have already taken place and obvious signs could have vanished.

The fact that there was only one species involved and since the number (20 to 30) was relatively low compared to the numerous gizzard shad that were observed breaking the surface, it appears that a chemical or thermal shock was not the cause. Mr. McIntire also informed us that he had already contacted plant chemistry and operations personnel to establish if any releases or unusual situation occurred during the past few days. He was informed that everything was normal.

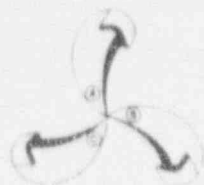
The search for explanations as to why gizzard shad congregate and subsequently die-off in heated discharges has been going on since the 1950s. Some theories involve the idea that this was once a marine species that got land-locked. Since the cooling tower blow-down has higher salt concentrations this may be one of the reasons gizzard shad are attracted to the discharges. Heated water is another reasonable explanation as to why this species congregates in the discharge area. Some research suggests that since these fish are crowded, they also become stressed. This stress leads to higher metabolic rates, subsequent fatigue, and higher vulnerability to disease.

Additional information on the possible causes of attraction and die-off of the gizzard shad is attached. This report was co-authored by Robert Shema.



EASTERN GIZZARD SHAD

Dorosoma cepedianum (Lesueur)



LAB LOG NUMBER: _____

Page ____ of ____

FISH LABORATORY WORK SHEET

Client Name BYPS-DLU
 Client Number _____
 Type of Sample FISH
 Station DISCHARGE
 Date Sample Collected 1-12-89
 Date Sample Analyzed 1-12-89
 Sample Analyzed by CMS, MEN

Copies sent to:
 Fish Lab File _____ Yes _____ No _____
 Section Leader _____
 Project Manager _____
 M.O. Central File _____

Fish No.	Species Name	Length (TL, FL, SL mm)	Weight (grams)	Scales Taken	GILL COLOR	K Factor	VOUCHER NUMBER
01	Gizzard Shad	340	408	X	REDDISH PINK		
02	"	342	400	X	"		
03	"	329	361	X	"		
04	"	308	280	X	PINKISH		
05	"	300	243	X	"		
06	"	344	390	X	BRD-PINK		
07	"	282	225	X	PINK		
08	"	285	232	X	WH PINK		
09	"	219	108	X	PINK		
10	"	354	525	X	RED-PINK		
11	"	104			WH-PINK		
12	"	84			"		
13	"	87			"		
14	"	100			"		
15	"	105			"		
16	"	89	68		PINK		
17	"	91			WH-PINK		
18	"	97			"		
19	"	80			"		
20	"	87			"		
21							
22							

A STUDY OF THE EFFECTS OF THE OPERATION
OF A STEAM ELECTRIC GENERATING STATION
ON THE AQUATIC ECOLOGY OF
PRESQUE ISLE BAY, ERIE, PENNSYLVANIA

By

Daniel G. Bardarik, PhD., Director

Jon C. Alden, M.S., Project Leader

Robert L. Shema, B.S., Aquatic Biologist

FOR

PENNSYLVANIA ELECTRIC COMPANY

April, 1973

Aquatic Ecology Associates
5100 Centre Avenue
Pittsburgh, Pa. 15232

4. Some Possible Causes of Attraction and Die-Off of the
Gizzard Shad

a. Factors Attracting Shad

Movement of the schools of gizzard shad from the outer areas of the bay toward the boat basins occurred with the onset of winter. The shad were observed to be moving toward

the boat basins within a 65°F temperature regime as the bay waters progressively cooled. That the condenser cooling water discharge during the winter months attracts the fishes, cannot be disputed.

Preliminary observations indicate however that there are other subtle factors operating that attract the live fish to the intake and discharge structures once they are in the boat basin area. The fact that the lake emerald shiner was attracted to the auxiliary Holland Street intake on several occasions, from an area where water temperature and chemistry were unaffected by power station operations, very strongly points to intake velocity as being a factor responsible for attracting them to the intake portal. A personal observation of this phenomena was made during investigations on the Ohio River in the vicinity of the Shippingport Nuclear Power Station during 1958-59. At that time, massive schools of the emerald shiner were observed immediately in front of the intake structure. No other reasons except intake velocity could account for the attraction.

Similarly, velocity seems to be a factor operating at the main intake as well as at the discharge. Why certain gizzard shad swim with the current at the intake while others swim against the current in the discharge channel cannot be explained without further investigation.

Another factor which may provide an attraction to the gizzard shad during the winter months is the gradual buildup of dissolved solids in the east and west inner boat basins

as a result of the discharge of the backwash from the demineralizers, and the ash pond discharge to the vicinity of the east slip in front of the main intake structure. Specific conductance measurements indicated a very decided increase in the dissolved solid concentration particularly after the ice formation in the bay. The "bathtub effect" created by the thermal barring previously described causes a recirculation of the dissolved solids and as a result, a noticeable increase occurs.

Throughout the winter of 1971-72 a station log was kept which contained observations of the quantity and general size of the gizzard shad which were removed by the traveling screens. In addition, the log entries made note of general weather conditions and the length of time of operation of the traveling screens. One notable phenomena consistently appears in the log. A heavy influx of gizzard shad which invariably required the activation of the traveling screens, always occurred when there was a very decided drop in air temperature accompanied by adverse weather conditions. What is implied here is that a combination of change in atmospheric pressure and air temperature stimulates the massive movement of gizzard shad into the intake canal. As nearly as can be determined this is not principally a water temperature oriented response but apparently is associated with a change in weather conditions. This movement, associated with a change in weather has been suggested by others. The exact details of the triggering mechanism are not known and require further investigation.

b. Gizzard Shad Die-Off

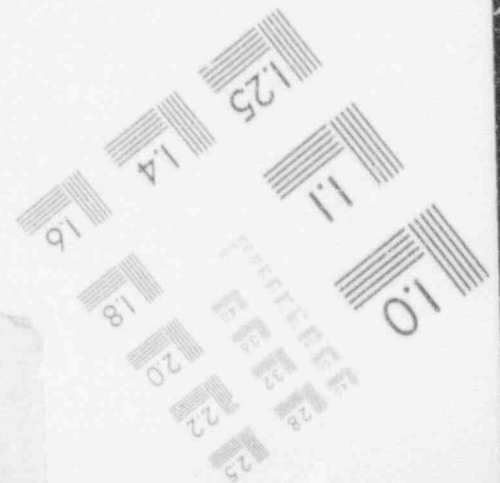
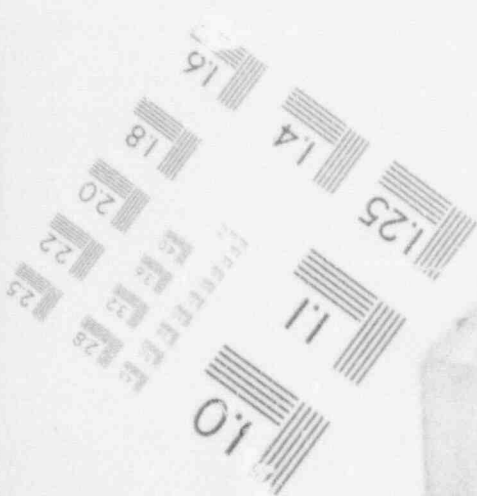
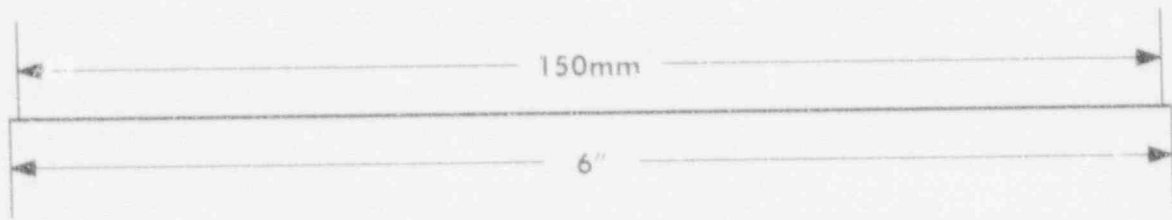
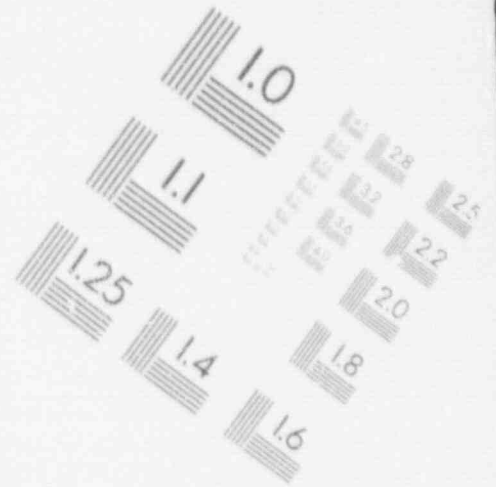
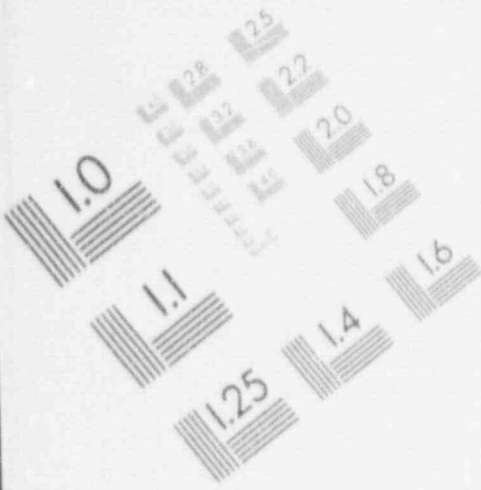
The exact cause of the die-off of the gizzard shad has not been determined. What has been determined is that maximum discharge temperatures and maximum fluctuations in discharge temperatures in excess of a 2°F change in any one hour period does not cause any fish kills. The various fluctuations in temperature in the inner boat basins during winter acting synergistically with other factors may be indirectly responsible for the die-off of the fishes but has yet to be demonstrated.

The increase in dissolved solids that occurs in the inner boat basins during the winter months as a result of regeneration of demineralizers, the ash pond discharge, and the leaching from the coal storage pile may also be acting as an attractant to the gizzard shad. Temperature tolerance and avoidance studies that were conducted by Meldrim and Gift (1971) using certain estuarine fishes found that the response of the fishes to variations in water temperature was influenced by variation in salinity (i.e., specific conductance) and turbidity. Since the gizzard shad is historically an ocean fish which has become land-locked in fresh water and still retains certain structural and functional characteristics more appropriate to an ocean environment, the increase in dissolved solids in the boat basins may be an important factor to take into consideration.

Field observations conducted during January of 1972 provides evidence pointing to the physical and chemical

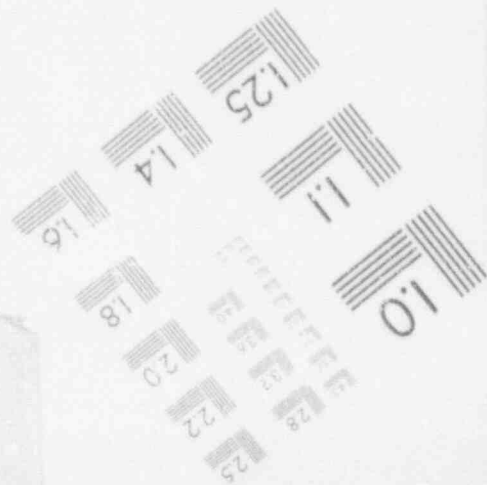
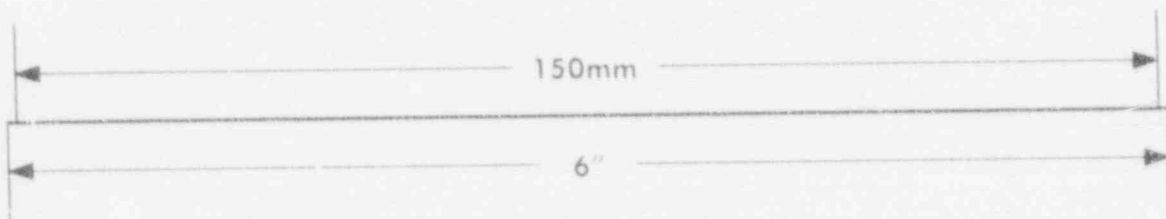
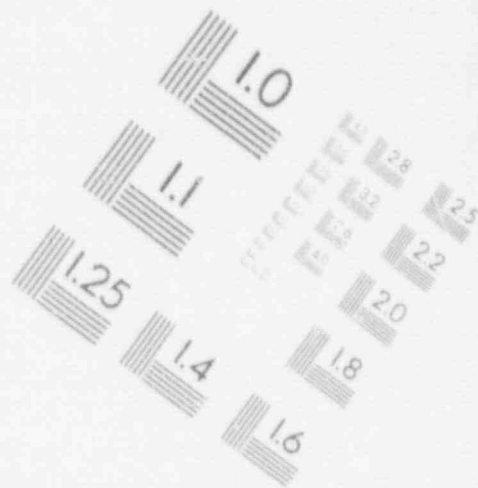
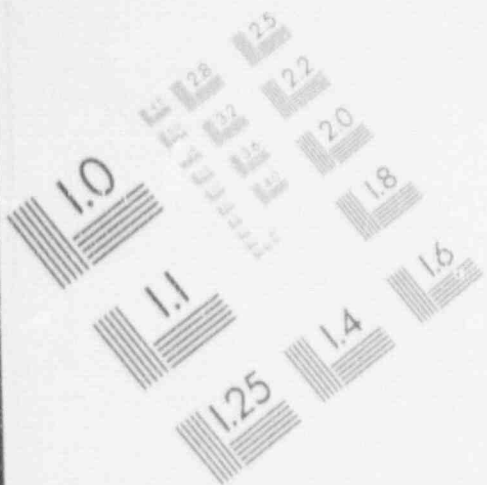
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IMAGE EVALUATION TEST TARGET (MT-3)



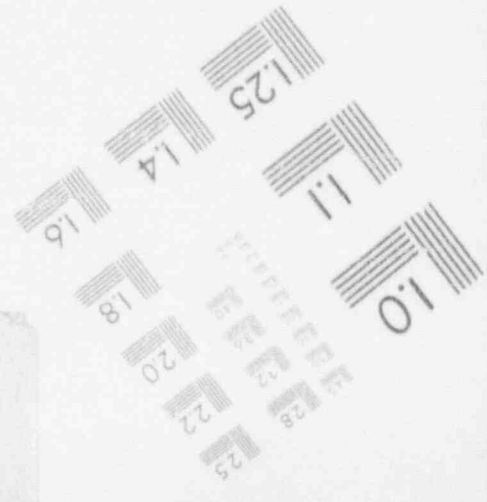
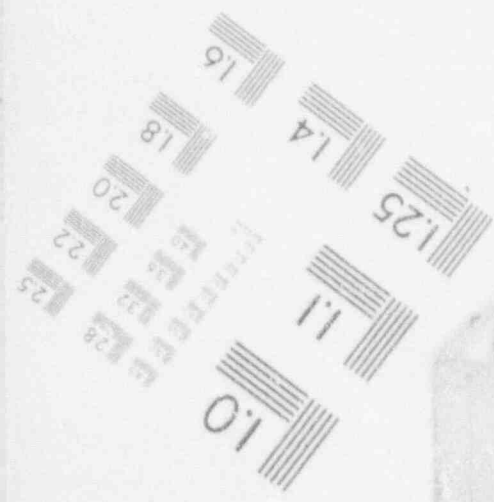
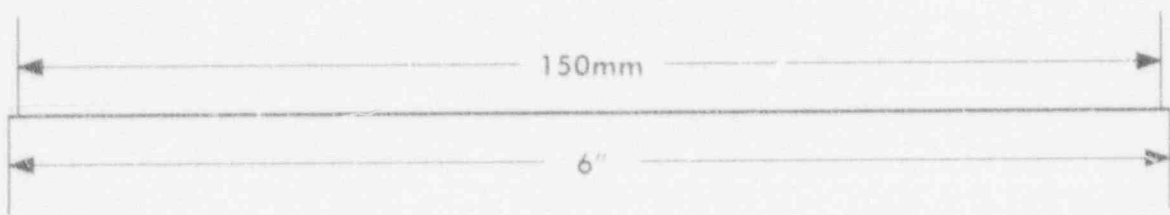
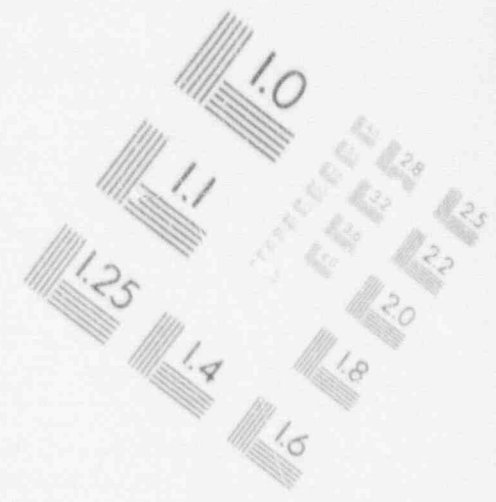
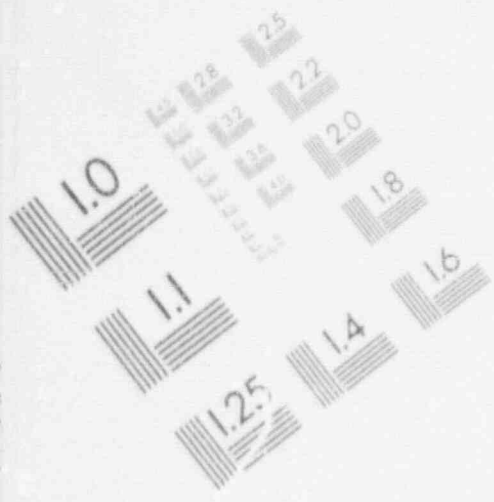
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IMAGE EVALUATION TEST TARGET (MT-3)



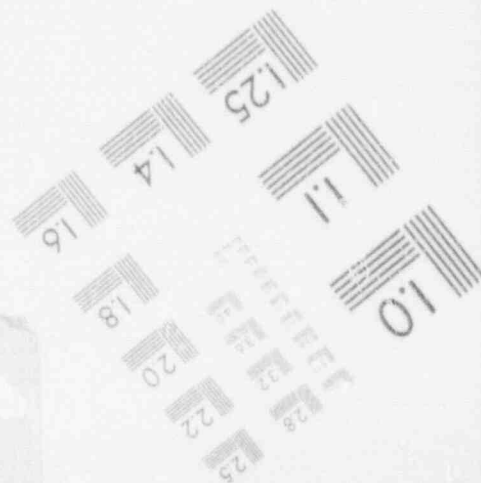
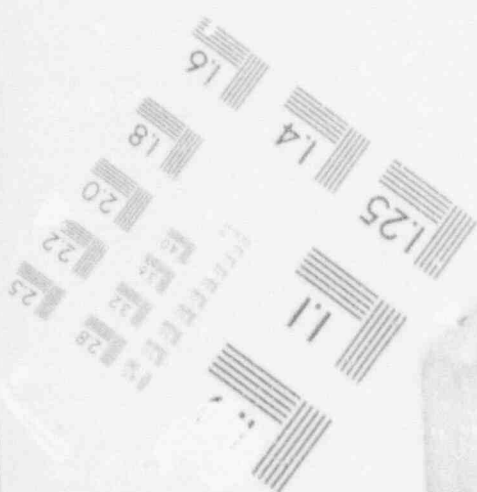
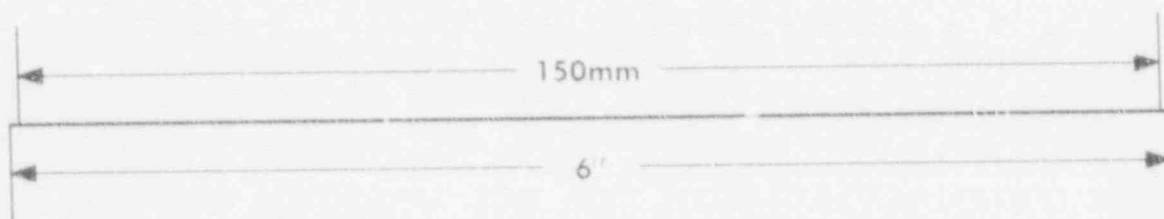
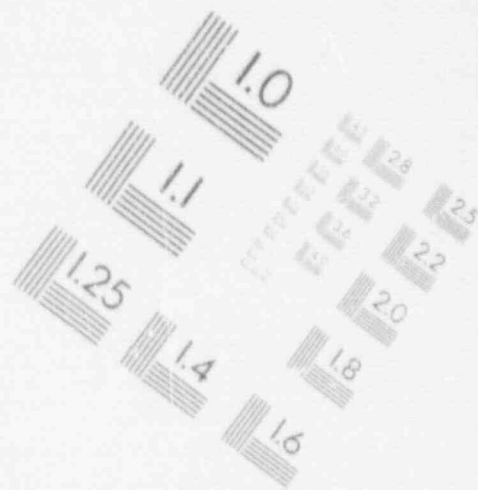
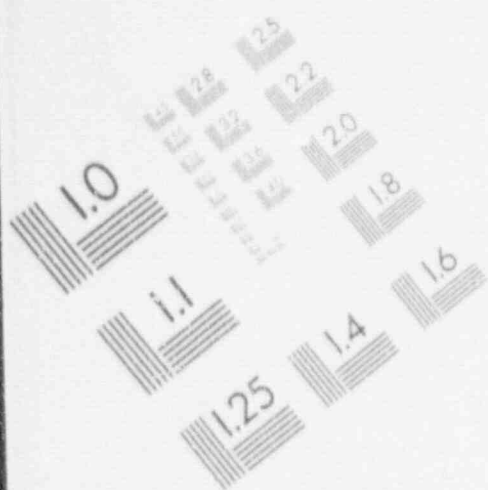
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IMAGE EVALUATION TEST TARGET (MT-3)



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IMAGE EVALUATION TEST TARGET (MT-3)



complexities associated with the die-off of fishes. It appears that ice formation, severe winter temperatures, dissolved solids, and dissolved gases react synergistically and to varying degree within the inner boat basins to create a situation of considerable stress which cannot be tolerated by fishes. Obviously the formation of ice and the extreme low winter temperatures cannot be controlled.

A description of the events which occurred between January 9 and 19, 1972 is of considerable interest. On January 9th, massive schools of the lake emerald shiner were attracted to the intake by the thousands. They were too small to be removed by the traveling screens, and were killed upon passing through the condensers. Between the 10th and the 14th the large adult gizzard shad were observed to be bobbing to the surface and gulping air. Between the 14th and 15th air temperatures took a severe drop to 0°F and the bay froze for the first time. In the power station between the 15th and 18th, boilers were drained on five occasions.

On the 18th, large numbers of gizzard shad were found dead along the banks in the discharge area. They appeared to have been dead for several days. While these fish were being examined a sudden fish kill took place in the vicinity of the discharge. The kill was not confined solely to the gizzard shad but included several other species as well. During the fish kill, fishes formerly observed in the discharge tank adjacent to the power station were no longer

present. From the immediate reaction displayed by the fishes it was suspected that a heavy metal ion might have been responsible for the sudden fish kill. Analysis of water samples taken from the vicinity of the discharge prior to, during, and after the fish kill were analyzed for heavy metals. The results of the analysis for various heavy metals (Table 26) show that the levels were well below those concentrations known to have a toxic affect on fish life.

Analysis of water samples obtained at the time revealed that ammonia nitrogen levels reached 2.5 mg/l, and field measurements of the dissolved oxygen revealed a drop to 2.5 mg/l. The ammonia nitrogen concentration was the highest ever measured and the dissolved oxygen was the lowest concentration ever measured. The results of tests conducted in the past indicate that ammonia levels of 2.5 parts per million with a pH from 7.0 to 7.4 are toxic or lethal to certain species of fish and that the toxicity of ammonia is intensified by reductions in the dissolved oxygen. It appears therefore, that the ammonia and dissolved oxygen concentrations were primarily responsible for the sudden fish kill that occurred on that date. Subsequently, a series of investigations were conducted to determine the cause of the increase in ammonia. In cooperation with local authorities, an attempt was made to determine if ammonia could have entered the discharge canal or the west basin from private, adjacent facilities.

During the week of February 9, 1972, dye studies were conducted along the entire adjacent waterfront. No evidence of

Table 26 Analysis of Water Samples from Station Wb1 for Heavy Metals Prior to, During and After the Fish Kill of January 18, 1972, Presque Isle Bay, Erie, Pennsylvania.

PARAMETER	DEPTH*	11/15/71	1/18/72	2/11/72
Chromium	T	<.01	<.01	<.01
	B	<.01	<.01	<.01
Copper	T	<.003	0.027	0.009
	B	0.003	0.033	0.009
Nickel	T	<.01	<.01	<.01
	B	<.01	<.01	<.01
Cadmium	T	<.004	<.004	<.004
	B	<.004	<.004	<.004
Lead	T	<.03	<.03	<.03
	B	<.03	<.03	<.03
Iron	T	0.75	2.28	1.06
	B	0.75	1.23	1.27
Manganese	T	0.039	0.069	0.103
	B	0.049	0.057	0.094
Zinc	T	0.071	0.049	0.049
	B	0.089	0.058	0.049

* T = Top
B = Bottom

dye appeared at any time in either the east or west boat basins. Subsequently, a complete examination of the various chemicals that are used in the operation of the plant was conducted in an attempt to determine whether any chemical or chemicals in combination with one another might, during the normal operations of the plant, result in the formation of ammonia.

It was determined that the only possible source of ammonia might have been from the use of hydrazine (NH_2NH_2) which is used as an oxygen scavenger in boiler feed water treatment. From the examination of plant records and calculation of the concentration of hydrazine that could have entered the basins, it appears unlikely that this would have been the cause.

An experiment was initiated on the 14th of February to determine to what extent the presence of dead gizzard shad in the boat basins might contribute to the buildup of ammonia through the natural decay process. Results of this experiment have been previously described in the section on bay chemistry and the results of laboratory tests are contained in Table 6. To reiterate briefly, these results indicate that the decomposition of the gizzard shad in the basins and the ash ponds contribute a significant amount of ammonia to the surrounding waters particularly after ice formation and the formation of thermal barring which results in the complete recirculation of water between the east and the west basins. This continues until dissipation once again occurs in the bay after the ice

leaves in the spring.

The high concentration of ammonia and the associated low concentration of oxygen was apparently the cause of the January 18th fish kill in the west basin. The cause of the gradual die-off of the gizzard shad was observed to commence about the middle of November when ammonia concentrations were lower and oxygen concentrations were higher. It appears that a combination of fluctuations in water chemistry, changes in climactic conditions, and the condenser cooling water temperatures combine in some way to produce a subtle chronic condition which eventually has a lethal effect on the gizzard shad.

There is some indication that the solubility of gases in water is being affected by atmospheric pressure, air temperature and water temperature and directly relates to Henry's law of solubility of gases in water and Dalton's law of partial pressures. Since oxygen and ammonia have not been a problem, except for one incident described above, the only other gas remaining to be examined is nitrogen. The effects of excess dissolved nitrogen gas in water on fishes has been known for some time. It produces a characteristic disease referred to as gas-bubble disease and is usually found in fish hatchery operations, home aquaria, and occasionally in the tail-race waters at the base of large reservoirs at certain times of the year. Very recently the occurrence of gas-bubble disease in fishes in the heated effluent of a steam generating station was reported for the first time (DeMont and Miller, 1971).

Gas-bubble disease can occur when the blood of fishes becomes supersaturated with gases. They state that this condition may result when a fish at equilibrium with air-saturated water is subjected to an increase in temperature, a decrease in pressure, or both. More commonly, gas-bubble disease develops when a fish is exposed to an environment that is supersaturated with dissolved gases. When the degree of supersaturation is great enough, fishes develop a characteristic external symptom in which gas bubbles can be observed accumulating in the head and in the fins. It also causes an accumulation of bubbles in the tissues behind or within the eye causing them to become distended outward. The eye condition is referred to as "popeye" and is readily detectable. These extreme characteristics were not noticed in the gizzard shad in the boat basins but this does not totally disallow the possibility. Although fishes may recover if the condition is not severe, mortality may be heavy. Susceptibility and reaction to the gas-bubble disease differs among various species and in some, may have only a debilitating affect rather than causing mortality.

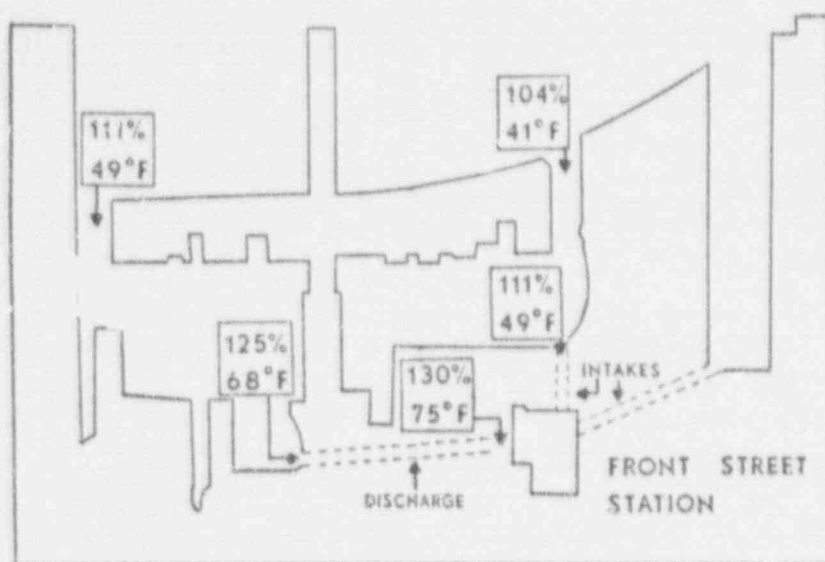
A series of water samples were collected on January 17, 1973 and analyzed for nitrogen gas concentrations. The results of these analyses (Table 27) indicates that a variation exists which suggests the possibility that supersaturation of nitrogen in the basins may be a contributing factor to the die-off of the gizzard shad. These preliminary results strongly suggest further investigation.

Table 27 Nitrogen Saturation Levels in the Inner Boat Basins, and at the Discharge, Presque Isle Bay, Erie, Pennsylvania, January 17, 1973.

	% Saturation	ppm N ₂	ml/l	Temp. °F
East Basin	103.9	21.4	17.12	41
West Basin	111.0	20.65	16.52	49
End of Discharge Channel	122.7 126.5 125.9	18. 19.01 18.93	14.76 15.21 15.14	68
Intake	109.6 112.9	20.38 21.00	16.30 16.80	49
Discharge Tank	130.3 129.8	18.43 18.38	14.76 14.70	75

A number of investigations have been carried out mainly with game species such as the salmon and trout. Westgard (1964) found that the nitrogen gas-bubble disease caused blindness in salmon and that mortality occurred as a result of invasion of fungi and bacteria into the damaged eyes. Rucker and Hodgeboom (1953) found that gases in the atmosphere are often forced into water when it is pumped, increasing both the oxygen and the nitrogen content. Removal of excess nitrogen in a hatchery water supply system by means of a trough deaeration system has been successfully demonstrated (Rucker and Tuttle, 1948). Harvey and Smith (1962: in Ebel, 1970) indicated that saturation as low as 108% produced gas-bubble disease in fingerling trout. Ebel (1970) also found that major causes of supersaturation of water with gases are heavy concentrations of algae, warming of water without adequate circulation and exposure to the atmosphere for equilibration, and falling of water into an enclosed catch basin. Observations of migrating salmon in the Columbia River passing thermal plumes from reactor stations were observed to be under stress. It was determined that fishes exposed to supersaturation of gases had less tolerance to rapid temperature increases, and losses of fish which inadvertently had entered the thermal plume were inevitably high.

The following figure shows a comparison of the percent nitrogen gas saturation for the samples collected in the boat basin area on January 17, 1973.



The pattern conforms with the observations of Westgard (1964). Gases escape from the intake water as temperatures are increased through the condensers and pressures build up which exceed atmospheric pressure. Since gases enter solution according to the product of their solubility and partial pressure, more nitrogen apparently remains in solution as it equilibrates with its increased partial pressure. Upon leaving the power station, supersaturation occurs as the water exits into atmospheric pressure.

One remaining possibility that has been tentatively suggested as being a causal factor in the formation of nitrogen gas-bubbles in the blood stream of fishes is suggested by Jester and Jensen (1972). He attributed die-off of gizzard shad from nitrogen gas-bubble disease to a bacteria, *Aerobacter aerogenes*. This bacteria is common in surface water and is not necessarily of fecal origin. It is harmless to fishes under ordinary

conditions but may cause a gas-bubble disease when fishes are subjected to strong environmental stress, such as extreme crowding. Since the gizzard shad in the west basin usually occur in extremely dense numbers in a very confined space, the severe crowding may be a contributing factor in this case. In any event, severe crowding observed in the west basin does cause stress by way of depletion of oxygen due to the large numbers of fish present and the abrasion from close contact with other individuals and with physical features of the basin. Body contact creates physical trauma and renders the fishes more susceptible to invasion by bacteria and fungi.

Various complex ramifications of the gizzard shad die-off phenomena suggest the need for additional investigation to determine the most feasible method for reducing and hopefully, eliminating the problem. Solving of the problem may entail investigation of the feasibility of additional temperature, water flow velocity, and dissolved solids control.