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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

**Subject: Beaver Valley Power Station, Unit No. 1 and No. 2**
**BV-1 Docket No. 50-334, License No. DPR-66**
**BV-2 Docket No. 50-412, License No. NPF-73**
**Beaver Valley Power Station Annual Environmental Report, Non-Radiological**

The 1999 Annual Environmental Report, Non-Radiological (Attachment 1) for Beaver Valley Power Station Units 1 and 2 is being forwarded, as required by Appendix B of our Unit 2 Operating License Section 5.4.1.

If you have any questions regarding this submittal, please contact Mr. John Maracek, Supervisor, Licensing at (412) 393-5232.

Sincerely,

Lew W Myers

Lew W. Myers

c: Mr. D. S. Collins, Project Manager
Mr. D. M. Kern, Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Ms. M. E. O'Reilly (FirstEnergy Legal Department)

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# 1999 ANNUAL ENVIRONMENTAL REPORT

## NON-RADIOLOGICAL

## BEAVER VALLEY POWER STATION

## UNITS NO. 1 AND 2

## LICENSES DPR-66 AND NPF-73

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**NON-RADIOLOGICAL**

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## EXECUTIVE SUMMARY

The 1999 Beaver Valley Power Station (BVPS) Units 1 and 2 Non-Radiological Environmental Monitoring Program consisted of an Aquatic Program that included surveillance and field sampling of the Ohio River's aquatic life in the vicinity of the station. The Aquatic Program is an annual program conducted to provide baseline aquatic resources data, to assess the impact of the operation of BVPS on the aquatic ecosystem of the Ohio River, and to monitor for potential impacts of biofouling organisms (*Corbicula* and zebra mussels) on BVPS operations. This is the 24th year of operational environmental monitoring for Unit 1 and the 13th for Unit 2. In December 1999, First Energy Nuclear Operating Company (FENOC) acquired full ownership of BVPS from Duquesne Light Company (DLC) and also assumed responsibility of the Aquatic Program. As in previous years, the results of the program did not indicate any adverse environmental impact to the aquatic life in the Ohio River associated with the operation of BVPS.

The results of the 1999 benthic macroinvertebrate surveys conducted in May and September did not indicate any abnormal community structure in the Ohio River either upstream or downstream of the BVPS. These benthic surveys are a continuation of a Fate and Effects Study conducted from 1990 through 1992 for the Pennsylvania Department of Environmental Protection (PADEP) to assess the ecosystem impacts of the molluscicides Betz Clamtrol CT-1 and CT-2 that is used to control biofouling organisms at BVPS. To date the benthic studies have not indicated any impacts of operation at the BVPS including the use of CT-1 on the benthic community below the BVPS discharge.

Substrate was probably the most important factor influencing the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft muck-type substrate along the shoreline found in 1999 and previous years was conducive to segmented worm (oligochaete) and midge (chironomid) proliferation. In 1999, the muck contained a greater percentage of sand than previous years which possibly impacted the densities of oligochaetes and chironomids which were present in relatively fewer numbers than in previous years. This drop in densities occurred throughout the study reach and was not confined to either the control or non-control areas. It could, therefore, not be attributed to affects of the BVPS discharge. In 1999, oligochaetes accounted for 37 percent of the benthic macroinvertebrate collected; whereas Chironomidae (midge fly) and Mollusca (snails and bivalves) accounted for 21 and 24 percent, respectively.

In 1999, nine taxa were added to the cumulative list of benthic macroinvertebrates collected near BVPS. ***The overall community structure has changed little since pre-operational years, and program results did not indicate that BVPS operations were affecting the benthic community of the Ohio River.***

The fish community of the Ohio River in the vicinity of the BVPS was sampled in May, July, September and November of 1999 with night electrofishing and daytime seining. Results from the 1999 fish surveys indicated that a normal community structure for the Ohio River existed near BVPS based on species composition and relative abundance. Since monitoring began in the early 1970's, the number of identified fish taxa has increased from 43 to 77 for the New Cumberland Pool.

During the 1999 survey, forage species were collected in the highest numbers, principally gizzard shad and emerald shiner. This indicated a healthy fish community since game species rely on the availability of abundant forage for survival. Variations in the annual catch were probably attributable to normal fluctuations in the population size of the forage species and the predator populations that depend on them. Forage species, such as gizzard shad and emerald shiners, which have high reproductive potential, frequently respond to changes in the environment with large fluctuations in population size. This in turn influences the population of predator species.

large fluctuations in population size. This in turn influences the population of predator species.

In 1999, species composition remained comparable among control and non-control stations. Common taxa collected included gizzard shad, emerald shiner, freshwater drum, redhorse sucker species, sand shiner, sauger, quillback, and smallmouth bass. The catch per unit effort (number of fish per minute) for electrofishing sampling in 1999 was 1.96 fish. This compared favorably with results of the previous year when electrofishing resulted in 1.51 fish per minute. These differences may be the result of population changes or caused by environmental conditions (e.g. turbidity, waves, water temperature, flow) on specific electrofishing sampling data that affected fish distribution or collective gear efficiency.

Little difference in the species composition of the catch was observed between the control (Station 1) and non-control (Stations 2A, 2B and 3). Habitat preference and availability were probably the most important factors affecting where and when fish were collected. ***There was no indication that the BVPS was affecting the near station fish community in the Ohio River.***

The monthly reservoir ponar samples collected in Units 1 and 2 cooling towers and the intake during 1999 indicated *Corbicula* were entering and colonizing the reservoirs. Overall the numbers of *Corbicula* collected in the samples were low which continued the trend over the past few years of fewer *Corbicula* and reflected a water-body-wide trend observed in the Ohio River.

No cooling tower density sampling was performed in 1999. Neither cooling tower was scheduled for sediment removal and basin cleaning.

Since 1991, zebra mussels have progressively moved upstream in the Ohio River. In 1993, zebra mussels were identified 50 miles downstream of BVPS. In 1995, live zebra mussels were collected for the first time by divers in the BVPS main intake and auxiliary intake structures during scheduled cleanings. Densities were generally low. During 1997, zebra mussel veligers, juveniles and adults were observed for the first time in sample collections. Densities of zebra mussels in samples increased in 1998.

Overall, both the number of observations of settled mussels and the densities of veligers at BVPS were greater in 1999 than in prior years. Observations by in plant personnel observed zebra mussels densities in the BVPS intake bays ranging from $1/ft^2$ to $50/ft^2$. Some drusing and layering were reported by divers. If trends continue and the number of zebra mussels in the Ohio River increase in 2000, BVPS should maintain their diligent zebra mussel monitoring and control program.

## ANALYSIS OF SIGNIFICANT CHANGE

During 1999, no significant changes to operations that could affect the environment were made at Beaver Valley Power Station. As in previous years, results of the BVPS environmental programs did not indicate any adverse environmental impacts from station operation.

# 1.0 INTRODUCTION

This report summarizes the Non-Radiological Environmental Program conducted by the Beaver Valley Power Station[1] (BVPS) Units 1 and 2; Operating License Numbers DPR-66 and NPF-73. This is a non-mandatory program, because on February 26, 1980, the Nuclear Regulatory Commission (NRC) granted BVPS's request to delete all of the Aquatic Monitoring Program, with the exception of the fish impingement program (Amendment No. 25), from the Environmental Technical Specifications (ETS). In 1983, BVPS was permitted to also delete the fish impingement studies from the ETS program of required sampling along with non-radiological water quality requirements. However, in the interest of providing an uninterrupted database, BVPS has continued the Aquatic Monitoring Program.

## 1.1 Objectives of the Program

The objectives of the 1999 environmental program were:

(1) To monitor for any possible environmental impact of BVPS operation on the benthic macroinvertebrate and fish communities in the Ohio River;

(2) To provide a minimal sampling program to continue an uninterrupted environmental database for the Ohio River near BVPS, pre-operational to present; and

(3) To evaluate the presence, growth, and reproduction of macrofouling *Corbicula* (Asiatic clam) and zebra mussels (*Dreissena spp.*) at BVPS.

## 1.2 Scope of Services

Personnel from Beak Consultants Incorporated (Beak) performed the 1999 Aquatic Monitoring Program as specified in the Environmental Programs Manual Procedure (EPMP) 5.01 - Aquatic Ecological Monitoring Procedures. This EPMP describes in detail the field and laboratory procedures used in the various monitoring programs, as well as the data analysis and reporting requirements. These procedures are summarized according to task below.

1 In December 1999, ownership of the Beaver Valley Power Station was transferred from Duquesne Light Company to FirstEnergy Corporation.

### 1.2.1 Benthic Macroinvertebrate Monitoring

The benthic macroinvertebrate monitoring program consisted of benthic sampling using a Ponar grab sampler at four stations on the Ohio River. Prior to 1996, duplicate sampling occurred at Stations 1, 2A, and 3, while triplicate sampling occurred at Station 2B (i.e., one sample at each shoreline and mid-channel) (Figures 1.1 and 1.2). In 1996, a review of the sampling design indicated that sampling should be performed in triplicate at each station to conform with standardized U.S. Environmental Protection Agency (USEPA) procedures. Therefore, starting in 1996, triplicate samples were taken at Stations 1, 2A, and 3, as in 1995, with triplicate samples also collected at each shore and mid-channel location at Station 2B. A petite ponar dredge was used to collect the samples, replacing the standard ponar dredge used in prior studies. This sampling was conducted in May and September, 1999. For each 1999 field effort, a total of 18 benthic samples was collected and processed in the laboratory, as described in the EPMP.

### 1.2.2 Fish Monitoring

The fish monitoring program consisted of seasonal sampling (May, July, September, and November) using boat electrofishing and seining techniques. Boat electrofishing was conducted at night along both shorelines at Stations 1, 2A, 2B, and 3 (Figure 1.3). Seining occurred at Stations 1 and 2B during the day and generally was performed in early evening. All field procedures and data analysis were conducted in accordance with the EPMP.

### 1.2.3 Larval Cages/Zebra Mussel Scraper/Bridal Veil Samplers/Pump/Biobox Sampling

Larval cages (two long term and two short term) were set in the project intake structure to sample for *Corbicula* beginning in 1996. The cages continued to be used to monitor for *Corbicula* through August 1997. Results from a study conducted from April through June 1997 to compare short-term larval cage and petite ponar sample results indicated that ponar sampling provided comparable results to short-term larval cages for monthly sampling. In August 1997, ponar sampling replaced short-term larval cage sampling. Long-term cages were used until May 1998 when all larval cages were removed at the request of BVPS personnel.

Wall scraping samples were collected monthly from the Unit 1 cooling tower, the Unit 2 cooling tower, the barge slip, and the intake wall in 1996 and 1997. Wall scrapings were taken with a D-frame scraper, with five scrapes of approximately 2 ft each made per sample at the sampling locations. In 1998, two additional locations were added; the emergency outfall (June through November) and the emergent outfall impact basin (August through November). In 1999 these added sites were sampled from April through November.

Bridal veil samplers were deployed in the intake structure in 1996 to monitor for zebra mussel veligers. The samplers were removed, and the bridal veil replaced and redeployed once per month until May 1998 when the samplers were removed at the request of BVPS personnel.

The intake sampling and wall scraping sampling was historically conducted once per month, year long. Beginning in December 1997, it was decided to forego sampling in December and January of each year, since buildup of the target organisms, *Corbicula* and zebra mussels, does not occur in these cold water months. Monthly sampling has been maintained throughout the balance of the year.

A pump sample for zebra mussel veligers was collected at the barge slip location monthly from April through October in 1996 and 1997. The scope of the sampling was expanded in 1998 to also include the intake structure. In June 1998, the emergency outfall basin and splash pool locations were also added. Additional pump samples were collected from the cooling tower of Unit 1 and Unit 2 in October, 1998. In 1999 these additional locations were sampled from April through November.

In April 1998, a biobox was set up at the emergency outfall basin to monitor for settling zebra mussels. The biobox was checked each month, and four substrate plates were removed and analyzed in November 1998. The biobox program was continued in 1999. In 1999, artificial substrate samplers were deployed and retrieved monthly, April through October, from the outside wall of the intake structure.

### 1.2.4 *Corbicula*/Zebra Mussel Density Determinations

During all *Corbicula*/zebra mussel sampling activities, observations were made of the shoreline and other adjoining hard substrates for the presence of macrofouling species.

### 1.2.5 Monthly Activity Reports

Activity reports were prepared each month that summarized the activities that took place the previous month. The reports included the results of the monthly *Corbicula*/zebra mussel monitoring including any trends observed and any preliminary results available from the benthic and fisheries programs. The reports addressed progress made on each task, and reported any observed biological activity of interest.

## 1.3 Site Description

BVPS is located on a 501-acre tract of land on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania. The Shippingport Atomic Power Station once shared the site with BVPS before being decommissioned. Figure 1.4 is a plan view of BVPS. The site is approximately 1 mile (1.6 km) from Midland, Pennsylvania; 5 miles (8 km) from East Liverpool, Ohio; and 25 miles (40 km) from Pittsburgh, Pennsylvania. The population within a 5 mile (8 km) radius of the plant is approximately 18,000. The Borough of Midland, Pennsylvania has a population of approximately 3,500.

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

The station is situated on the Ohio River at river mile 34.8 (Latitude: 40°,36',18", Longitude: 80°,26',02", at a location on the New Cumberland Pool that is 3.3 river miles (5.3 km) downstream from Montgomery Lock and Dam and 19.4 miles (31.2 km) upstream from New Cumberland Lock and Dam. The Pennsylvania-Ohio-West Virginia border is 5.2 river miles (8.4

km) downstream from the site. The river flow is regulated by a series of dams and reservoirs on the Beaver, Allegheny, Monongahela, and Ohio Rivers and their tributaries.

Ohio River water temperatures generally vary from 32°F to 84°F (0°C to 29°C). Minimum and maximum temperatures generally occur in January and July/August, respectively.

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

# 2.0 AQUATIC MONITORING PROGRAM

## 2.1 Introduction

The environmental study area, established to assess potential impacts, consists of four sampling stations each having a north and south shore (Figure 1.1). Station 1 is located at river mile (RM) 34.5, approximately 0.3 mile (0.5 km) upstream of BVPS and is the control station. Station 2A is located approximately 0.5 mile (0.8 km) downstream of the BVPS discharge structure in the main channel. Station 2B is located in the back channel of Phillis Island, also 0.5 mile downstream of the BVPS discharge structure. Station 2B is the principal non-control station because the majority of discharges from BVPS Units 1 and 2 are released to this back channel. Station 3 is located approximately 2 miles (3.2 km) downstream of BVPS.

Sampling dates for each of the program elements are presented in Table 2.1.

The following sections summarize the findings for each of the program elements.

## 2.2 Benthic Macroinvertebrate Monitoring Program

### 2.2.1 Objectives

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

### 2.2.2 Methods

Benthic surveys were scheduled and performed in May and September, 1999. Benthic samples were collected at Stations 1, 2A, 2B, and 3 (Figure 1.2), using a petite ponar grab sampler. Triplicate samples were taken off the south shore at Stations 1, 2A, and 3. Sampling at Station2B, in the back channel of Phillis Island, consisted of triplicate petite ponar grabs at the south side, middle, and north side of the channel (i.e., sample Stations 2B1, 2B2, and 2B3, respectively).

The contents of each grab were gently washed through a U.S. Standard No. 30 sieve and the retained contents were placed in a labeled bottle and preserved in ethanol. In the laboratory, rose bengal stain was added to aid in sorting and identifying the benthic organisms. Macroinvertebrates were sorted from each sample, identified to the lowest taxon practical and counted. Mean densities (number/$m^2$) for each taxon were calculated for each replicate. Four indices used to describe the benthic community were calculated: Shannon-Weiner diversity index; evenness (Pielou, 1969), species richness, and the number of taxa. These estimates provide an indication of the relative quality of the macroinvertebrate community.

2.2.3 Habitats

Substrate type is an important factor in determining the composition of the benthic community. Two distinct benthic habitats existed in the Ohio River near BVPS. These habitats are the result of damming, channelization, and river traffic. Shoreline habitats were generally soft muck substrates composed of sand, silt, and detritus. An exception occurred along the north shoreline of Phillis Island at Station 2A where clay and sand dominated. The other distinct habitat, hard substrate, was located in mid-channel of the back channel of Phillis Island. The hard substrate is probably the result of channelization and scouring by river currents.

2.2.4 Results

Fifty-two macroinvertebrate taxa were identified during the 1999 monitoring program (Tables 2.2 and 2.3). There were 1,268 macroinvertebrates/$m^2$ collected in May and 481/$m^2$in September (Table 2.4). The macroinvertebrate assemblage during 1999 was dominated by burrowing organisms typical of soft unconsolidated substrates. Oligochaetes (segmented worms) and chironomid (midge fly) larvae were abundant (Table 2.4).

Thirteen of the 52 taxa were present in both May and September. Thirty-three taxa were present in the May samples that were not in the September samples, compared with six (6) taxa in the September samples that were not present in the May samples (Table 2.3).

The Asiatic clam (*Corbicula sp.*), has been observed in the Ohio River near BVPS from 1974 to present. Zebra mussels were collected in the BVPS benthic samples in 1998. Adult zebra mussels, however, were detected in 1995 and 1996 by divers in the BVPS main and auxiliary intake structures during scheduled cleaning operations. Zebra mussel veligers, adults and juveniles were collected during the 1997-1999 sampling program (see Section 2.5, Zebra Mussel Monitoring Program).

In 1999, nine (9) taxa were added to the cumulative taxa list of macroinvertebrates collected near BVPS (Table 2.2). These included two (2) genera of segmented worm, two genera of caddisfly, two (2) genera of midgefly, two (2) genera of biting midges and one subspecies of bivalve. No state or Federal threatened or endangered macroinvertebrate species were collected during 1999.

### 2.2.5 Community Structure and Spatial Distribution

Oligochaetes accounted for the highest mean density of macroinvertebrates (Table 2.4) in May and September 1999 (739/$m^2$ and 257/$m^2$, respectively). Chironomids had the second highest mean density in both May 1999 (372/$m^2$) and September 1999 (144/$m^2$).

Station 3 had the highest mean density of macroinvertebrates with a total of 2,992 organisms/$m^2$ in May and 1037/$m^2$ in September. Station 2B2 had the lowest mean density of organisms in May (118/$m^2$) and September (79/$m^2$).

### 2.2.6 Comparison of Control and Non-Control Stations

For this analysis, Station 1 was designated the control station since it was always out of the influence of the BVPS discharge and Station 2B the non-control station since it was the station subjected most to the 1998 discharge. Stations 3 and 2A may be under the influence of the plume under certain conditions, but it is unlikely that they are regularly influenced by BVPS.

Species composition between the control and non-control sample stations was comparable in May (Table 2.5). The density of macroinvertebrates found at the non-control station was only 33 percent greater than at the control station. The density of oligochaetes was lower at the control station ($577/m^2$) than at the non-control station ($772/m^3$). Chironomids were present at lower densities at the control station ($118/m^2$) than at the non-control station ($423/m^2$). These differences probably reflected the natural differences in substrate and water flow between the stations rather than project-related impacts.

In September, approximately 33 percent more macroinvertebrates were present at the non-control than at the control station. Oligochaetes, chironomids and mollusks occurred at similar densities at the control station. Oligochaetes were the dominant organism at the non-control station ($270/m^2$). As in May, the differences observed between Station 1 (control) and Station 2B (non-control) were probably related to observed differences in habitat at each station. Differences were within the expected range of variation for natural populations of macroinvertebrates.

Indices were calculated to determine the relative diversity, evenness, and richness of the macroinvertebrate population structure among stations and between control and non-control sites. The Shannon-Weiner diversity indices in May collections ranged from 0.36 at Station 2A to 1.13 at Station 1 (Table 2.6). A higher diversity index indicates a relatively better structured assemblage of organisms, while a lower index generally indicates a low quality or stressed community. Evenness, an index that estimates the relative contribution of each taxon to the community assemblage, ranged from 0.40 at non-control Station 2A to 9.31 at the control Station 1. The community richness, another estimate of the quality of the macroinvertebrate community, was greatest at Station 1 and lowest at Station 2A.

In September, the highest diversity was present at the non-control Station 2B1 and lowest at non-control Station 2B2. Evenness ranged from 0.45 at Station 3 to 0.90 at Station 2B3. Richness was greatest at Station 2B1 and lowest at Station 2B3. The low number of taxa (3) and total organisms (79) collected at Station 2B2 was probably a result of the substrate present, which was a coarse, hard substrate that ponar techniques under-sample, rather than a result of any effect of the BVPS discharge. These low numbers tend to lower the reliability of these indices. The evenness and richness indices at the control station were similar to most of those at the non-control stations. No impacts of the BVPS on the benthic community, as measured by differences, were evident.

### 2.2.7 Seasonal Comparison

The density of benthic organisms observed in May 1999 was about three times greater than in September 1999 (Table 2.3). Forty-six taxa were identified in May, and 19 in September. Oligochaetes were the most commonly collected macroinvertebrates but chironomids and mollusks were also common in both the May and September samples.

### 2.2.8 Discussion

Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft, mucky substrates that existed along the shoreline are conducive to oligochaete, chironomid, and mollusk proliferation and limit species of macroinvertebrates that require a more stable bottom. Results from 1999 reflect the lowest mean number of organisms observed since 1978 at the control Station 1 and 1981 at non-control Station 2B, both operational years. These low numbers were not confirmed to either the control or non-control stations so likely reflect natural fluctuations and not any affects of the BVPS operations. Community structure has changed little since pre-operational years, and the available evidence does not indicate that BVPS operations have affected the benthic community of the Ohio River (Table 2.7).

## 2.3 Fish

### 2.3.1 Objectives

Fish sampling was conducted to provide a continuous baseline of data and to detect possible changes that may have occurred in the fish populations in the Ohio River near BVPS.

### 2.3.2 Methods

Adult fish surveys were scheduled and performed in May, July, September, and November 1999. During each survey, fish were sampled by standardized electrofishing techniques at four stations (Figure 1.3). Seining was performed at Station 1 (north shore) and Station 2B (south shore of Phillis Island), to sample species that are generally under-represented in electrofishing catches (e.g., young-of-the-year fish and small cyprinids).

Night electrofishing was conducted using a boom electroshocker and flood lights mounted to the bow of the boat. A Coffelt variable voltage, pulsed-DC electrofishing unit powered by a 3.5-kW generator was used. The voltage selected depended on water conductivity and was adjusted based on the amperage of the current passing through the water. The north and south shoreline areas at each station were shocked for at least 10 minutes of unit "on" time (approximately five minutes along each shore) during each survey.

When large schools of fish of a single species were encountered during electrofishing efforts, all of the stunned fish were not netted and retrieved onboard the boat. A few fish were netted for verification of identity, and the number of observed stunned fish remaining in the water was estimated. The size range of the individual fish in the school was also estimated and recorded. This was done in an effort to expedite sample processing and cover a larger area during the timed electrofishing run. Regardless of the number of individuals, all game fish were boated when observed.

Fish seining was performed at Station 1 (control) and Station 2B (non-control) during each scheduled 1999 BVPS fishery survey. A 30-ft long bag seine made of 1/4-inch nylon mesh netting was used to collect fish located close to shore in 1 to 4 ft of water. Three seine hauls were performed at both Station 1 (north shore) and Station 2B (south shore of Phillis Island) during each survey.

Fish collected during electrofishing and seining efforts were processed according to standardized procedures. All captured game fishes were identified, counted, measured for total length (nearest 1 mm), and weighed (nearest 1 g). Non-game fishes were counted, and a random subsample of lengths was taken. Live fish were returned to the river immediately after processing was completed. All fish that were unidentifiable or of questionable identification and were obviously not on the endangered or threatened species list were placed in plastic sample bottles, preserved, labeled and returned to the laboratory for identification. Any fish that had not previously been collected at BVPS was retained for the voucher collection. Any threatened or endangered species (if collected), would be photographed and released.

2.3.3 Results

Fish population surveys have been conducted in the Ohio River near BVPS annually from 1970 through 1999. These surveys have resulted in the collection of 72 fish species and five different hybrids (Table 2.8).

In 1999, 517 fishes representing 30 taxa were collected (i.e., handled) during BVPS surveys by electrofishing and seining (Tables 2.9 and 2.10). An estimated additional 10,425 were observed but not handled during electrofishing surveys (Table 2.15). The most common species in the 1999 BVPS surveys, collected by electrofishing and seining combined, were gizzard shad (38.0 percent), emerald shiner (15.5 percent), redhorse sucker species (11.0 percent). The remaining species combined accounted for 35.5 percent of the total handled catch. The most frequently observed (handled and not handled combined) fish in 1999 were gizzard shad (estimated n=9,126), followed by spottail shiner (estimated n=1,237), and emerald shiner (n=323) (Tables 2.9, 2.10, and 2.15). Game fishes collected during 1999 included channel catfish, striped bass, white bass, bluegill, pumpkinseed, largemouth bass, smallmouth bass, muskellunge, sauger, and spotted bass. Game fishes represented 17.8 percent of the total handled catch.

A total of 320 fish, representing 25 taxa, was collected by electrofishing in 1999 (Table 2.9). Gizzard shad accounted for the largest percentage (30.7 percent) of the electrofishing catch in 1999 followed by golden redhorse sucker (12.9 percent), sauger (11.0 percent). The most frequently-collected game species was sauger (11.0 percent of all fish collected) followed by smallmouth bass (6.0 percent).

A total of 197 fishes representing 14 taxa was collected by seining in 1999 (Table 2.10). Fish taxa collected included gizzard shad (49.7 percent), emerald shiner (30.5 percent), and sand shiner (7.6 percent).

A total of 96 fish representing 13 species was captured during the May 1999 sample event (Table 2.11). No fish were captured by seining at sample Station S-2 in May. A total of 95 fish were collected during electrofishing and 1 during seining. Gizzard shad was the most common species during electrofishing efforts and white perch was the only species captured by seining. Spottail shiner was the most commonly observed fish species in May (Table 2.15).

A total of 82 fish representing 10 species was captured during the July 1999 sample event (Table 2.12). No fish were captured by seining at sample Station S-2 in July. A total of 79 fish was collected during electrofishing and three (3) during seining. Gizzard shad was the most common species during the electrofishing and seining efforts. Gizzard shad was the most common observed fish species in May (Table 2.15).

During the September sample event, 221 fish were collected (Table 2.13). Fish were collected at all sample stations. Gizzard shad was the most common species captured by both electrofishing and seining. The most common observed fish species was gizzard shad as well (Table 2.15).

During the November sample event, 117 fish were captured (Table 2.14). Fish were collected at all sample stations. Sauger, golden redhorse sucker, and striped bass were the most abundant species captured by electrofishing. Emerald shiner was the most abundant species captured by seining. The most common observed fish species was gizzard shad (Table 2.15).

At the request of the Pennsylvania Fish and Boat Commission (PFBC), electrofishing catch rates were calculated as fish per minute (i.e., power on time) of sampling for 1996 through 1999. Electrofishing catch rates are presented in Tables 2.16, 2.17, and 2.18 for fish that were boated and handled during the 1997 through 1999 surveys by season.

In 1999, the annual catch rate was 1.96 fish per electrofishing minute. The greatest electrofishing catch rate was in May (2.38 fish/electrofishing minute). The lowest catch rate was observed in September (1.58 fish/electrofishing minute).

In 1998 the annual catch rate was 1.51 fish per electrofishing minute. The greatest electrofishing catch rate was in May (2.18 fish/electrofishing minute). The lowest catch rate was observed in November (1.10 fish/electrofishing minute).

In 1997, the annual catch rate was 3.52 fish per electrofishing minute. The greatest electrofishing catch rate was in May (6.23 fish/electrofishing minute). The lowest catch rate was observed in November (2.00 fish/electrofishing minute), followed by the fall survey (2.62 fish/electrofishing minute) and the summer survey (3.11 fish/electrofishing minute).

### 2.3.4 Comparison of Control and Non-Control Stations

The electrofishing data (Table 2.9) did not indicate any major differences in species composition between the control station (1) and the non-control Stations 2A, 2B, and 3.

A greater number of fish representing more species was captured at non-control stations than control stations. This was most likely due to the extra effort expended at non-control stations versus control stations (i.e., there are three non-control stations and only one control station).

The seine data for 1999 (Table 2.10) indicated no major differences in species composition between control and non-control stations. The total number of fish captured at non-control stations was larger than at the control station.

### 2.3.5 Discussion

The results of the 1999 fish surveys indicated that there is a normal community structure in the Ohio River in the vicinity of BVPS based on species composition and relative abundance of fish observed during the surveys. Forage species were collected in the highest numbers. Variations in annual catch were probably attributable to normal fluctuations in the population size of the forage species and the predator populations that rely on them. Forage species, such as gizzard shad and emerald shiner with high reproductive potentials, frequently respond to changes in natural environmental factors (competition, food availability, cover, and water quality) with large fluctuations in population size. This, in turn, influences their appearance in the sample populations during annual surveys. Spawning/rearing success due to abiotic factors is usually the determining factor of the size and composition of a fish community.

Also, differences in electrofishing catch rate can be attributed to environmental conditions that prevail during sampling efforts. High water, increased turbidity, and swift currents that occur during electrofishing efforts in some years can decrease the collection efficiency of this gear.

In 1999, species composition remained comparable among stations. Common taxa collected in the 1999 surveys by all methods included gizzard shad, freshwater drum, emerald shiner, redhorse sucker species, sand shiner, sauger, quillback, and smallmouth bass. Little difference in the species composition of the catch was observed between the control (1) and non-control stations (2A, 2B and 3). Habitat preference and availability were probably the most important factors affecting where and when different species of fish are collected.

## 2.4 *Corbicula* Monitoring Program

### 2.4.1 Introduction

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

One adult Asiatic clam is capable of producing many thousands of young called early juveniles. These early juveniles are very small (approximately 0.2 mm) and will easily pass through the water passages of a power plant. Once the juveniles settle on the substrate, rapid growth occurs. If *Corbicula* develop within a power plant's water passages, they can impede the flow of water through the plant, especially through blockage of condenser tubes and small service water piping. Reduction of flow may be so severe that a plant shutdown is necessary. *Corbicula* are of particular concern when they develop undetected in emergency systems where the flow of water is not constant (NRC, IE Bulletin 81-03).

The *Corbicula* Monitoring Program at BVPS includes sampling the circulating river water and the service water systems of the BVPS (intake structure and cooling towers). This report describes this Monitoring Program and the results of the field and plant surveys conducted in 1999.

2.4.2 Monitoring

(a) Objectives

The objectives of the ongoing Monitoring Program are to evaluate the presence of *Corbicula* at BVPS, and to evaluate the potential for and timing of infestation of the BVPS. This program is also used to monitor for the presence of macrofouling zebra mussels (see Section 2.5).

(b) Methods

(1) Cooling Towers - Monthly Reservoir Sampling

*Corbicula* enter the BVPS from the Ohio River by passing through the water intakes, and eventually settle in low flow areas including the lower reservoirs of the Units 1 and 2 cooling towers. The density and growth of these *Corbicula* were monitored by collecting monthly samples from the lower reservoir side-walls and sediments. The sampler used on the side-walls consisted of a D-frame net attached behind a 24-inch long metal scraping edge. This device was connected to a pole long enough to allow the sampler to extend down into the reservoir area from the outside wall of the cooling tower. Sediments were sampled with a petite ponar.

Each month February through November, a single petite ponar grab sample was scheduled to be taken in the reservoir of each cooling tower to obtain density and growth information from the bottom sediment. Due to unit outages, no samples were collected from Unit 1 in April or Unit 2 in March. The samples collected from each cooling tower were returned to the laboratory and processed. Samples were individually washed, and any *Corbicula* removed and rinsed through a series of stacked U.S. Standard sieves that ranged in mesh size from 16.0 mm to 0.6 mm. Live and dead clams on each sieve were counted and the numbers were recorded. The size distribution data obtained using the sieves reflected clam width, rather than length. Samples containing a small number of *Corbicula* were not sieved; individuals were measured and placed in their respective length categories.

After discussions with BVPS, it was decided to eliminate *Corbicula* monitoring during the winter months of December and January. The life histories of both macrofouling bivalves present at BVPS (i.e., *Corbicula* and zebra mussels) minimize the need to monitor for them during these winter months. Settlement of spat (i.e., juvenile bivalves) does not successfully take place, and growth of any settled individuals is minimal. This schedule was initiated in December 1997.

(2) Cooling Towers - *Corbicula* Density Determination

Population surveys of both BVPS cooling tower reservoirs have been conducted during scheduled outages (1986 through 1997) to estimate the number of *Corbicula* present in these structures. In 1998 and 1999, neither Unit 1 or Unit 2 were sampled during a scheduled outage to estimate the *Corbicula* population.

(c) Results

(1) Unit 1 Cooling Tower - Monthly Reservoir Sampling

In 1999, a total of 224 *Corbicula* (21 percent alive) was collected from the Unit 1 cooling tower basin during monthly reservoir sampling. The largest live *Corbicula* collected measured 21 mm in length (Table 2.19 and Figure 2.1)). The greatest number of *Corbicula* were collected in October (40 individuals) and September (56 individuals). *Corbicula* were collected in lower numbers in the other months sampled except March when no *Corbicula* were collected.

In 1999, DLC continued its *Corbicula* control program (tenth year) which included the use of a molluscicide (CT-1) to prevent the proliferation of *Corbicula* within BVPS.

BVPS was granted permission by the Pennsylvania Department of Environmental Protection to use CT-1 to target the Unit 1 river water system and the Unit 2 service water system.

In 1990 through 1993, the molluscicide applications (CT-1) focused on reducing the *Corbicula* population throughout the entire river water system of each BVPS plant (Units 1 and 2). In 1994 and 1995, the CT-1 applications targeted the internal water systems, therefore the CT-1 concentrations in the cooling towers were reduced during CT-1 applications. Consequently, adult and juvenile *Corbicula* in the cooling towers often survived the CT-1 applications. Reservoir sediment samples taken after CT-1 applications represent mortality of *Corbicula* in the cooling tower only and do not reflect mortality in BVPS internal water systems. CT-1 applications occurred on July 14, October 19, and November 2, 1999 for Unit 1 and on July 7 and 23, plus October 16 and 25,1999 for Unit 2.

(2) Unit 2 Cooling Tower - Monthly Reservoir Sampling

In 1999, 26 *Corbicula* (46 percent alive) were collected from the Unit 2 cooling tower reservoir during monthly sampling. The largest *Corbicula* collected was dead and measured 11 mm in length (Table 2.20 and Figure 2). Individuals were collected from August through November. None were collected earlier which may be attributed to a prolonged unit outage.

(3) Cooling Towers - *Corbicula* Density Determination

Unit 1 Cooling Tower

No *Corbicula* density determination collections were made during 1999 for Unit 1 cooling tower.

Unit 2 Cooling Tower

No *Corbicula* density determination sampling was conducted in the Unit 2 cooling tower reservoir in 1999.

(d) Discussion

The monthly reservoir sediment samples collected in Units 1 and 2 cooling towers during 1999 demonstrated that *Corbicula* were entering and colonizing the reservoirs. The overall densities were consistent with those in 1998 but much lower than previous years. The maximum density of *Corbicula* in Unit 1 was 2,413 clams per square meter which occurred in September. The maximum density of clams in Unit 2 was 518 per square meter which occurred in October. The lower density of *Corbicula* in Unit 2 compared to Unit 1 was consistent with 1998. The reduction of *Corbicula* at the BVPS over the last few years reflects a water body wide trend observed in the Ohio River.

2.4.3 *Corbicula* Juvenile Study

(a) Objective

The *Corbicula* larvae study was designed to collect data on *Corbicula* spawning activities and growth of individuals entering the intake from the Ohio River.

(b) Methods

Specially constructed clam cages were initially utilized for this study. Each cage was constructed of a 1 ft durable plastic frame with fiberglass screening (1 mm mesh) secured to cover all open areas. Each cage contained approximately 10 lbs of industrial glass beads (3/8-inch diameter) to provide ballast and a uniform substrate for the clams. The clam cage mesh size permits only very small clams or pediveliger larvae to enter and colonize the cage.

In 1988 through 1994, the cages were left in place for five months following initial placement. Changes in procedure were made to better define the time period when *Corbicula* were spawning in the Ohio River and releasing larvae that could enter BVPS through the intake structure.

Larval cages were maintained in the BVPS intake structure in 1995 according to the following procedure. Each month, two empty clam cages were placed in the intake structure bays. Each cage was left in place for two months, after which time it was removed and examined for clams. Four clam cages were maintained in the intake structure bays each month throughout 1995-1996.

In February 1996, it was decided to modify the sampling regime so that two of the four cages in the forebay were long-term samplers and the other two were monthly short-term samplers. Each month, the two long-term samplers were pulled; the fine sediment was carefully washed from the cage and any *Corbicula* present were measured. The cages were immediately redeployed along with any identified *Corbicula*. The two short-term cages were pulled monthly and the contents removed for laboratory analyses. New short-term cages were then deployed.

Each short-term clam cage removed after the one or two month colonization period was returned to the laboratory where it was processed to determine the number of clams that had colonized the cage. *Corbicula* obtained from each cage were rinsed through a series of stacked U.S. Standard sieves ranging in mesh size from 9.5 mm to 0.6 mm. Live and dead clams on each sieve were counted and the numbers were recorded. The largest and smallest clams were measured to establish a length range for the sample. The size distribution data obtained using the sieves reflected clam width, rather than length.

Observational-based concerns that the clam cages could quickly clog with sediment during high sediment periods and, as a result, not sample effectively, led to an evaluation of an alternate sampling technique. From April through June 1997, a study was conducted to compare the results of the clam cage samplers to a petite ponar dredge technique to determine *Corbicula* presence and density in the BVPS intake bays. It was hypothesized that using a ponar sampler to collect bottom sediments and analysis of those sediments would provide a more representative sample of *Corbicula* settlement and growth rates, and had the added benefit of not requiring confined space entry to conduct the sampling.

During the 1998 sampling season, at the request of BVPS personnel, all clam cages were removed after the May 18, 1998 collection. Monthly petite ponar grabs continued thereafter.

(c) Results

Figure 2.3 illustrates the abundance and size distribution data for samples collected in the intake structure by petite ponar in 1999. *Corbicula* were first collected in April and were present in each month thereafter. Multiple year classes of *Corbicula* including both recently settled juveniles and older individuals were present throughout the period when clams were present. The numbers of individuals generally increased through the year but overall low numbers were collected.

(d) Discussion

A spring/early-summer spawning period typically occurs in the Ohio River near BVPS each year when optimal spawning temperatures are reached (Figure 2.4). The offspring from this spawning event generally begin appearing in the sample collections in late April (Figure 2.3). The settled clams generally increased in size during the year. As in the cooling towers the numbers of clams collected were consistent with numbers collected in1998 but much lower than in previous years which is reflective of a reported reduction in the number of *Corbicula* in the Ohio River.

## 2.5 Zebra Mussel Monitoring Program

### 2.5.1 Introduction

Zebra mussels (*Dreissena polymorpha*) are exotic freshwater mollusks that have ventrally flattened shells generally marked with alternating dark and lighter bands. They are believed to have been introduced into North America through the ballast water of ocean-going cargo vessels probably from Eastern Europe. They were first identified in Lake St. Clair in 1987 and rapidly spread to other Great Lakes and the Mississippi River drainage system, becoming increasingly abundant in the lower, middle, and upper Ohio River in recent years.

Adult zebra mussels can live up to five years and grow to 2 inches in length. North American research suggests that each female may be capable of producing over one million microscopic (veliger larvae) offspring per year, that can easily pass through water intake screens. They use strong adhesive byssal threads, collectively referred to as the byssus, to attach themselves to any hard surfaces (e.g., boat hulls, intake pipes and other mussels). Transport of these organisms between waterbodies is accomplished in part by boats that have adult mussels attached to their hulls or larvae in their live wells and/or bilges. In anticipation of zebra mussel infestation and responding to NRC Notice No. 89-76 (Biofouling Agent-Zebra Mussel, November 21, 1989), BVPS instituted a Zebra Mussel Monitoring Program in January 1990.

The Zebra Mussel Monitoring Program included the Ohio River and the circulating river water system of the BVPS (intake structure and cooling towers). This section describes this Monitoring Program and the results obtained during Ohio River and BVPS surveys conducted through 1999.

2.5.2 Monitoring

(a) Objectives

The objectives of the Monitoring Program were:

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

(2) To provide data as to when the larvae were mobile in the Ohio River and insights as to their vulnerability to potential treatments; and

(3) To provide data on their overall density and growth rates under different water temperatures and provide estimates on the time it requires for these mussels to reach the size and density that could impact the plant.

(b) Methods

(1) Intake Structure and Barge Slip

The surveillance techniques used in the intake structure and open water were:

- Wall scraper sample collections on a monthly basis (February through November) from the barge slip and the riprap near the intake structure to detect attached adults;
- Pump sample collections from the barge slip, to detect the planktonic early life forms (April through October); and
- Sampling of substrate plates used for detection of settled stages in the impact basin below the Emergency outfall (April through November).
- Sampling of two artificial substrate plates suspended in the Ohio River from the outer wall of the intake house (April through November).

(2) Cooling Towers

The techniques used in the Unit 1 and Unit 2 cooling tower locations were:

- Monthly reservoir scraper sample collections in each cooling tower (February through November); and

- Pump samples in April through October to detect planktonic life forms.

(3) Emergency Outfall

The emergency outfall was sampled from April through October to monitor for planktonic life forms of zebra mussels.

(4) Impact Basin

The impact basin was sampled from April through October to monitor for planktonic life forms.

(c) Results

Zebra mussels were detected in both pump samples (Table 2.21) and substrate samples. Zebra mussel veligers were present in pump samples collected from June through October. The greatest density of veligers was present in the splash pool sample collected in the splash pool in August (34,500/$m^2$). This is the highest density of mussels collected at BVPS in any year. In August, veliger samples were not preserved to determine if they were live. This was especially important to determine in the cooling tower samples which are thermally enriched at times to near the reported upper lethal limit of the mussels. Live veligers were present in all samples except the cooling tower 1 sample. Whether this is due to temperature merits investigation in 2000. Veliger densities are overall an order of magnitude greater than those reported in 1998. In 1998, the greatest density collected was 2,800 per square meter. Densities over 1,000 per square meter occurred in only three samples in 1998. In 1999, veliger densities exceeded 1,000 per square meter in 14 of the samples.

Juvenile mussels were observed in ponar dredge samples from Intake Bays A and D at BVPS in July. Two settled juveniles were collected.

Attached zebra mussels were collected at the barge slip in July and in September. Zebra mussels were also attached to the artificial substrate samplers suspended at the intake in July and in October. The mussels collected at the intake in July included a juvenile and an adult (25 mm) that had translocated to the substrate sampler and resettled. The mussel collected in October was a recently settled juvenile. No settled zebra mussels were observed on the substrate plates from the emergency outfall impact basin or the outside wall of the intake structure.

(d) Discussion

From 1991 through 1993, based on reports, zebra mussels moved progressively upstream from the lower to upper Ohio River. In 1994, there were confirmed zebra mussel sightings at locations both upstream and downstream from BVPS, including the Allegheny River. The July 1995 sighting of zebra mussels at Maxwell Locks and Dam on the Monongahela River established the presence of these organisms within the Allegheny, Monongahela and Ohio Rivers in Western Pennsylvania.

In 1995, live zebra mussels were found by divers in the BVPS main intake structure and auxiliary intake structure during scheduled cleaning operations.

The 1996 Zebra Mussel Monitoring Program at BVPS did not collect any live zebra mussels at BVPS. During the first quarter 1996 (January and February) intake bay cleaning, divers observed an undetermined number of zebra mussels in the intake bays. During the second quarter 1996 cleaning, no mussels were reported. During the third and fourth quarter 1996 intake bay cleanings, about one dozen mussels were observed each time in Bay C only. None were collected by the divers for confirmation.

During 1997, zebra mussel veligers were observed in June. Juvenile zebra mussels appeared in the clam cage and ponar dredge samples. In November 1997, adult zebra mussels were found in the intake ponar dredge samples.

During the 1998 Zebra Mussel Monitoring Program at BVPS, zebra mussel veligers, juveniles, and an adult were observed in sample collections. A moderate density of zebra mussel veligers was observed during the August through November 1998 samples, indicating that spawning occurred sometime during the late summer. Juvenile zebra mussels appeared during March sampling. These mussels were 3.5, 3.5, and 4.5 mm in length, which indicates that they were probably young-of-the-year in 1997. Young-of-the-year zebra mussels appeared in September through November. This observation confirms successful zebra mussel spawning in the area around BVPS.

During 1998, zebra mussels were also found on the walls of the main intake structure during each of the quarterly inspections that took place. During the first quarter, greater than 100 zebra mussels/$ft^2$ were present in Bay B, although fewer were present in the other bays. Less than 5 mussels/$ft^2$ were observed during the second quarter inspection that took place in April. Only Bays A and B were inspected, however. A few small zebra mussels were observed during the third quarter inspection; however, any recently-settled mussels would be easily missed during a visual inspection. Few (>10/$ft^2$) mussels were also observed during the fourth quarter inspection. *Corbicula* were also present in the main intake structure during each quarterly inspection. Zebra mussels were also observed in the alternate intake structure during the last three quarters of 1998, however, densities were low.

Overall both the number of observations of settled mussels and the densities of veligers were greater in 1999 than in previous years. Observations by in plant personnel indicated that the densities of attached mussels on the walls of the intake structure were higher than in previous years. If trends continue and the numbers of mussels in the Ohio River near

BVPS continue to increase in 2000, BVPS should maintain their diligent zebra mussel monitoring and control program.

During the 1999 quarterly intake bay cleanings, zebra mussel densities on the walls were reported from a low of 1 zebra mussel per square foot to a high of 50 per square foot. Some layering and drusing were reported by divers.

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# TABLE 2.1

## BEAVER VALLEY POWER STATION (BVPS)
## SAMPLING DATES FOR 1999

| Study | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benthic Macroinvertebrate | | | | | 12 | | | | 24 | | | |
| Fish | | | | | 12 | | 24 | | 24 | | 29/30 | |
| Corbicula and Zebra Mussel | | | 3, 29 | 21 | 12 | 8 | 22 | 19 | 24 | 22 | 19 | |
| Corbicula CT Density * | | | | | | | | | | | | |
| Zebra Mussel Veliger | | | 3, 29 | 21 | 12 | 8 | 22 | 19 | 24 | 22 | 19 | |

* No Corbicula cooling tower density samples were collected during 1999

## TABLE 2.2

## SYSTEMATIC LIST OF MACROINVERTEBRATES COLLECTED FROM 1973 THROUGH 1999 IN THE OHIO RIVER NEAR BVPS

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
|---|---|---|---|
| Porifera | | | |
| Spongilla fragilis | X | | |
| Cnidaria | | | |
| Hydrozoa | | | |
| Clavidae | | | |
| Cordylophora lacustris | X | | |
| Hydridae | | | |
| Craspedacusta sowerbii | X | | |
| Hydra sp. | X | | |
| Platyhelminthes | | | |
| Tricladida | X | | |
| Rhabdocoela | X | | |
| Nemertea | X | | |
| Nematoda | X | X | |
| Entoprocta | | | |
| Urnatella gracilis | X | | |
| Ectoprocta | | | |
| Fredericella sp. | X | | |
| Paludicella articulata | X | | |
| Pectinatella sp. | X | | |
| Plumatella sp. | X | | |
| Annelida | | | |
| Oligochaeta | X | | |
| Aeolosomatidae | X | | |
| Tubificida | X | X | |
| Enchytraeidae | X | X | |
| Naididae | | | |
| Allonais pectinata | X | | |
| Amphichaeta leydigi | X | | |
| Amphichaeta sp. | X | | |
| Arcteonais lomondi | X | | |
| Aulophorus sp. | X | | |
| Chaetogaster diaphanus | X | | |
| C. diastrophus | X | | |
| Dero digitata | X | | |
| Dero flabelliger | X | | |
| D. nivea | X | | |
| Dero sp. | X | | |
| Nais barbata | X | X | |
| N. behningi | X | | |
| N. bretscheri | X | | |
| N. communis | X | | |
| N. elinguis | X | | |
| N. pardalis | X | X | |

**TABLE 2.2**
**(Cont'd)**

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
|---|---|---|---|
| N. pseudobtusa | X | | |
| N. simplex | X | | |
| N. variabilis | X | | |
| Nais sp. | X | X | |
| Ophidonais serpentina | X | | |
| Paranais frici | X | X | |
| Paranais litoralis | | X | * |
| Paranais sp. | X | | |
| Piguetiella michiganensis | X | | |
| Pristina idrensis | X | | |
| Pristina longisoma | X | | |
| Pristina longiseta | X | | |
| P. osborni | X | | |
| P. sima | X | | |
| Pristina sp. | X | | |
| Pristinella osborni | | X | |
| Ripistes parasita | X | | |
| Slavina appendiculata | X | | |
| Specaria josinae | | X | * |
| Stephensoniana trivandrana | X | | |
| Stylaria fossularis | X | | |
| S. lacustris | X | X | |
| Uncinais uncinata | X | | |
| Vejdovskyella comata | X | | |
| Vejdovskyella intermedia | X | | |
| Vejdovskyella sp. | X | | |
| Tubificidae | X | | |
| Aulodrilus limnobius | X | | |
| A. pigueti | X | | |
| A. pluriseta | X | | |
| Aulodrilus sp. | X | | |
| Bothrioneurum vejdovskyanum | X | | |
| Branchiura sowerbyi | X | X | |
| Ilyodrilus templetoni | X | | |
| Limnodrilus cervix | X | | |
| L. cervix (variant) | X | | |
| L. claparedianus | X | X | |
| L. hoffmeisteri | X | X | |
| L. maumeensis | X | X | |
| L. profundicla | X | | |
| L. spiralis | X | | |
| L. udekemianus | X | | |
| Limnodrilus sp. | X | | |
| Peloscolex multisetosus longidentus | X | | |
| P. m. multisetosus | X | | |
| Potamothrix moldaviensis | X | X | |
| P. vejdovskyi | X | X | |
| Psammoryctides curvisetosus | X | | |
| Tubifex tubifex | X | X | |
| Unidentified immature forms: | | | X |
| with hair chaetae | | X | |
| without hair chaetae | X | | |
| Lumbriculidae | X | X | |
| Hirudinae | X | | |
| Glossiphoniidae | X | | |
| Helobdella elongata | X | | |

## TABLE 2.2
## (Cont'd)

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
|---|---|---|---|
| H. stagnalis | X | | |
| Helobdella sp. | X | | |
| Erpobdellidae | | | |
| Erpobdella sp. | X | | |
| Mooreobdella microstoma | X | | |
| | | | |
| Arthropoda | | | |
| Acarina | X | | |
| Ostracoda | X | | |
| Isopoda | | | |
| Asellus sp. | X | | |
| Amphipoda | | | |
| Talitridae | | | |
| Hyalella azteca | X | | |
| Gammaridae | | | |
| Crangonyx pseudogracilis | X | | |
| Crangonyx sp. | X | | |
| Gammarus fasciatus | X | | |
| Gammarus sp. | X | X | |
| Decapoda | X | | |
| Collembola | X | | |
| Ephemeroptera | | | |
| Heptageniidae | X | | |
| Stenacron sp. | X | | |
| Stenonema sp. | X | | |
| Ephemeridae | | | |
| Ephemera sp. | X | | |
| Hexagenia sp. | X | X | |
| Ephron sp. | X | | |
| Baetidae | X | | |
| Baetis sp. | | | |
| Caenidae | | | |
| Caenis sp. | X | | |
| Serattella sp. | X | | |
| Potamanthidae | | | |
| Potamanthus sp. | | | |
| Tricorythidae | | | |
| Tricorythodes sp. | X | | |
| Megaloptera | | | |
| Sialis sp. | X | | |
| Odonata | | | |
| Gomphidae | | | |
| Argia sp. | X | | |
| Dromogomphus spoliatus | X | | |
| Dromogomphus sp. | X | | |
| Gomphus sp. | X | | |
| Libellulidae | | | |
| Libellula sp. | X | | |
| Trichoptera | | | |
| Hydropsychidae | X | | |
| Cheumatopsyche sp. | X | | |
| Hydropsyche sp. | X | | |
| Parapsyche sp. | | X | * |
| Psychomyiidae | | | |
| Psychomyia sp. | | | |
| Hydroptilidae | | | |

**TABLE 2.2**
**(Cont'd)**

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
|---|---|---|---|
| *Hydroptila* sp. | X | | |
| *Orthotrichia* sp. | | | |
| *Oxyethira* sp. | X | | |
| Leptoceridae | | | |
| *Ceraclea* sp. | X | | |
| *Leptocerus* sp. | | X | * |
| *Oecetis* sp. | X | | |
| Polycentropodidae | | | |
| *Cymellus* sp. | X | X | |
| *Polycentropus* sp. | X | | |
| Coleoptera | X | | |
| Hydrophilidae | X | | |
| Elmidae | | | |
| *Ancyronyx variegatus* | X | | |
| *Dubiraphia* sp. | X | | |
| *Helichus* sp. | X | | |
| *Stenelmis* sp. | X | | |
| Psephenidae | X | | |
| Diptera | | | |
| Unidentified Diptera | X | X | |
| Psychodidae | X | | |
| *Pericoma* sp. | X | | |
| *Psychoda* sp. | X | | |
| *Telmatoscopus* sp. | X | | |
| Unidentified Psychodidae pupae | X | | |
| Chaoboridae | | | |
| *Chaoborus* sp. | X | | |
| Simuliidae | | | |
| *Similium* sp. | X | | |
| Chironomidae | X | X | |
| Chironominae | X | | |
| Tanytarsini pupa | X | | |
| Chironominae pupa | X | X | |
| *Axarus* sp. | X | | |
| *Chironomus* sp. | X | | |
| *Cladopelma* sp. | X | | |
| *Cladotanytarsus* sp. | | X | * |
| *Cryptochironomus* sp. | X | X | |
| *Dicrotendipes nervosus* | X | | |
| *Dicrotendipes* sp. | X | | |
| *Glyptotendipes* sp. | X | | |
| *Harnischia* sp. | X | | |
| *Microchironomus* sp. | X | | |
| *Micropsectra* sp. | X | X | |
| *Microtendipes* sp. | X | | |
| *Parachironomus* sp. | X | X | |
| *Paracladopelma* sp. | X | | |
| *Paratanytarsus* sp. | | | |
| *Paratendipes albimanus* | X | | |
| *Phaenopsectra* sp. | X | | |
| *Polypedilum* (s.s.) *convictum* type | X | | |
| *P.* (s.s.) *simulans* type | X | | |
| *Polypedilum* sp. | X | X | |
| *Rheotanytarsus* sp. | X | | |
| *Stenochironomus* sp. | X | | |
| *Stictochironomus* sp. | X | | |

# TABLE 2.2
# (Cont'd)

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
| --- | --- | --- | --- |
| Tanytarsus coffmani | X | | |
| Tanytarsus sp. | X | | |
| Tribelos sp. | X | | |
| Xenochironomus sp. | X | | |
| Tanypodinae | X | | |
| Tanypodinae pupae | X | | |
| Ablabesmyia sp. | X | | |
| Clinotanypus sp. | X | X | |
| Coelotanypus scapularis | X | | |
| Coelotanypus sp. | X | X | |
| Djalmabatista pulcher | X | | |
| Djalmabatista sp. | X | | |
| Procladius (Procladius) | X | | |
| Procladius sp. | X | X | |
| Tanypus sp. | X | | |
| Thienemannimyia group | X | | |
| Zavrelimyia sp. | X | | |
| Orthocladiinae | X | X | |
| Orthocladiinae pupae | X | | |
| Cricotopus bicinctus | X | | |
| C. (s.s.) trifascia | X | | |
| Cricotopus (Isocladius)-<br>-sylvestris Group | X | | |
| C. (Isocladius) sp. | X | | |
| Cricotopus (s.s.) sp. | X | | |
| Eukiefferiella sp. | X | | |
| Hydrobaenus sp. | X | | |
| Limnophyes sp. | X | | |
| Nanocladius (s.s.) distinctus | X | | |
| Nanocladius sp. | X | | |
| Orthocladius sp. | X | | |
| Parametriocnemus sp. | X | X | |
| Paraphaenocladius sp. | X | | |
| Psectrocladius sp. | X | | |
| Psectrotanypus sp. | | X | * |
| Pseudorthocladius sp. | X | | |
| Pseudosmittia sp. | X | | |
| Smittia sp. | X | | |
| Diamesinae | | | |
| Diamesa sp. | X | | |
| Potthastia sp. | X | | |
| Ceratopogonidae | X | X | |
| Bezzia sp. | X | X | |
| Culicoides sp. | | X | * |
| Dolichopodidae | X | | |
| Empididae | X | | |
| Wiedemannia sp. | X | | |
| Ephydridae | X | | |
| Muscidae | X | | |
| Rhagionidae | X | | |
| Tipulidae | X | | |
| Stratiomyidae | X | | |
| Syrphidae | X | | |
| Lepidoptera | X | | |
| Hydrachnidia | X | X | |

**TABLE 2.2**
**(Cont'd)**

| Taxa | Collected in Previous Years | Collected in 1999 | New in 1999 |
|---|---|---|---|
| Mollusca | | | |
| Gastropoda | X | X | |
| Physacea | X | | |
| Physidae | X | | |
| Physa sp. | X | X | |
| Ancylidae | X | X | |
| Ferrissia sp. | X | | |
| Planorbidae | X | | |
| Valvatidae | X | | |
| Valvata perdepressa | X | X | |
| Valvata sincera sincera | | X | * |
| Pelecypoda | X | X | |
| Sphaeriacea | X | | |
| Corbiculidae | | | |
| Corbicula fluminea | X | | |
| Corbicula sp. | X | X | |
| Sphaeriidae | X | | |
| Pisidium ventricosum | X | X | |
| Pisidium sp. | X | | |
| Sphaerium sp. | X | | |
| Unidentified immature Sphaeriidae | X | | |
| Dreissenidae | | | |
| Dreissena polymorpha | X | X | |
| Unionidae | X | | |
| Anodonta grandis | X | | |
| Anodonta (immature) | X | | |
| Elliptio sp. | X | | |
| Unidentified immature Unionidae | X | | |

TABLE 2.3

**BENTHIC MACROINVERTEBRATE COUNTS FOR TRIPLICATE SAMPLES TAKEN AT EACH SAMPLE STATION BY SAMPLE DATE FOR 1999**

| May 12, 1999<br>**Scientific name** | **Location** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **2A** | **2B1** | **2B2** | **2B3** | **3** | **Total** |
| Nematoda | 2 | | | | 1 | 4 | 7 |
| Oligochaeta | 3 | | | | | 1 | 4 |
| Enchytraeidae | | | 1 | | | | 1 |
| Naididae | 3 | | 1 | | | | 4 |
| Nais barbata | 1 | | 4 | | | 1 | 6 |
| Nais pardalis | 10 | 43 | 34 | 1 | | 8 | 96 |
| Nais sp. | | | 1 | | | | 1 |
| Paranais frici | 5 | | 1 | | | 2 | 8 |
| Paranais litoralis | 2 | | 16 | | | 5 | 23 |
| Pristinella osborni | 1 | | | | | | 1 |
| Specaria josinae | | | 1 | | | | 1 |
| Stylaria lacustris | 3 | | 1 | | | 2 | 6 |
| Branchiura sowerbyi | | | 1 | | | | 1 |
| Limnodrilus hoffmeisteri | | | 1 | | 1 | 4 | 6 |
| Limnodrilus maumeensis | | | 2 | | | 10 | 12 |
| Potamothrix vejdovskyi | 4 | | | | | 6 | 10 |
| Tubificid | 11 | | 51 | 1 | 31 | 63 | 157 |
| Lumbriculidae | 1 | | | | | | 1 |
| Gammarus sp. | | 2 | | 1 | | | 3 |
| Hexagenia sp. | 2 | | | | | 3 | 5 |
| Parapsyche sp. | | 1 | | | | | 1 |
| Leptocerus sp. | | | | 1 | | | 1 |
| Cymellus sp. | | 1 | | | | | 1 |
| Diptera sp. | | | 1 | | | 1 | 2 |
| Chironomid pupae | | 2 | | | | 1 | 3 |
| Chironomus sp. | 2 | | 6 | | | | 8 |
| Cryptochironomus sp. | | | 5 | | 3 | 1 | 9 |
| Micropsectra sp. | 2 | 1 | 1 | | | | 4 |
| Parachironomus sp. | | | | | 2 | | 2 |
| Polypedilum sp. | 4 | 1 | 23 | | 8 | 91 | 127 |
| Coelotanypus sp. | | | 1 | | 1 | | 2 |
| Procladius sp. | 1 | 1 | | | | 5 | 7 |
| Orthocladiinae | | 1 | | | 1 | | 2 |
| Orthocladius sp. | | 3 | 1 | | | 1 | 5 |
| Psectrotanypus sp. | | | 1 | | | | 1 |
| Ceratopogonidae | 1 | | | | | | 1 |
| Bezzia sp. | 3 | | | | | | 3 |
| Culicoides sp. | | | | | | 2 | 2 |
| Hydrachnidia | | | | | 1 | | 1 |
| Gastropoda | 1 | | | | | 2 | 3 |
| Ancylidae | | | | 1 | | 1 | 2 |
| Valvata sincera sincera | | | | | 1 | | 1 |
| Pelecypoda | 5 | | 1 | | | | 6 |
| Corbicula sp. | | | 11 | 3 | 4 | 16 | 34 |
| Pisidium ventricosum | | | | | | 2 | 2 |
| Dreissena polymorpha | | | | 1 | | | 1 |
| **May 1999 Total:** | 67 | 56 | 166 | 9 | 54 | 232 | 584 |

**TABLE 2.3 Continued.**

**BENTHIC MACROINVERTEBRATE COUNTS FOR TRIPLICATE SAMPLES TAKEN AT EACH SAMPLE STATION BY SAMPLE DATE FOR 1999**

| September 24, 1999<br>**Scientific name** | **Location** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **2A** | **2B1** | **2B2** | **2B3** | **3** | **Total** |
| Oligochaeta | | | | | | 3 | 3 |
| Branchiura sowerbyi | | 1 | 2 | 1 | | | 4 |
| Limnodrilus claparedianus | | 1 | | | | | 1 |
| Limnodrilus hoffmeisteri | 1 | 2 | | | 5 | 1 | 9 |
| Limnodrilus maumeensis | | 4 | | | | 4 | 8 |
| Potamothrix moldaviensis | | | | | | 1 | 1 |
| Potamothrix vejdovskyi | | 1 | 1 | | | 1 | 3 |
| Tubificid | 8 | 14 | 5 | 1 | 7 | 41 | 76 |
| Cladotanytarsus sp. | | | 6 | | | | 6 |
| Lumbriculidae | | | | | | 1 | 1 |
| Cryptochironomus sp. | | | 7 | | 3 | 5 | 15 |
| Micropsectra sp. | 2 | | 12 | | | | 14 |
| Polypedilum sp. | 4 | 1 | 25 | | | 2 | 32 |
| Clinotanypus sp. | | | 1 | | | | 1 |
| Procladius sp. | | | | | 1 | | 1 |
| Orthocladiinae | | | 3 | | | | 3 |
| Physa sp. | 1 | | | | | | 1 |
| Valvata perdepressa | | | 1 | | | | 1 |
| Corbicula sp. | 7 | 2 | 4 | 4 | 3 | 20 | 40 |
| **September 1999 Total:** | 23 | 26 | 67 | 6 | 19 | 79 | 220 |

TABLE 2.4

MEAN NUMBER OF MACROINVERTEBRATES (NUMBER/M$^2$) AND PERCENT COMPOSITION OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA, AND OTHER ORGANISMS, 1999 BVPS

| | Station | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 (Control) | | 2A (Non-control) | | 2B1 (Non-control) | | 2B2 (Non-control) | | 2B3 (Non-control) | | 3 (Non-control) | |
| | #/m$^2$ | % | #/m$^2$ | % | #/m$^2$ | % | #/m$^2$ | % | #/m$^2$ | % | #/m$^2$ | % |
| **May 12** | | | | | | | | | | | | |
| Oligochaeta | 577 | 66 | 564 | 77 | 1509 | 69 | 26 | 22 | 420 | 59 | 1339 | 45 |
| Chironomidae | 118 | 13 | 118 | 16 | 499 | 23 | 0 | 0 | 197 | 28 | 1299 | 43 |
| Mollusca | 79 | 9 | 0 | 0 | 157 | 7 | 66 | 56 | 66 | 9 | 276 | 9 |
| Others | 105 | 12 | 52 | 7 | 13 | 1 | 26 | 22 | 26 | 4 | 79 | 3 |
| *Total* | 879 | 100 | 735 | 100 | 2178 | 100 | 118 | 100 | 709 | 100 | 2992 | 100 |
| **September 24** | | | | | | | | | | | | |
| Oligochaeta | 118 | 39 | 302 | 88 | 184 | 21 | 26 | 33 | 157 | 63 | 682 | 66 |
| Chironomidae | 79 | 26 | 13 | 4 | 630 | 72 | 0 | 0 | 52 | 21 | 92 | 9 |
| Mollusca | 105 | 35 | 26 | 8 | 66 | 7 | 52 | 67 | 39 | 16 | 262 | 25 |
| Others | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Total* | 302 | 100 | 341 | 100 | 879 | 100 | 79 | 100 | 249 | 100 | 1037 | 100 |

## TABLE 2.5

**MEAN NUMBER OF MACROINVERTEBRATES (NUMBER/M$^2$) AND PERCENT COMPOSITION OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA, AND OTHER ORGANISMS FOR THE CONTROL STATION (1) AND THE AVERAGE FOR NON-CONTROL STATIONS (2A, 2B1, 2B2, 2B3, AND 3), 1999 BVPS**

**May 12**

| | Control Station (Mean) | | Non-Control Station (Mean) | |
|---|---|---|---|---|
| | #/m$^2$ | % | #/m$^2$ | % |
| Oligochaeta | 577 | 66 | 772 | 57 |
| Chironomidae | 118 | 13 | 423 | 31 |
| Mollusca | 79 | 9 | 113 | 8 |
| Others | 105 | 12 | 39 | 3 |
| TOTAL | 879 | 100 | 1346 | 100 |

**September 24**

| | Control Station (Mean) | | Non-Control Station (Mean) | |
|---|---|---|---|---|
| | #/m$^2$ | % | #/m$^2$ | % |
| Oligochaeta | 118 | 39 | 270 | 52 |
| Chironomidae | 79 | 26 | 157 | 30 |
| Mollusca | 105 | 35 | 89 | 17 |
| Others | 0 | 0 | 0 | 0 |
| TOTAL | 302 | 100 | 517 | 100 |

TABLE 2.6

SHANNON-WEINER DIVERSITY, EVENNESS AND RICHNESS INDICES FOR BENTHIC MACROINVERTEBRATES COLLECTED IN THE OHIO RIVER, 1999

| | Station | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2A | 2B1 | 2B2 | 2B3 | 3 |
| Date: May 12 | | | | | | |
| No. of Taxa | 18 | 8 | 21 | 7 | 11 | 20 |
| Shannon-Weiner Index | 1.13 | 0.36 | 0.92 | 0.80 | 0.58 | 0.84 |
| Evenness | 0.90 | 0.40 | 0.70 | 0.95 | 0.56 | 0.65 |
| Richness | 9.31 | 4 | 9.01 | 6.29 | 5.77 | 8.03 |
| Date: September 24 | | | | | | |
| No. of Taxa | 6 | 8 | 11 | 3 | 5 | 9 |
| Shannon-Weiner Index | 0.66 | 0.66 | 0.74 | 0.38 | 0.63 | 0.43 |
| Evenness | 0.85 | 0.73 | 0.71 | 0.80 | 0.90 | 0.45 |
| Richness | 3.67 | 4.95 | 5.48 | 2.57 | 3.13 | 4.22 |

## TABLE 2.7

## BENTHIC MACROINVERTEBRATE DENSITIES (NUMBER/M$^2$) FOR STATION 1 (CONTROL) AND STATION 2B (NON-CONTROL) DURING PREOPERATIONAL AND OPERATIONAL YEARS THROUGH 1999 BVPS

| Month | Preoperational Years | | | | | | Operational Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1973 | | 1974 | | 1975 | | 1976 | | 1977 | | 1978 | | 1979 | | 1980 | |
| | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B |
| May | 248 | 508 | 1,116 | 2,197 | | | 927 | 3,660 | 674 | 848 | 351 | 126 | 1,004 | 840 | 1,041 | 747 |
| August | 99 | 244 | 143 | 541 | 1,017 | 1,124 | 851 | 785 | 591 | 3,474 | 601 | 1,896 | 1,185 | 588 | | |
| September | | | | | | | | | | | | | | | 1,523 | 448 |
| Mean | 173 | 376 | 630 | 1,369 | 1,017 | 1,124 | 889 | 2,223 | 633 | 2,161 | 476 | 1,011 | 1,095 | 714 | 1,282 | 598 |

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

## TABLE 2.7 (Cont'd)

## BENTHIC MACROINVERTEBRATE DENSITIES (NUMBER/M²) FOR STATION 1 (CONTROL) AND STATION 2B (NON-CONTROL) DURING PREOPERATIONAL AND OPERATIONAL YEARS THROUGH 1998 BVPS

| Month | Operational Years | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1988 | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | |
| | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B |
| May | 1,804 | 1,775 | 3,459 | 2,335 | 15,135 | 5,796 | 7,760 | 6,355 | 7,314 | 10,560 | 8,435 | 2,152 | 6,980 | 2,349 |
| September | 1,420 | 1,514 | 1,560 | 4,212 | 5,550 | 1,118 | 3,855 | 2,605 | 2,723 | 4,707 | 4,693 | 2,143 | 1,371 | 2,930 |
| Mean | 1,612 | 1,645 | 2,510 | 3,274 | 10,343 | 3,457 | 5,808 | 4,480 | 5,019 | 7,634 | 6,564 | 2,148 | 4,176 | 2,640 |

| Month | Operational Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | | 1996 | | 1997* | | 1998* | | 1999* | |
| | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B | 1 | 2B |
| May | 8,083 | 9,283 | 1,978 | 1,333 | 1,411 | 2,520 | 1,699 | 888 | 879 | 1002 |
| September | 1,669 | 3,873 | 1,649 | 2,413 | 1,944 | 2,774 | 2,534 | 557 | 302 | 402 |
| Mean | 4,876 | 6,578 | 1,814 | 31,873 | 1,678 | 2,647 | 2,117 | 723 | 591 | 702 |

*Mean of 2B1, 2B2, 2B3

# TABLE 2.8

# SCIENTIFIC AND COMMON NAME[1] OF FISH COLLECTED IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1970 THROUGH 1999 BVPS



| Family and Scientific Name | Common Name |
|---|---|
| Lepisosteidae (gars) | |
| Lepisosteus osseus | Longnose gar |
| Hiodontidae (mooneyes) | |
| Hiodon alosoides | Goldeye |
| H. tergisus | Mooneye |
| Clupeidae (herrings) | |
| Alosa chrysochloris | Skipjack herring |
| A. pseudoharengus | Alewife |
| Dorosoma cepedianum | Gizzard shad |
| Cyprinidae (carps and minnows) | |
| Campostoma anomalum | Central stoneroller |
| Carassius auratus | Goldfish |
| Ctenopharyngodon idella | Grass carp |
| Cyprinella spiloptera | Spotfin shiner |
| Cyprinus carpio | Common carp |
| C. carpio x C. auratus | Carp-goldfish hybrid |
| Luxilus chrysocephalus | Striped shiner |
| Macrhybopsis storeriana | Silver chub |
| Nocomis micropogon | River chub |
| Notemigonus crysoleucas | Golden shiner |
| Notropis atherinoides | Emerald shiner |
| N. buccatus | Silverjaw minnow |
| N. hudsonius | Spottail shiner |
| N. rubellus | Rosyface shiner |
| N. stramineus | Sand shiner |
| N. volucellus | Mimic shiner |
| Pimephales notatus | Bluntnose minnow |
| P. promelas | Fathead minnow |
| Rhinichthys atratulus | Blacknose dace |
| Semotilus atromaculatus | Creek chub |
| Catostomidae (suckers) | |
| Carpiodes carpio | River carpsucker |
| C. cyprinus | Quillback |
| C. velifer | Highfin carpsucker |
| Catostomus commersoni | White sucker |
| Hypentelium nigricans | Northern hogsucker |
| Ictiobus bubalus | Smallmouth buffalo |
| I. niger | Black buffalo |
| Minytrema melanops | Spotted sucker |

# TABLE 2.8
# (Continued)



| Family and Scientific Name | Common Name |
|---|---|
| Moxostoma anisurum | Silver redhorse |
| M. carinatum | River redhorse |
| M. duquesnei | Black redhorse |
| M. erythrurum | Golden redhorse |
| M. macrolepidotum | Shorthead redhorse |
| Ictaluridae (bullhead catfishes) | |
| Ameiurus catus | White catfish |
| A. melas | Black bullhead |
| A. natalis | Yellow bullhead |
| A. nebulosus | Brown bullhead |
| Ictalurus punctatus | Channel catfish |
| Noturus flavus | Stonecat |
| Pylodictis olivaris | Flathead catfish |
| Esocidae (pikes) | |
| Esox lucius | Northern pike |
| E. masquinongy | Muskellunge |
| E. lucius x E. masquinongy | Tiger muskellunge |
| Salmonidae (trouts) | |
| Oncorhynchus mykiss | Rainbow trout |
| Percopsidae (trout-perches) | |
| Percopsis omiscomaycus | Trout-perch |
| Cyprinodontidae (killifishes) | |
| Fundulus diaphanus | Banded killifish |
| Atherinidae (silversides) | |
| Labidesthes sicculus | Brook silverside |
| Percichthyidae (temperate basses) | |
| Morone chrysops | White bass |
| M. saxatilis | Striped bass |
| M. saxatilis x M. chrysops | Striped bass hybrid |
| Centrarchidae (sunfishes) | |
| Ambloplites rupestris | Rock bass |
| Lepomis cyanellus | Green sunfish |
| L. gibbosus | Pumpkinseed |
| L. macrochirus | Bluegill |
| L. microlophus | Redear sunfish |
| L. gibbosus x L. microlophus | Pumpkinseed-redear sunfish hybrid |
| Micropterus dolomieu | Smallmouth bass |
| M. punctulatus | Spotted bass |
| M. salmoides | Largemouth bass |
| Pomoxis annularis | White crappie |
| P. nigromaculatus | Black crappie |

## TABLE 2.8
## (Continued)



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

[1]Nomenclature follows Robins, et al. (1991)

## TABLE 2.9

## COMPARISON OF CONTROL VS. NON-CONTROL ELECTROFISHING CATCHES DURING THE BVPS 1999 FISHERIES SURVEY

| *Common Name* | *Scientific Name* | *Control* | *%* | *Non-Control* | *%* | *Total fish* | *%* |
|---|---|---|---|---|---|---|---|
| Black buffalo | Ictiobus niger | | | 1 | 0.4 | 1 | 0.3 |
| Black redhorse | Moxostoma duguesnei | | | 1 | 0.4 | 1 | 0.3 |
| Bluegill | Lepomis macrochirus | 1 | 1.3 | | 0.0 | 1 | 0.3 |
| Brown bullhead | Ameiurus nebulosus | | | 1 | 0.4 | 1 | 0.3 |
| Channel catfish | Ictalurus punctatus | 1 | 1.3 | 2 | 0.8 | 3 | 0.9 |
| Emerald shiner | Notropis atherinoid | | | 20 | 8.2 | 20 | 6.3 |
| Freshwater drum | Aplodinotus grunniens | 1 | 1.3 | 14 | 5.8 | 15 | 4.7 |
| Gizzard shad | Dorosoma cepedianum | 29 | 37.7 | 69 | 28.4 | 98 | 30.7 |
| Golden redhorse | Moxostoma erythrurum | 7 | 9.1 | 34 | 14.0 | 41 | 12.9 |
| Mooneye | Hiodon tergisus | | | 1 | 0.4 | 1 | 0.3 |
| Muskellunge | Esox masquinongy | | | 1 | 0.4 | 1 | 0.3 |
| Quillback | Carpiodes cyprinus | 2 | 2.6 | 13 | 5.3 | 15 | 4.7 |
| Sand shiner | Notropis stramineus | 1 | 1.3 | | 0.0 | 1 | 0.3 |
| Sauger | Stizostedion canadense | 13 | 16.9 | 22 | 9.1 | 35 | 11.0 |
| Shorthead redhorse sucker | Moxostoma macrolepidotum | 2 | 2.6 | 5 | 2.1 | 7 | 2.2 |
| Silver redhorse | Moxostoma anisurum | 1 | 1.3 | 6 | 2.5 | 7 | 2.2 |
| Smallmouth bass | Micropterus dolomieu | 7 | 9.1 | 12 | 4.9 | 19 | 6.0 |
| Smallmouth buffalo | Ictiobus bubalus | | | 1 | 0.4 | | |
| Spottail shiner | Notropis hudsonius | 11 | 14.3 | 18 | 7.4 | 29 | 9.1 |
| Spotted bass | Micropterus punctulatus | | | 3 | 1.2 | 3 | 0.9 |
| Striped bass | Morone saxatilis | 1 | 1.3 | 15 | 6.2 | 16 | 5.0 |
| Walleye | Stizostedion vitreum vitreum | | | 1 | 0.4 | 1 | 0.3 |
| White bass | Morone chrysops | | | 1 | 0.4 | 1 | 0.3 |
| White perch | Morone americana | | | 1 | 0.4 | 1 | 0.3 |
| White sucker | Catostomus commersoni | | | 1 | 0.4 | 1 | 0.3 |
| Electrofishing | Gear Total: | 77 | 100 | 243 | 100 | 319 | 100 |

**TABLE 2.10**

**COMPARISON OF CONTROL VS. NON-CONTROL SEINE CATCHES DURING THE BVPS 1999 FISHERIES SURVEY**

| Common Name | Scientific Name | Control | % | Non-Control | % | Total Fish | % |
|---|---|---|---|---|---|---|---|
| Bluegill | Lepomis macrochirus | 1 | 1.0 | 1 | 1.03 | 2 | 1.0 |
| Bluntnose minnow | Pimephales notatus | 2 | 2.0 | | | 2 | 1.0 |
| Common carp | Cyprinus carpio | | | 2 | 2.06 | 2 | 1.0 |
| Emerald shiner | Notropis atherinoid | 39 | 39.0 | 21 | 21.6 | 60 | 30.5 |
| Fathead minnow | Pimephales promelas | | | 1 | 1.03 | 1 | 0.5 |
| Freshwater drum | Aplodinotus grunniens | | | 1 | 1.03 | 1 | 0.5 |
| Gizzard shad | Dorosoma cepedianum | 44 | 44.0 | 54 | 55.7 | 98 | 49.7 |
| Golden redhorse | Moxostoma erythrurum | | | 2 | 2.06 | 2 | 1.0 |
| Mimic shiner | Notropis volucellus | | | 2 | 2.06 | 2 | 1.0 |
| Pumpkinseed | Lepomis gibbosus | | | 6 | 6.19 | 6 | 3.0 |
| Sand shiner | Notropis stramineus | 9 | 9.0 | 6 | 6.19 | 15 | 7.6 |
| Spottail shiner | Notropis hudsonius | 1 | 1.0 | | | 1 | 0.5 |
| Spotted bass | Micropterus punctulatus | 3 | 3.0 | 1 | 1.03 | 4 | 2.0 |
| White perch | Morone americana | 1 | 1.0 | | | 1 | 0.5 |
| Seine | Gear Total: | 100 | 100 | 97 | 100 | 197 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Seine and Electrofishing | Year Total | 177 | ---- | 340 | ---- | 516 | ---- |

TABLE 2.11

**FISH SPECIES COLLECTED DURING THE MAY 1999 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS**

| Common Name | Scientific Name | Sample locations * S-1 | S-2 | E-1 | E-2A | E-2B | E-3 | Seine Total | Seine % | Electrofishing Total | Electrofishing % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Black buffalo | Ictiobus niger | | | | | | 1 | | | 1 | 1.1 |
| Bluegill | Lepomis macrochirus | | | 1 | | | | | | 1 | 1.1 |
| Channel catfish | Ictalurus punctatus | | | 1 | | | 1 | | | 2 | 2.1 |
| Emerald shiner | Notropis atherinoid | | | | 1 | | | | | 1 | 1.1 |
| Freshwater drum | Aplodinotus grunniens | | | | 1 | 1 | 1 | | | 3 | 3.2 |
| Gizzard shad | Dorosoma cepedianum | | | 11 | 4 | 10 | 7 | | | 32 | 33.7 |
| Golden redhorse | Moxostoma erythrurum | | | 2 | 7 | 2 | 8 | | | 19 | 20.0 |
| Quillback | Carpiodes cyprinus | | | | 1 | | | | | 1 | 1.1 |
| Sauger | Stizostedion canadense | | | | 5 | 1 | 1 | | | 7 | 7.4 |
| Smallmouth bass | Micropterus dolomieu | | | 1 | 2 | 2 | | | | 5 | 5.3 |
| Spottail shiner | Notropis hudsonius | | | 10 | 6 | 5 | | | | 21 | 22.1 |
| White bass | Morone chrysops | | | | | | 1 | | | 1 | 1.1 |
| White perch | Morone americana | 1 | | | | | 1 | 1 | 100 | 1 | 1.1 |
| Total | | 1 | 0 | 26 | 27 | 21 | 21 | 1 | 100 | 95 | 100 |

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

**TABLE 2.12**

**FISH SPECIES COLLECTED DURING THE JULY 1999 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS**

| Common Name | Scientific Name | Sample locations * | | | | | | Seine | | Electrofishing | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S-1 | S-2 | E-1 | E-2A | E-2B | E-3 | Total | % | Total | % |
| Brown bullhead | Ameiurus nebulosus | | | | | 1 | | | | 1 | 1.3 |
| Emerald shiner | Notropis atherinoid | 1 | | | 10 | | 9 | 1 | 33.3 | 19 | 24.1 |
| Freshwater drum | Aplodinotus grunniens | | | 1 | | | | | | 1 | 1.3 |
| Gizzard shad | Dorosoma cepedianum | 2 | | 10 | 10 | 10 | 11 | 2 | 66.7 | 41 | 51.9 |
| Golden redhorse | Moxostoma erythrurum | | | | | 1 | | | | 1 | 1.3 |
| Quillback | Carpiodes cyprinus | | | | | 1 | | | | 1 | 1.3 |
| Sauger | Stizostedion canadense | | | 2 | | 1 | | | | 3 | 3.8 |
| Smallmouth bass | Micropterus dolomieu | | | | | 1 | 2 | | | 3 | 3.8 |
| Spottail shiner | Notropis hudsonius | | | 1 | | 7 | | | | 8 | 10.1 |
| White sucker | Catostomus commersoni | | | | 1 | | | | | 1 | 1.3 |
| TOTAL | | 3 | 0 | 14 | 21 | 22 | 22 | 3 | 100 | 79 | 100 |

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

## TABLE 2.13

## FISH SPECIES COLLECTED DURING THE SEPTEMBER 1999 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

| Common Name | Scientific Name | Sample locations * | | | | | | Seine | | Electrofishing | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S-1 | S-2 | E-1 | E-2A | E-2B | E-3 | Total | % | Total | % |
| Bluegill | Lepomis macrochirus | | 1 | | | | | 1 | 0.6 | | |
| Channel catfish | Ictalurus punctatus | | | | | | 1 | | | 1 | 2 |
| Common carp | Cyprinus carpio | | 2 | | | | | 2 | 1.3 | | |
| Emerald shiner | Notropis atherinoid | 21 | 17 | | | | | 38 | 24.1 | | |
| Fathead minnow | Pimephales promelas | | 1 | | | | | 1 | 0.6 | | |
| Freshwater drum | Aplodinotus grunniens | | 1 | | | 2 | 7 | 1 | 0.6 | 9 | 14 |
| Gizzard shad | Dorosoma cepedianum | 42 | 54 | 5 | 3 | 3 | 8 | 96 | 60.8 | 19 | 30 |
| Golden redhorse | Moxostoma erythrurum | | 2 | | 1 | | 2 | 2 | 1.3 | 3 | 5 |
| Mimic shiner | Notropis volucellus | | 2 | | | | | 2 | 1.3 | | |
| Mooneye | Hiodon tergisus | | | | | 1 | | | | 1 | 2 |
| Pumpkinseed | Lepomis gibbosus | | 6 | | | | | 6 | 3.8 | | |
| Quillback | Carpiodes cyprinus | | | 2 | 2 | 3 | | | | 7 | 11 |
| Sand shiner | Notropis stramineus | | 5 | | | | | 5 | 3.2 | | |
| Sauger | Stizostedion canadense | | | 1 | | 1 | 2 | | | 4 | 6 |
| Silver redhorse | Moxostoma anisurum | | | | | 1 | 3 | | | 4 | 6 |
| Smallmouth bass | Micropterus dolomieu | | | 5 | 2 | | | | | 7 | 11 |
| Spotted bass | Micropterus punctulatus | 3 | 1 | | 2 | 1 | | 4 | 2.5 | 3 | 5 |
| Striped bass | Morone saxatilis | | | | 3 | | 2 | | | 5 | 8 |
| TOTAL | | 66 | 92 | 13 | 13 | 12 | 25 | 158 | 100 | 63 | 100 |

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

## TABLE 2.14

## FISH SPECIES COLLECTED DURING THE NOVEMBER 1999 SAMPLING OF THE OHIO RIVER IN THE VICINITY OF BVPS

| Common Name | Scientific Name | Sample locations * | | | | | | Seine | | Electrofishing | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S-1 | S-2 | E-1 | E-2A | E-2B | E-3 | Total | % | Total | % |
| Black redhorse | Moxostoma duguesnei | | | | | 1 | | | | 1 | 1.2 |
| Bluegill | Lepomis macrochirus | 1 | | | | | | 1 | 2.9 | | |
| Bluntnose minnow | Pimephales notatus | 2 | | | | | | 2 | 5.7 | | |
| Emerald shiner | Notropis atherinoid | 17 | 4 | | | | | 21 | 60.0 | | |
| Freshwater drum | Aplodinotus grunniens | | | | | 2 | | | | 2 | 2.4 |
| Gizzard shad | Dorosoma cepedianum | | | 3 | 1 | 1 | 1 | | | 6 | 7.3 |
| Golden redhorse | Moxostoma erythrurum | | | 5 | 2 | 7 | 4 | | | 18 | 22.0 |
| Muskellunge | Esox masquinongy | | | | | 1 | | | | 1 | 1.2 |
| Quillback | Carpiodes cyprinus | | | | 4 | 1 | 1 | | | 6 | 7.3 |
| Sand shiner | Notropis stramineus | 9 | 1 | 1 | | | | 10 | 28.6 | 1 | 1.2 |
| Sauger | Stizostedion canadense | | | 10 | 5 | 1 | 5 | | | 21 | 25.6 |
| Shorthead redhorse sucker | Moxostoma macrolepidotum | | | 2 | 2 | 3 | | | | 7 | 8.5 |
| Silver redhorse | Moxostoma anisurum | | | 1 | 2 | | | | | 3 | 3.7 |
| Smallmouth bass | Micropterus dolomieu | | | 1 | | 2 | 1 | | | 4 | 4.9 |
| Smallmouth buffalo | Ictiobus bubalus | | | | 1 | | | | | | |
| Spottail shiner | Notropis hudsonius | 1 | | | | | | 1 | 2.9 | | |
| Striped bass | Morone saxatilis | | | 1 | 2 | 6 | 2 | | | 11 | 13.4 |
| Walleye | Stizostedion vitreum vitreum | | | | | | 1 | | | 1 | 1.2 |
| TOTAL | | 30 | 5 | 24 | 19 | 25 | 15 | 35 | 100 | 82 | 100 |

* Gear = (E) Fish captured by electrofishing; (S) captured by seining

**TABLE 2.15**

**ESTIMATED NUMBER OF FISH OBSERVED * DURING ELECTROFISHING OPERATIONS**

| Common Name | Scientific Name | May | July | September | November | Total |
|---|---|---|---|---|---|---|
| Channel catfish | Ictalurus punctatus | 1 | | | | 1 |
| Common carp | Cyprinus carpio | 10 | 15 | 10 | 5 | 40 |
| Emerald shiner | Notropis atherinoid | | 200 | | 43 | 243 |
| Gizzard shad | Dorosoma cepedianum | 204 | 2100 | 6500 | 126 | 8930 |
| Longnose gar | Lepisosteus osseus | | | 1 | | 1 |
| Smallmouth bass | Micropterus dolomieu | | 3 | | | 3 |
| Spottail shiner | Notropis hudsonius | 1104 | 100 | | 3 | 1207 |
| Total | | 1319 | 2418 | 6511 | 177 | 10425 |

* = Not boated or handled

## TABLE 2.16

## CATCH PER UNIT OF EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1997 FISHERIES SURVEY

| Season | Effort (min) | Common Name | Count of Species | CPUE (fish/min) |
|---|---|---|---|---|
| Spring | 39.00 | Gizzard shad | 3 | 0.0769 |
| | | Mooneye | 2 | 0.0513 |
| | | White sucker | 1 | 0.0256 |
| | | Smallmouth buffalo | 4 | 0.1026 |
| | | Silver redhorse | 27 | 0.6923 |
| | | Golden redhorse | 8 | 0.2051 |
| | | Channel catfish | 2 | 0.0513 |
| | | Flathead catfish | 1 | 0.0256 |
| | | White bass | 1 | 0.0256 |
| | | Smallmouth bass | 7 | 0.1795 |
| | | White crappie | 3 | 0.0769 |
| | | Sauger | 18 | 0.4615 |
| | | Walleye | 1 | 0.0256 |
| | | **Season Total** | **78** | **2.0000** |
| Summer | 45.40 | Longnose gar | 1 | 0.0220 |
| | | Gizzard shad | 49 | 1.0793 |
| | | Silver chub | 3 | 0.0661 |
| | | Emerald shiner | 40 | 0.8810 |
| | | Spottail shiner | 6 | 0.1322 |
| | | Northern hogsucker | 2 | 0.0441 |
| | | Black buffalo | 5 | 0.1101 |
| | | Silver redhorse | 17 | 0.3744 |
| | | White bass | 3 | 0.0661 |
| | | Bluegill | 1 | 0.0220 |
| | | Smallmouth bass | 3 | 0.0661 |
| | | Logperch | 1 | 0.0220 |
| | | Sauger | 4 | 0.0881 |

## TABLE 2.16 (Cont'd)

## CATCH PER UNIT OF EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1997 FISHERIES SURVEY

| | | | | |
|---|---|---|---|---|
| Summer (cont'd) | | Walleye | 3 | 0.0661 |
| | | Freshwater drum | 3 | 0.0661 |
| | | **Season Total** | **141** | **3.1057** |
| Fall | 40.10 | Gizzard shad | 34 | 0.8479 |
| | | Skipjack herring | 3 | 0.0748 |
| | | Mooneye | 3 | 0.0748 |
| | | Goldfish | 1 | 0.0249 |
| | | Emerald shiner | 2 | 0.0499 |
| | | Spottail shiner | 4 | 0.0998 |
| | | Quillback | 5 | 0.1247 |
| | | Smallmouth buffalo | 1 | 0.0249 |
| | | Silver redhorse | 11 | 0.2743 |
| | | Golden redhorse | 2 | 0.0499 |
| | | Channel catfish | 5 | 0.1247 |
| | | White bass | 7 | 0.1746 |
| | | Striped bass | 1 | 0.0249 |
| | | Smallmouth bass | 4 | 0.0998 |
| | | Sauger | 2 | 0.0499 |
| | | Freshwater drum | 20 | 0.4988 |
| | | **Season Total** | **105** | **2.6184** |
| Winter | 42.40 | Gizzard shad | 80 | 1.8868 |
| | | Skipjack herring | 1 | 0.0236 |
| | | Mooneye | 36 | 0.0708 |
| | | Emerald shiner | 80 | 1.8868 |
| | | Spottail shiner | 2 | 0.0472 |
| | | Quillback | 6 | 0.1415 |
| | | White sucker | 3 | 0.0708 |
| | | Black buffalo | 5 | 0.1179 |
| | | Silver redhorse | 19 | 0.4481 |

## TABLE 2.16 (Cont'd)

## CATCH PER UNIT OF EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1997 FISHERIES SURVEY

| | | | | |
|---|---|---|---|---|
| Winter (cont'd) | | Channel catfish | 3 | 0.0708 |
| | | White bass | 13 | 0.3066 |
| | | Bluegill | 1 | 0.0236 |
| | | Smallmouth bass | 5 | 0.1179 |
| | | Yellow perch | 1 | 0.0236 |
| | | Walleye | 1 | 0.0236 |
| | | Freshwater drum | 41 | 0.9670 |
| | | **Season Total** | **264** | **6.2264** |
| **Year** | **166.90** | | **588** | **3.5231** |

## TABLE 2.17

## CATCH PER UNIT OF EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1998 FISHERIES SURVEY

| Season | Effort (min) | Common Name | Count of Species | CPUE (fish/min) |
|---|---|---|---|---|
| Spring | 39.5 | Mooneye | 1 | 0.0253 |
| | | Gizzard shad | 15 | 0.3797 |
| | | Emerald shiner | 2 | 0.0506 |
| | | Quillback | 8 | 0.2025 |
| | | Smallmouth buffalo | 3 | 0.0759 |
| | | Black buffalo | 7 | 0.1772 |
| | | Silver redhorse | 4 | 0.1013 |
| | | Golden redhorse | 11 | 0.2785 |
| | | Muskellunge | 1 | 0.0253 |
| | | White bass | 9 | 0.2278 |
| | | Smallmouth bass | 3 | 0.0759 |
| | | Black crappie | 1 | 0.0253 |
| | | Logperch | 2 | 0.0506 |
| | | Sauger | 12 | 0.3038 |
| | | Freshwater drum | 7 | 0.1772 |
| | | **Season Total** | **86** | **2.1769** |
| Summer | 40.0 | Mooneye | 1 | 0.0250 |
| | | Gizzard shad | 5 | 0.1250 |
| | | Common carp | 6 | 0.1500 |
| | | Golden shiner | 1 | 0.0250 |
| | | Highfin carpsucker | 1 | 0.0250 |
| | | Quillback | 6 | 0.1500 |
| | | Silver redhorse | 7 | 0.1750 |
| | | Golden redhorse | 2 | 0.0500 |
| | | White bass | 2 | 0.0500 |
| | | Bluegill | 1 | 0.0250 |
| | | Smallmouth bass | 8 | 0.2000 |
| | | Largemouth bass | 1 | 0.0250 |

## TABLE 2.17 (Cont'd)

## CATCH PER UNIT OF EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1998 FISHERIES SURVEY

| | | | | |
|---|---|---|---|---|
| Summer (cont'd) | | Logperch | 3 | 0.0750 |
| | | Sauger | 6 | 0.1500 |
| | | Freshwater drum | 6 | 0.1500 |
| | | **Season Total** | **56** | **1.4000** |
| Fall | 40.0 | Gizzard shad | 14 | 0.3500 |
| | | Spottail shiner | 3 | 0.0750 |
| | | Black buffalo | 1 | 0.0250 |
| | | Silver redhorse | 8 | 0.2000 |
| | | Golden redhorse | 3 | 0.0750 |
| | | Smallmouth bass | 4 | 0.1000 |
| | | Logperch | 1 | 0.0250 |
| | | Sauger | 6 | 0.1500 |
| | | Freshwater drum | 15 | 0.3750 |
| | | **Season Total** | **55** | **1.3750** |
| Winter | 40.0 | Mooneye | 1 | 0.0250 |
| | | Gizzard shad | 10 | 0.2500 |
| | | Emerald shiner | 1 | 0.0250 |
| | | Sand shiner | 1 | 0.0250 |
| | | Silver redhorse | 2 | 0.0500 |
| | | Golden redhorse | 9 | 0.2250 |
| | | White bass | 3 | 0.0750 |
| | | Spotted bass | 1 | 0.0250 |
| | | Smallmouth bass | 2 | 0.0500 |
| | | Sauger | 3 | 0.0750 |
| | | Freshwater drum | 11 | 0.2750 |
| | | **Season Total** | **44** | **1.1000** |
| **Year** | **159.5** | | **241** | **1.5110** |

**Table 2.18**

**CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1999 FISHERIES SURVEY**

| Season | Effort (min) | Common Name | Count of species | CPUE (fish/min) |
|---|---|---|---|---|
| Spring | 40 | Black buffalo | 1 | 0.0250 |
| | | Bluegill | 1 | 0.0250 |
| | | Channel catfish | 2 | 0.0500 |
| | | Emerald shiner | 1 | 0.0250 |
| | | Freshwater drum | 3 | 0.0750 |
| | | Gizzard shad | 32 | 0.8000 |
| | | Golden redhorse | 19 | 0.4750 |
| | | Quillback | 1 | 0.0250 |
| | | Sauger | 7 | 0.1750 |
| | | Smallmouth bass | 5 | 0.1250 |
| | | Spottail shiner | 21 | 0.5250 |
| | | White bass | 1 | 0.0250 |
| | | White perch | 1 | 0.0250 |
| | | Season Total | 95 | 2.3750 |
| Season | Effort (min) | Common Name | Count of species | CPUE (fish/min) |
| Summer | 43.1 | Brown bullhead | 1 | 0.0232 |
| | | Emerald shiner | 19 | 0.4408 |
| | | Freshwater drum | 1 | 0.0232 |
| | | Gizzard shad | 41 | 0.9513 |
| | | Golden redhorse | 1 | 0.0232 |
| | | Quillback | 1 | 0.0232 |
| | | Sauger | 3 | 0.0696 |
| | | Smallmouth bass | 3 | 0.0696 |
| | | Spottail shiner | 8 | 0.1856 |
| | | White sucker | 1 | 0.0232 |
| | | Season Total | 79 | 1.8329 |

**Table 2.18 (Cont'd)**

**CATCH PER UNIT EFFORT (CPUE AS FISH/ELECTROFISHING MINUTE) BY SEASON DURING THE BVPS 1999 FISHERIES SURVEY**

| Season | Effort (min) | Common Name | Count of species | CPUE (fish/min) |
|---|---|---|---|---|
| Fall | 40 | Channel catfish | 1 | 0.0250 |
| | | Freshwater drum | 9 | 0.2250 |
| | | Gizzard shad | 19 | 0.4750 |
| | | Golden redhorse | 3 | 0.0750 |
| | | Mooneye | 1 | 0.0250 |
| | | Quillback | 7 | 0.1750 |
| | | Sauger | 4 | 0.1000 |
| | | Silver redhorse | 4 | 0.1000 |
| | | Smallmouth bass | 7 | 0.1750 |
| | | Spotted bass | 3 | 0.0750 |
| | | Striped bass | 5 | 0.1250 |
| | | Season Total | 63 | 1.5750 |
| Season | Effort (min) | Common Name | Count of species | CPUE (fish/min) |
| Winter | 40 | Black redhorse | 1 | 0.0250 |
| | | Freshwater drum | 2 | 0.0500 |
| | | Gizzard shad | 6 | 0.1500 |
| | | Golden redhorse | 18 | 0.4500 |
| | | Muskellunge | 1 | 0.0250 |
| | | Quillback | 6 | 0.1500 |
| | | Sand shiner | 1 | 0.0250 |
| | | Sauger | 21 | 0.5250 |
| | | Shorthead redhorse | 7 | 0.1750 |
| | | Silver redhorse | 3 | 0.0750 |
| | | Smallmouth bass | 4 | 0.1000 |
| | | Striped bass | 11 | 0.2750 |
| | | Walleye | 1 | 0.0250 |
| | | Season Total | 82 | 2.0500 |
| Year | 163.1 | | 319 | 7.8329 |

**TABLE 2.19**

**UNIT 1 COOLING RESERVOIR MONTHLY SAMPLING**
**CORBICULA DENSITY DATA FOR**
**1999 FROM BVPS**

| Collection Date | Area sampled (sq ft) | Live or Dead | Count | Mean Length (mm) | Maximum Length (mm) | Minimum Length (mm) | Estimated number (per sq m) |
|---|---|---|---|---|---|---|---|
| 02/18/1999 | 0.25 | Live | 1 | 17.40 | - | - | 43 |
| | | Dead | 6 | 0.96 | 1 | 1 | 259 |
| 03/29/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 05/12/1999 | 0.25 | Live | 1 | 12.00 | - | - | 43 |
| | | Dead | 0 | - | - | - | 0 |
| 06/08/1999 | 0.25 | Live | 16 | 4.55 | 14 | 2 | 690 |
| | | Dead | 24 | 2.31 | 8 | 1 | 1034 |
| 07/22/1999 | 0.25 | Live | 1 | 2.00 | - | - | 43 |
| | | Dead | 31 | 7.32 | 17 | 1 | 1336 |
| 08/19/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 17 | 3.05 | 11 | 1 | 733 |
| 09/24/1999 | 0.25 | Live | 24 | 5.52 | 11 | 2 | 1034 |
| | | Dead | 32 | 6.54 | 19 | 2 | 1379 |
| 10/99 | 0.25 | Live | 2 | 8.85 | 10 | 8 | 86 |
| | | Dead | 38 | 6.12 | 21 | 2 | 1638 |
| 11/99 | 0.25 | Live | 3 | 8.43 | 14 | 5 | 129 |
| | | Dead | 28 | 4.36 | 10 | 1 | 1207 |
| Unit summary | | Live | 48 | 58.75 | 14 | 2 | |
| | | Dead | 176 | 30.665 | 21 | 1 | |

## TABLE 2.20

## UNIT 2 COOLING RESERVOIR MONTHLY SAMPLING
## CORBICULA DENSITY DATA FOR
## 1999 FROM BVPS

| Collection Date | Area sampled (sq ft) | Live or Dead | Count | Mean Length (mm) | Maximum Length (mm) | Minimum length (mm) | Estimated number (per sq m) |
|---|---|---|---|---|---|---|---|
| 02/18/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 04/21/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 05/12/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 06/08/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 07/22/1999 | 0.25 | Live | 0 | - | - | - | 0 |
| | | Dead | 0 | - | - | - | 0 |
| 08/19/1999 | 0.25 | Live | 2 | 4.50 | 5 | 4 | 86 |
| | | Dead | 3 | 9.67 | 11 | 8 | 129 |
| 09/24/1999 | 0.25 | Live | 1 | 3.00 | - | - | 43 |
| | | Dead | 2 | 5.80 | 7 | 5 | 86 |
| 10/99 | 0.25 | Live | 6 | 4.63 | 6 | 2 | 259 |
| | | Dead | 6 | 7.92 | 11 | 3 | 259 |
| 11/99 | 0.25 | Live | 3 | 3.17 | 4 | 2 | 129 |
| | | Dead | 3 | 9.27 | 11 | 7 | 129 |
| Unit summary | | Live | 12 | 15.30 | 7 | 2 | |
| | | Dead | 14 | 32.65 | 11 | 3 | |

TABLE 2.21

ESTIMATED DENSITY OF ZEBRA MUSSEL VELIGERS (NUMBER/M3) IN PUMP SAMPLES FROM THE BVPS BARGE SLIP, WATER INTAKE STRUCTURE, EMERGENCY OUTFALL BUILDING, SPLASH POOL COOLING TOWER UNIT #1, AND COOLING TOWER UNIT #2 FOR 1999

| | | | Dead Observed Zebra Mussels | | | | Live Observed Zebra Mussels | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Collection Date | Station | Correction factor | Pre-D Density | D Density | Umbonal Density | Total dead | Pre-D Density | D Density | Umbonal Density | Total Live |
| 04/21/1999 | BS | 120.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/21/1999 | CT2 | 7.50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/21/1999 | EOS | 7.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/21/1999 | IS | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/21/1999 | IB | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | BS | 9.38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | CT1 | 8.75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | CT2 | 10.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | EOS | 52.91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | IS | 52.91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/12/1999 | IB | 50.26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 06/08/1999 | BS | 10.00 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 |
| 06/08/1999 | CT1 | 3.40 | 0 | 17 | 3 | 20 | 0 | 0 | 0 | 0 |
| 06/08/1999 | CT2 | 8.57 | 0 | 51 | 0 | 51 | 0 | 0 | 0 | 0 |
| 06/08/1999 | EOS | 10.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 06/08/1999 | IS | 8.75 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 |
| 06/08/1999 | IB | 10.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

BS = Barge slip
IS = Intake structure
EOS = Emergency outfall structure
IB = Impact basin
CT1 = Cooling tower #1
CT2 = Cooling tower #2

TABLE 2.21 (Cont'd)

**ESTIMATED DENSITY OF ZEBRA MUSSEL VELIGERS (NUMBER/M3) IN PUMP SAMPLES FROM THE BVPS BARGE SLIP, WATER INTAKE STRUCTURE, EMERGENCY OUTFALL BUILDING, SPLASH POOL COOLING TOWER UNIT #1, AND COOLING TOWER UNIT #2 FOR 1999**

| Collection Date | Station | Correction factor | Dead Observed Zebra Mussels | | | | Live Observed Zebra Mussels | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-D Density | D Density | Umbonal Density | Total dead | Pre-D Density | D Density | Umbonal Density | Total Live |
| 07/22/1999 | BS | 10.00 | 0 | 560 | 10 | 570 | 0 | 0 | 0 | 0 |
| 07/22/1999 | CT1 | 12.67 | 0 | 3053 | 38 | 3091 | 0 | 0 | 0 | 0 |
| 07/22/1999 | CT2 | 10.00 | 0 | 1000 | 50 | 1050 | 0 | 0 | 0 | 0 |
| 07/22/1999 | EOS | 10.00 | 0 | 70 | 80 | 150 | 0 | 0 | 0 | 0 |
| 07/22/1999 | IS | 10.00 | 0 | 1230 | 20 | 1250 | 0 | 0 | 0 | 0 |
| 07/22/1999 | IB | 20.00 | 0 | 4080 | 40 | 4120 | 0 | 0 | 0 | 0 |
| 08/19/1999 | BS | 10.00 | 0 | 490 | 10 | 500 | 0 | 840 | 60 | 900 |
| 08/19/1999 | CT1 | 10.00 | 0 | 1050 | 330 | 1380 | 0 | 0 | 0 | 0 |
| 08/19/1999 | CT2 | 14.00 | 0 | 1666 | 70 | 1736 | 0 | 868 | 126 | 994 |
| 08/19/1999 | EOS | 21.00 | 0 | 966 | 42 | 1008 | 0 | 4074 | 567 | 4641 |
| 08/19/1999 | IS | 10.00 | 0 | 310 | 10 | 320 | 0 | 1180 | 80 | 1260 |
| 08/19/1999 | IB | 150.00 | 0 | 5100 | 1800 | 6900 | 0 | 24000 | 3600 | 27600 |
| 09/24/1999 | BS | 10.00 | 0 | 150 | 290 | 440 | 0 | 0 | 0 | 0 |
| 09/24/1999 | CT1 | 10.00 | 0 | 70 | 120 | 190 | 0 | 0 | 0 | 0 |
| 09/24/1999 | CT2 | 10.00 | 0 | 2070 | 2110 | 4180 | 0 | 0 | 0 | 0 |
| 09/24/1999 | EOS | 10.00 | 0 | 1040 | 1580 | 2620 | 0 | 0 | 0 | 0 |
| 09/24/1999 | IS | 10.00 | 0 | 1050 | 1270 | 2320 | 0 | 0 | 0 | 0 |
| 09/24/1999 | IB | 10.00 | 0 | 610 | 1300 | 1910 | 0 | 0 | 0 | 0 |

BS = Barge slip
IS = Intake structure
EOS = Emergency outfall structure
IB = Impact basin
CT1 = Cooling tower #1
CT2 = Cooling tower #2

TABLE 2.21 (Cont'd)

**ESTIMATED DENSITY OF ZEBRA MUSSEL VELIGERS (NUMBER/M3) IN PUMP SAMPLES FROM THE BVPS BARGE SLIP, WATER INTAKE STRUCTURE, EMERGENCY OUTFALL BUILDING, SPLASH POOL COOLING TOWER UNIT #1, AND COOLING TOWER UNIT #2 FOR 1999**

| Collection Date | Station | Correction factor | Dead Observed Zebra Mussels | | | | Live Observed Zebra Mussels | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-D Density | D Density | Umbonal Density | Total dead | Pre-D Density | D Density | Umbonal Density | Total Live |
| 10/22/1999 | BS | 18.00 | 0 | 2898 | 126 | 3024 | 0 | 0 | 0 | 0 |
| 10/22/1999 | CT1 | 10.00 | 0 | 830 | 40 | 870 | 0 | 0 | 0 | 0 |
| 10/22/1999 | CT2 | 10.00 | 0 | 5660 | 1430 | 7090 | 0 | 0 | 0 | 0 |
| 10/22/1999 | EOS | 23.00 | 0 | 5290 | 299 | 5589 | 0 | 0 | 0 | 0 |
| 10/22/1999 | IS | 25.00 | 0 | 5600 | 175 | 5775 | 0 | 0 | 0 | 0 |
| 10/22/1999 | IB | 23.00 | 0 | 8004 | 529 | 8533 | 0 | 0 | 0 | 0 |

BS = Barge slip
IS = Intake structure
EOS = Emergency outfall structure
IB = Impact basin
CT1 = Cooling tower #1
CT2 = Cooling tower #2

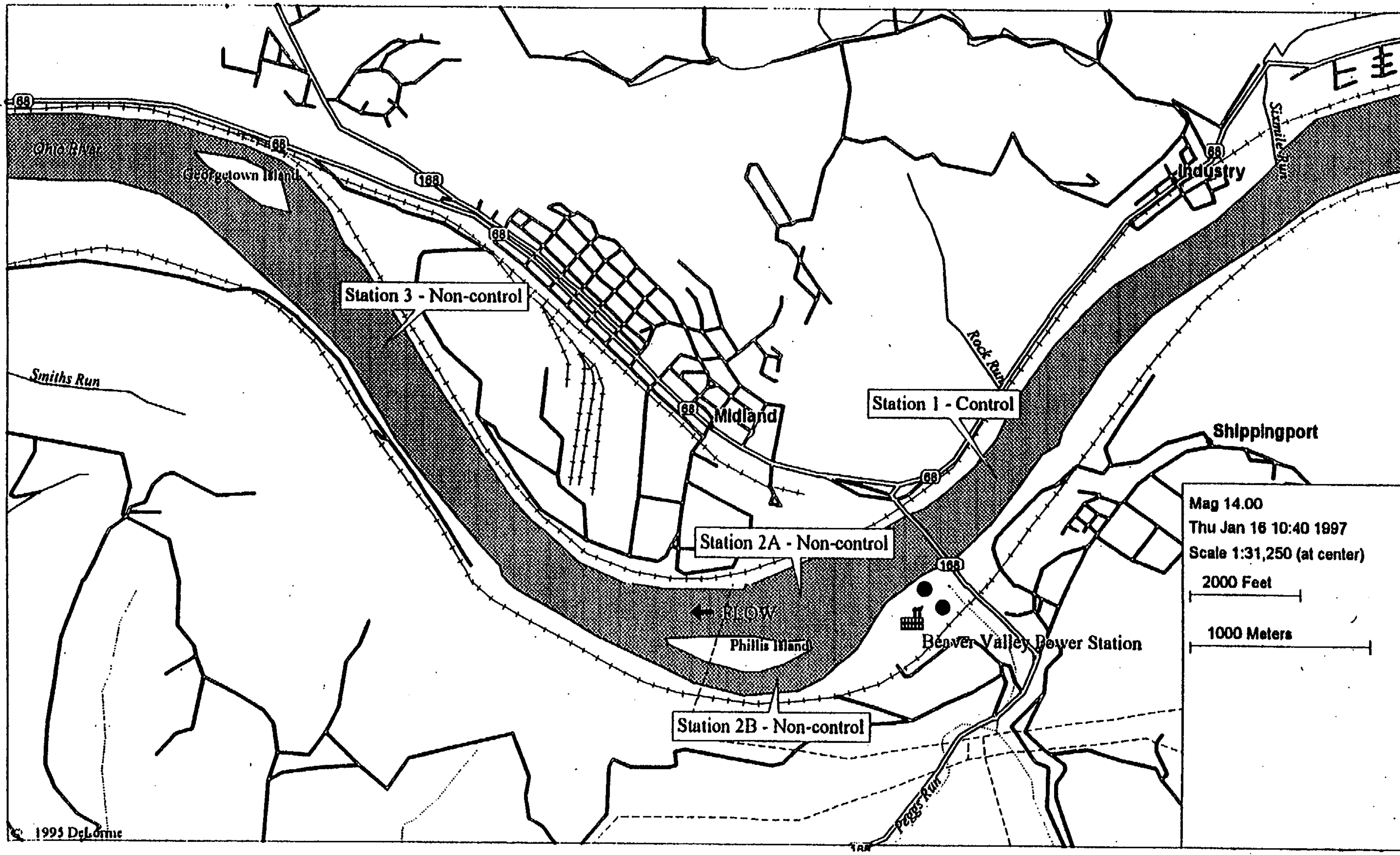



**FIGURE 1.1**
**LOCATION MAP FOR THE 1999 BEAVER VALLEY POWER STATION AQUATIC MONITORING PROGRAM SAMPLING CONTROL AND NON-CONTROL SAMPLING STATIONS**

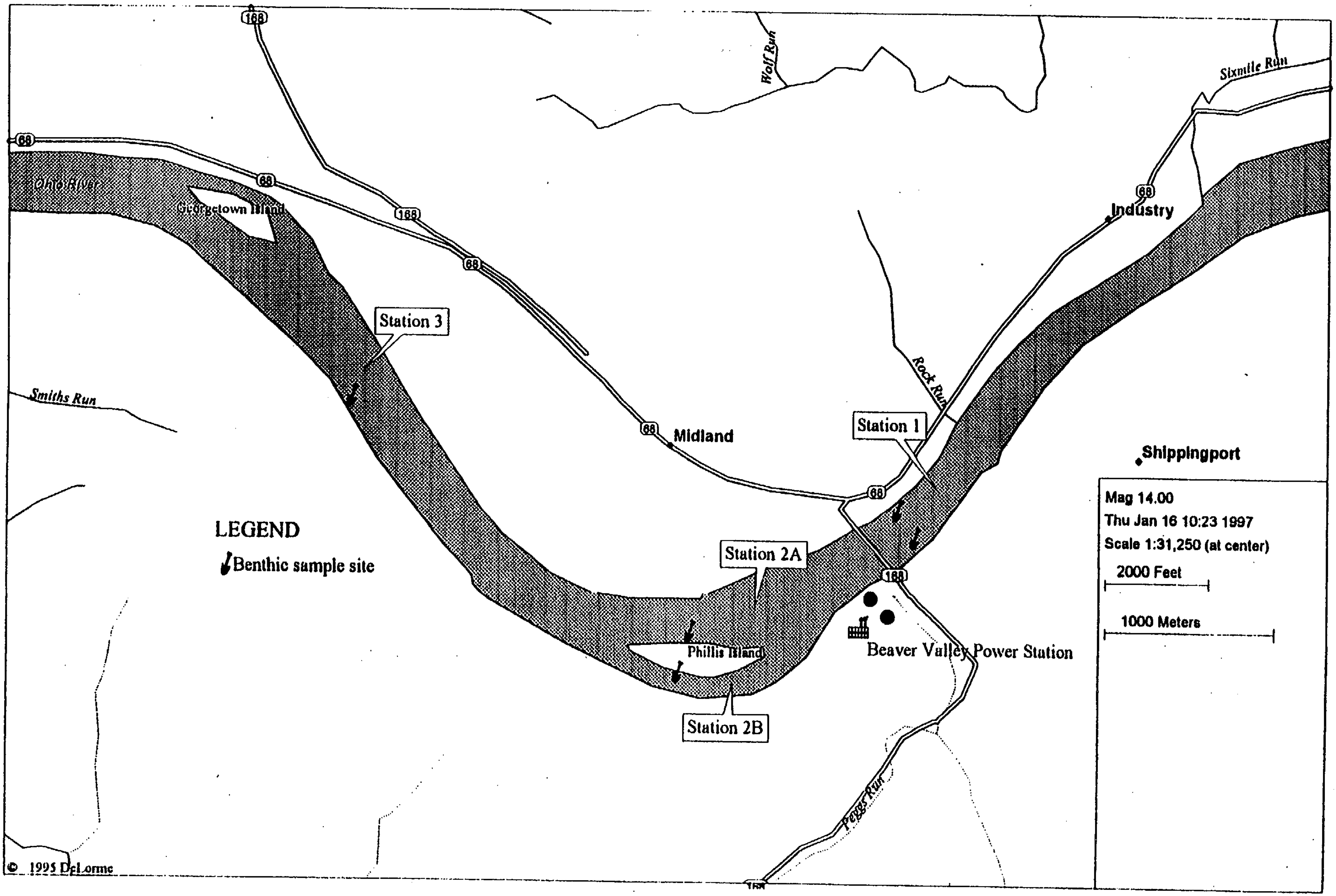



**FIGURE 1.2**
**LOCATION MAP FOR BEAVER VALLEY POWER STATION BENTHIC ORGANISM SURVEY SAMPLING SITES FOR THE 1999 STUDY**

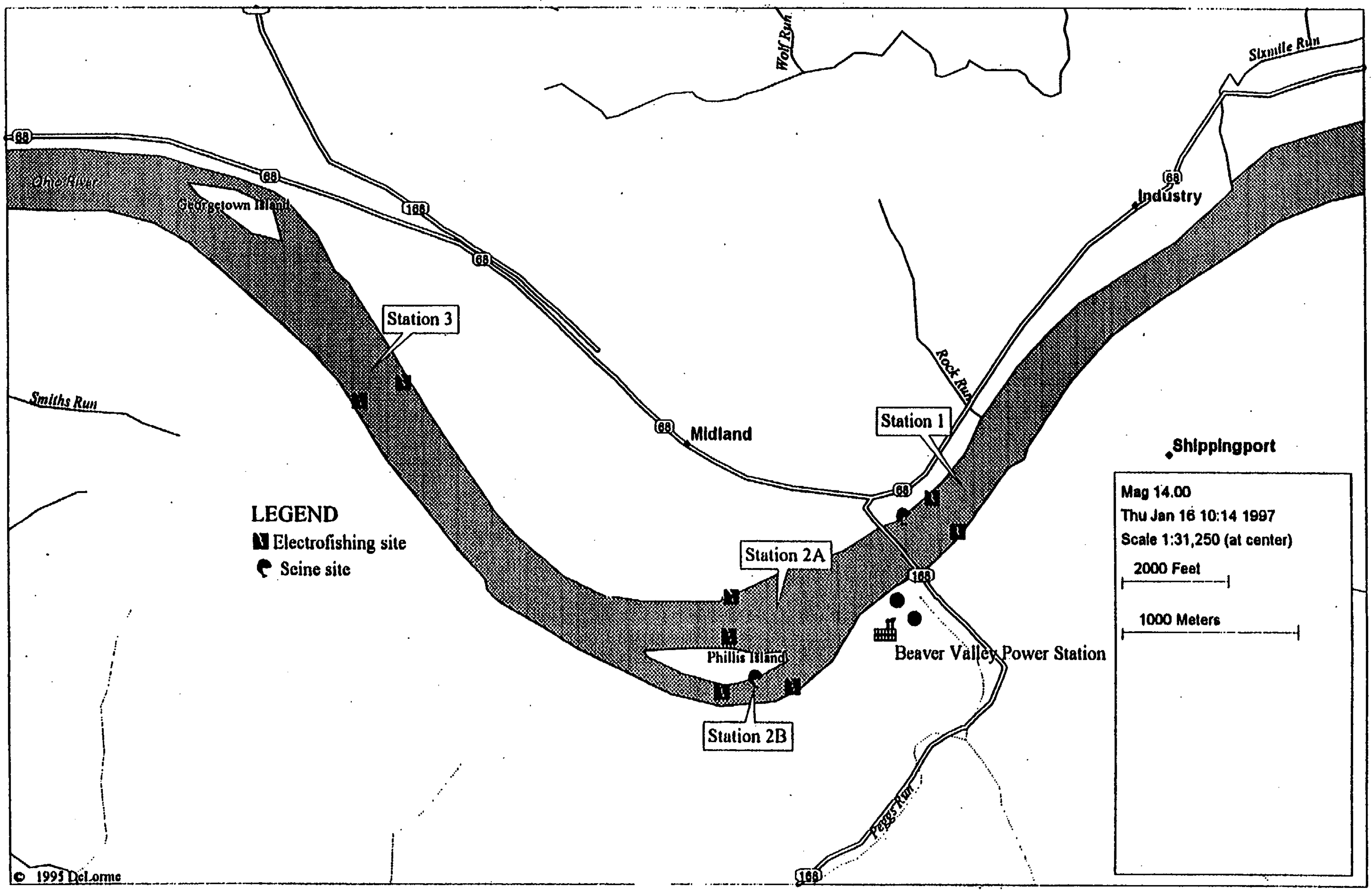



**FIGURE 1.3**
**LOCATION MAP FOR THE BEAVER VALLEY POWER STATION FISH POPULATION SURVEY**
**FISH SAMPLING SITES FOR THE 1999 STUDY**

DUQUESNE LIGHT COMPANY
ANNUAL ENVIRONMENTAL REPORT

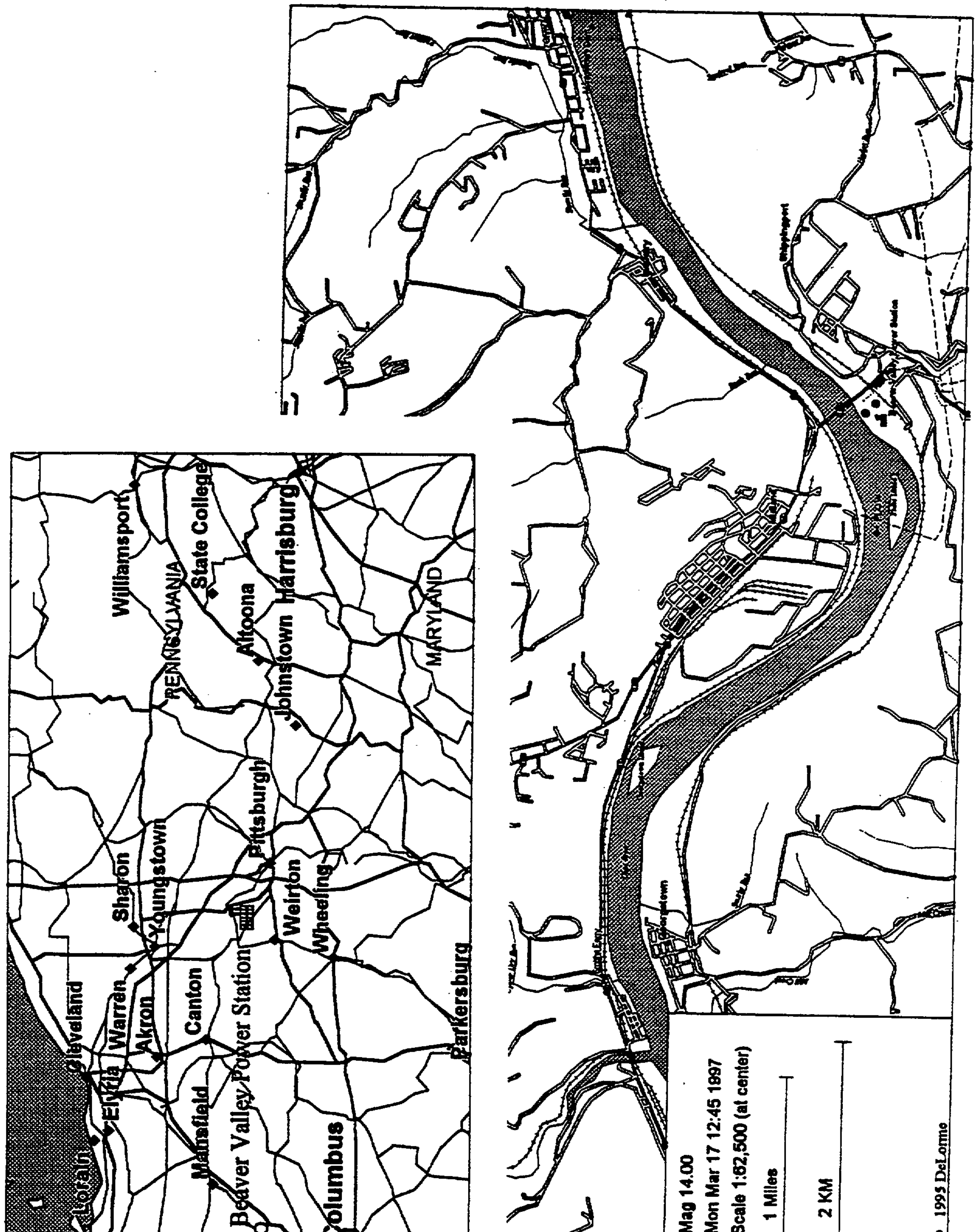
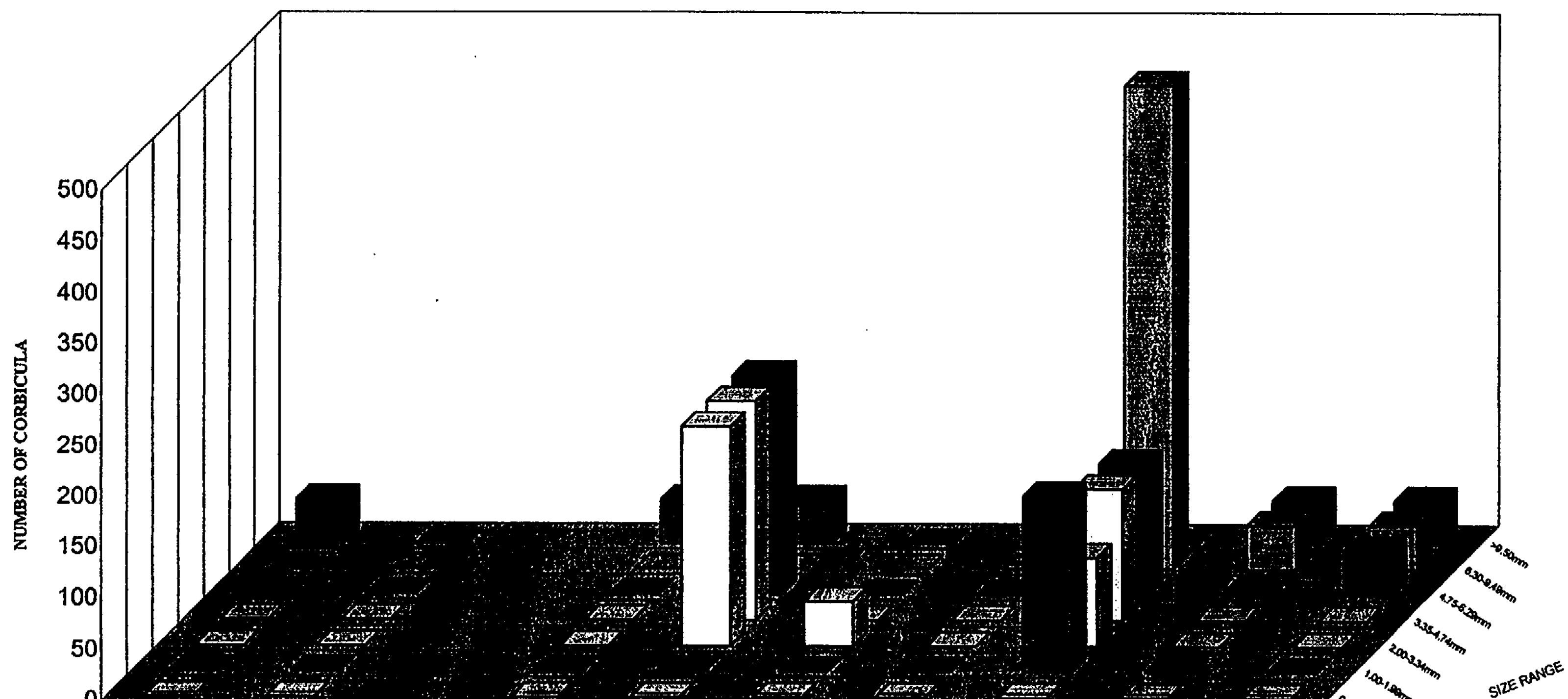



FIGURE 1.4
LOCATION OF STUDY AREA, BEAVER VALLEY POWER STATION
SHIPPINGPORT, PENNSYLVANIA
BVPS

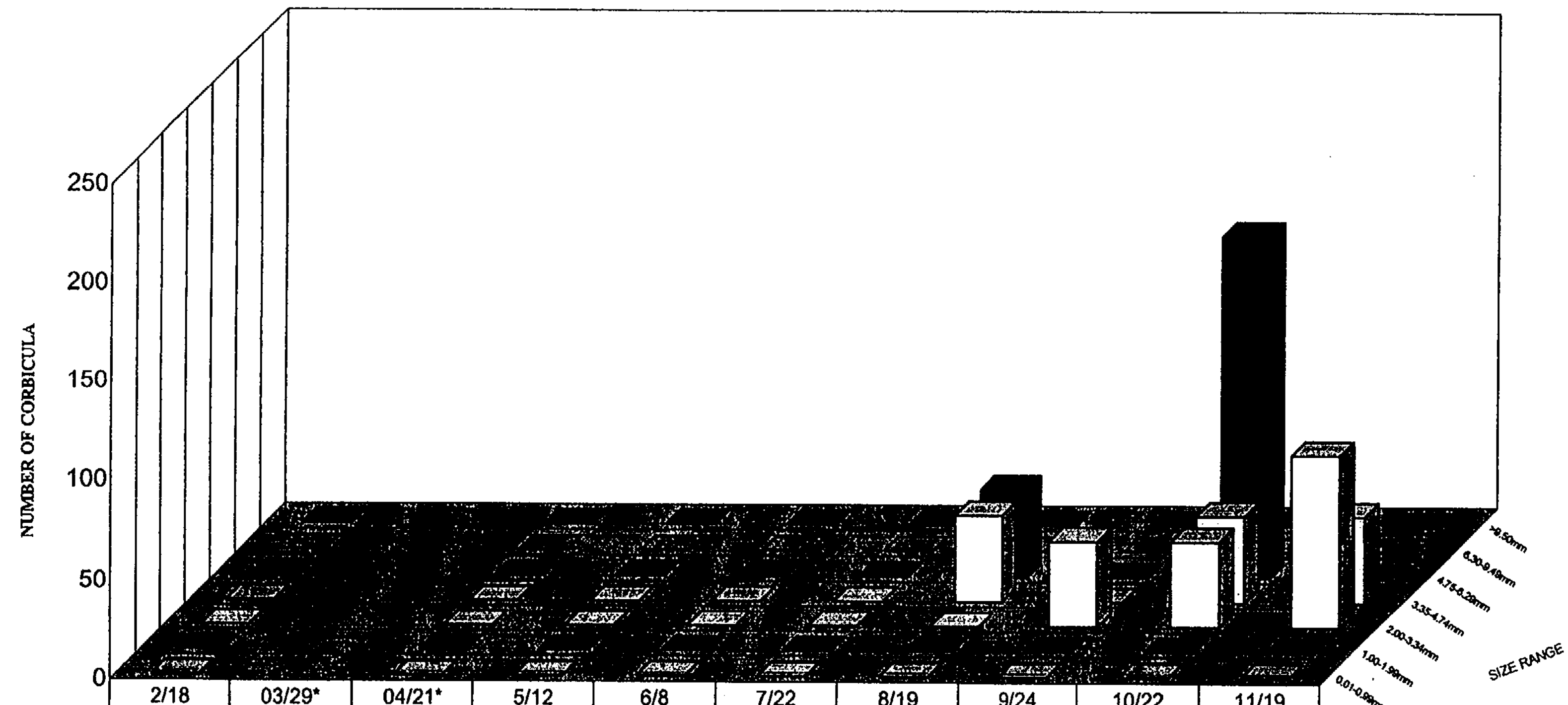
**Comparison of live Corbicula clam density estimates among 1999 BVPS Unit 1 cooling tower reservoir sample events, for various clam shell groups.ture sample events, for various shell size groups**




| | 2/18 | 3/29 | 4/21 | 5/12 | 6/8 | 7/22 | 8/19 | 9/24 | 10/22 | 11/19 |
|---|---|---|---|---|---|---|---|---|---|---|
| □0.01-0.99mm | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ■1.00-1.99mm | 0 | 0 | | 0 | 0 | 0 | 0 | 172 | 0 | 0 |
| □2.00-3.34mm | 0 | 0 | | 0 | 215 | 43 | 0 | 86 | 0 | 0 |
| □3.35-4.74mm | 0 | 0 | | 0 | 215 | 0 | 0 | 129 | 0 | 0 |
| ■4.75-6.29mm | 0 | 0 | | 0 | 215 | 0 | 0 | 129 | 0 | 43 |
| ⊡6.30-9.49mm | 0 | 0 | | 0 | 0 | 0 | 0 | 473 | 43 | 43 |
| ■>9.50mm | 43 | 0 | | 43 | 43 | 0 | 0 | 0 | 43 | 43 |
| Total #/m2 | 43 | 0 | 0 | 43 | 688 | 43 | 0 | 989 | 86 | 129 |
| TOTAL | 628 | 0 | 0 | 628 | 10045 | 628 | 0 | 14439 | 1256 | 129 |

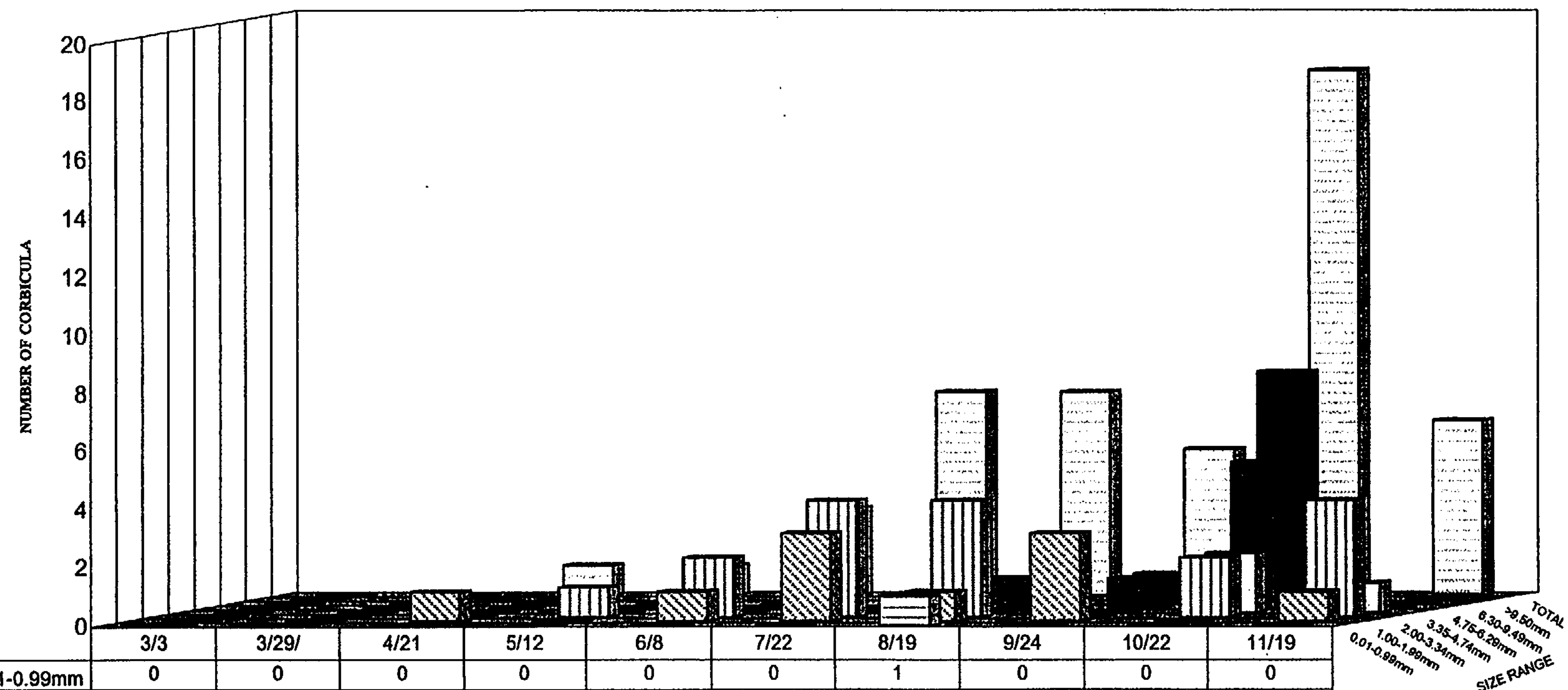
Figure 2.1

## Comparison of live Corbicula clam density estimates among 1999 BVPS Unit 2 cooling tower reservoir sample events, for various clam shell groups.ture sample events, for various shell size groups




| | 2/18 | 03/29* | 04/21* | 5/12 | 6/8 | 7/22 | 8/19 | 9/24 | 10/22 | 11/19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.01-0.99mm | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.00-1.99mm | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.00-3.34mm | 0 | | 0 | 0 | 0 | 0 | 0 | 43 | 43 | 86 |
| 3.35-4.74mm | 0 | | 0 | 0 | 0 | 0 | 43 | 0 | 43 | 43 |
| 4.75-6.29mm | 0 | | 0 | 0 | 0 | 0 | 43 | 0 | 172 | 0 |
| 6.30-9.49mm | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| >9.50mm | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total #/m2 | 0 | 0 | 0 | 0 | 0 | 0 | 86 | 43 | 258 | 129 |
| TOTAL | 0 | 0 | 0 | 0 | 0 | 0 | 1109 | 555 | 3328 | 1664 |

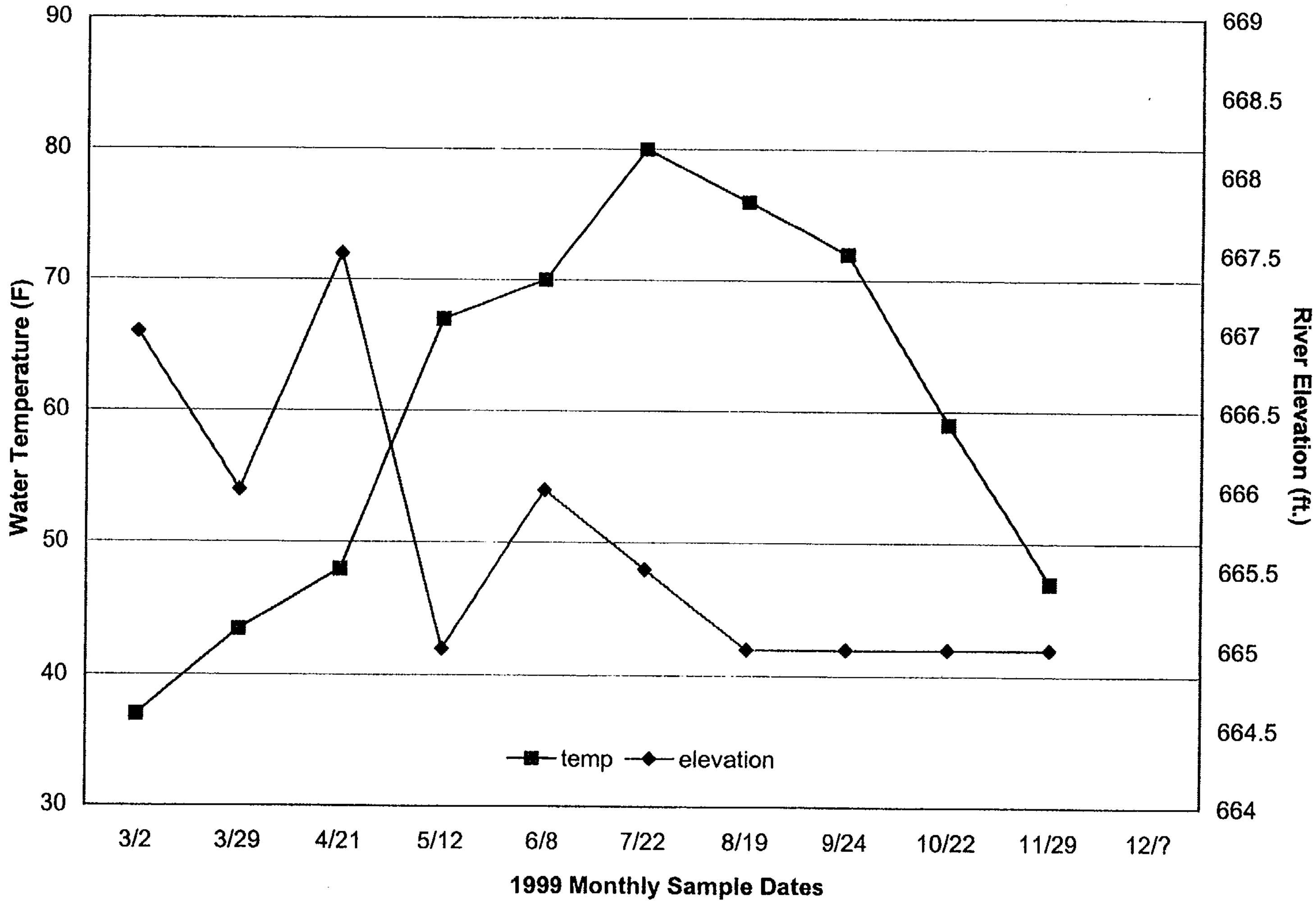
Figure 2.2




| | 3/3 | 3/29/ | 4/21 | 5/12 | 6/8 | 7/22 | 8/19 | 9/24 | 10/22 | 11/19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.01-0.99mm | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1.00-1.99mm | 0 | 0 | 1 | 0 | 1 | 3 | 1 | 3 | 0 | 1 |
| 2.00-3.34mm | 0 | 0 | 0 | 1 | 2 | 4 | 4 | 0 | 2 | 4 |
| 3.35-4.74mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| 4.75-6.29mm | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 0 |
| 6.30-9.49mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 0 |
| >9.50mm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| TOTAL | 0 | 0 | 1 | 1 | 3 | 7 | 7 | 5 | 18 | 6 |

**Comparison of live Corbicula clam density estimates among 1999 intake structure sample events, for various shell size groups**

Figure 2.3




**Water Temperature and River Elevation Recorded at the Ohio River at BVPS Intake Structure During the 1999 Monthly Sampling**

**Figure 2.4**