1989 ANNUAL ENVIRONMENTAL REPORT
NON-RADIOLOGICAL
DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
UNITS NO. 1 & 2

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DUQUESNE LIGHT COMPANY
1989 ANNUAL ENVIRONMENTAL REPORT

I. INTRODUCTION

This report presents a summary of the Non-Radiological Environmental Program conducted by Duquesne Light Company (DLC) during calendar year 1989, for the Beaver Valley Power Station (BVPS) Units 1 and 2, Operating License Numbers DPR-66 and NPF-73. This is primarily an optional program, since the Nuclear Regulatory Commission (NRC) on February 26, 1980, granted DLC's request to delete all of the aquatic monitoring program, with the exception of fish impingement (Amendment No. 25), from the Environmental Technical Specifications (ETS), and in 1983, dropped the fish impingement studies from the ETS program of required sampling along with non-radiological water quality requirements. However, in the interest of providing a non-disruptive data base DLC is continuing the Aquatic Monitoring Studies.

A. SCOPE AND OBJECTIVES OF THE PROGRAM

The objectives of the 1989 environmental program were:

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

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

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

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

B. SITE DESCRIPTION

BVPS is located on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania, on a 501 acre tract of land. The Shippingport Station once shared the site with BVPS before being decommissioned. Figure I-1 shows an aerial view of BVPS. The site is approximately 1 mile (1.6 km) from Midland, Pennsylvania; 5 miles (8 km) from East Liverpool, Ohio; and 25 miles (40 km) from Pittsburgh, Pennsylvania. Figure I-2 shows the site location in relation to the principal population centers. Population density in the immediate vicinity of the site is relatively low. The population within a 5 mile (8 km) radius of the plant is approximately 18,000 and the only area of concentrated population is the Borough of Midland, Pennsylvania, which has a population of approximately 4,000.

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

The station is situated on the Ohio River at river mile 34.8, at a location on the New Cumberland Pool that is 3.3 river miles (5.3 km) downstream from Montgomery Lock and Dam and 19.4 miles (31.2 km) upstream from New Cumberland Lock and Dam. The Pennsylvania-Ohio-West Virginia border is 5.2 river miles (8.4 km) downstream from the site. The river flow is regulated by a series of dams and reservoirs on the Beaver, Allegheny, Monongahela, and Ohio Rivers and their tributaries. Flow generally varies from 5,000 to 100,000 cubic feet per second (cfs). The range of flows in 1989 is shown on Figure I-3 as well as Table I-1.

Ohio River water temperatures generally vary from 32° to 82°F (0° to 28° C). Minimum and maximum temperatures generally occur in January and July/August, respectively. During 1989, minimum temperatures were observed in December/January and maximum temperatures in August (Figures I-3 and Table I-1).

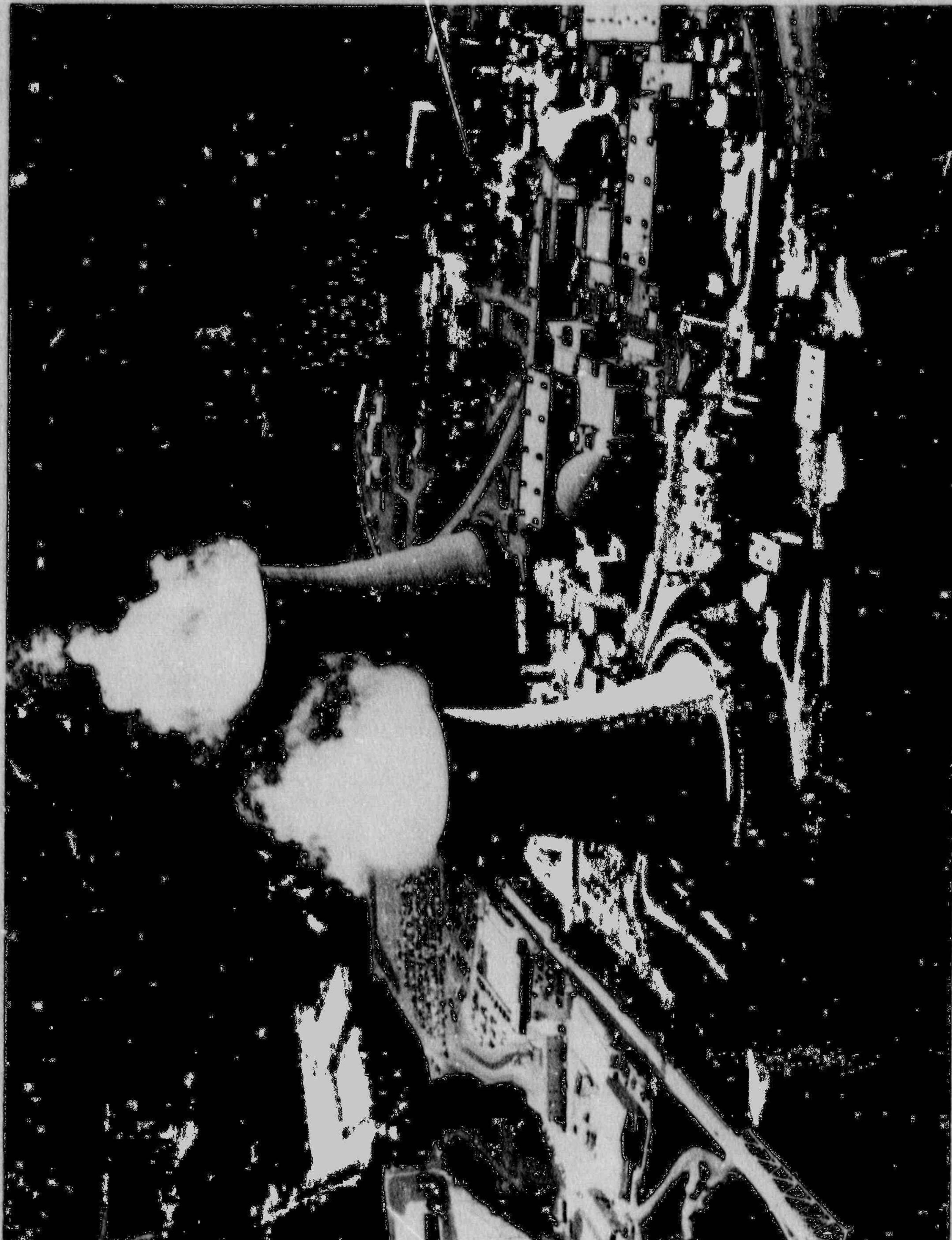


FIGURE I-1

VIEW OF THE BEAVER VALLEY POWER STATION
BVPS

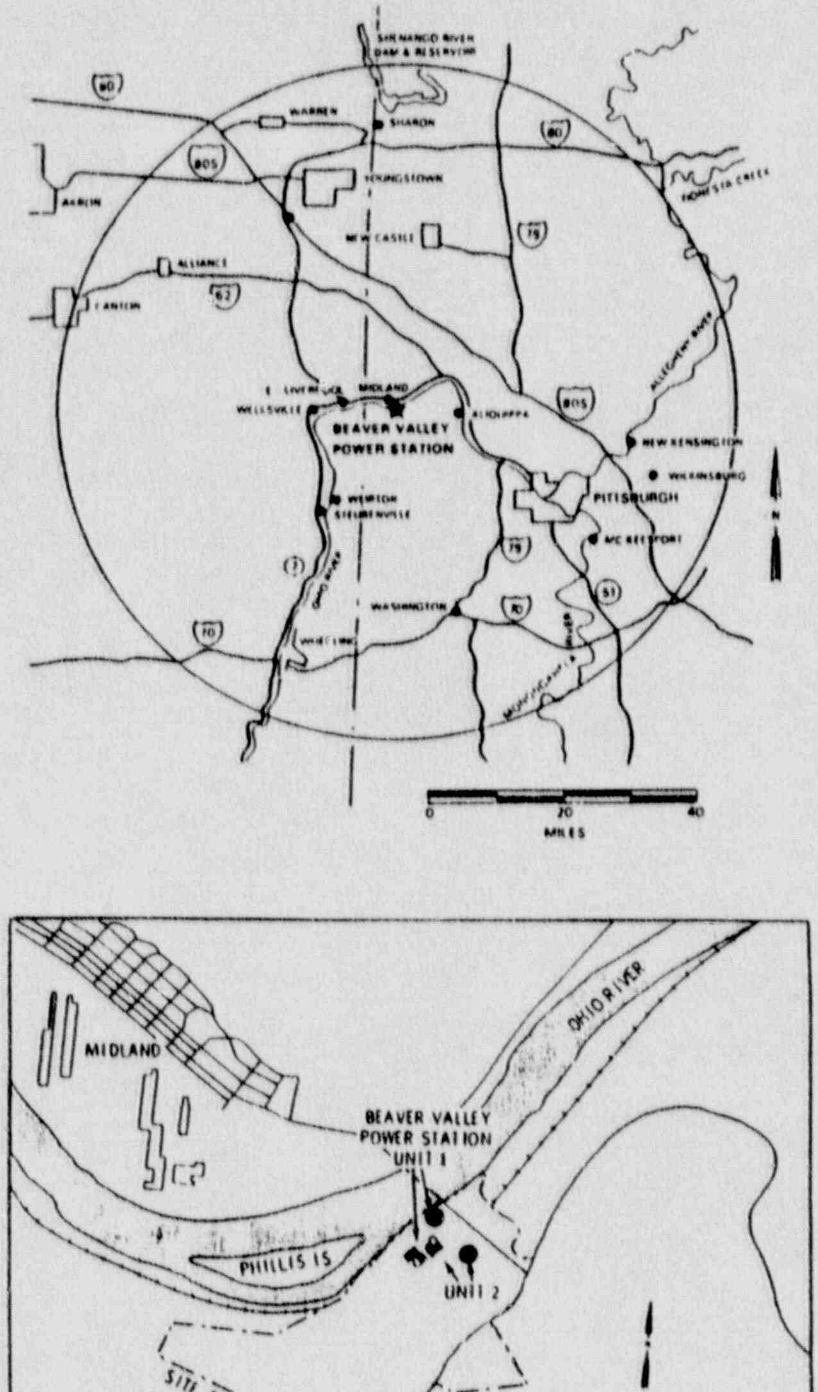
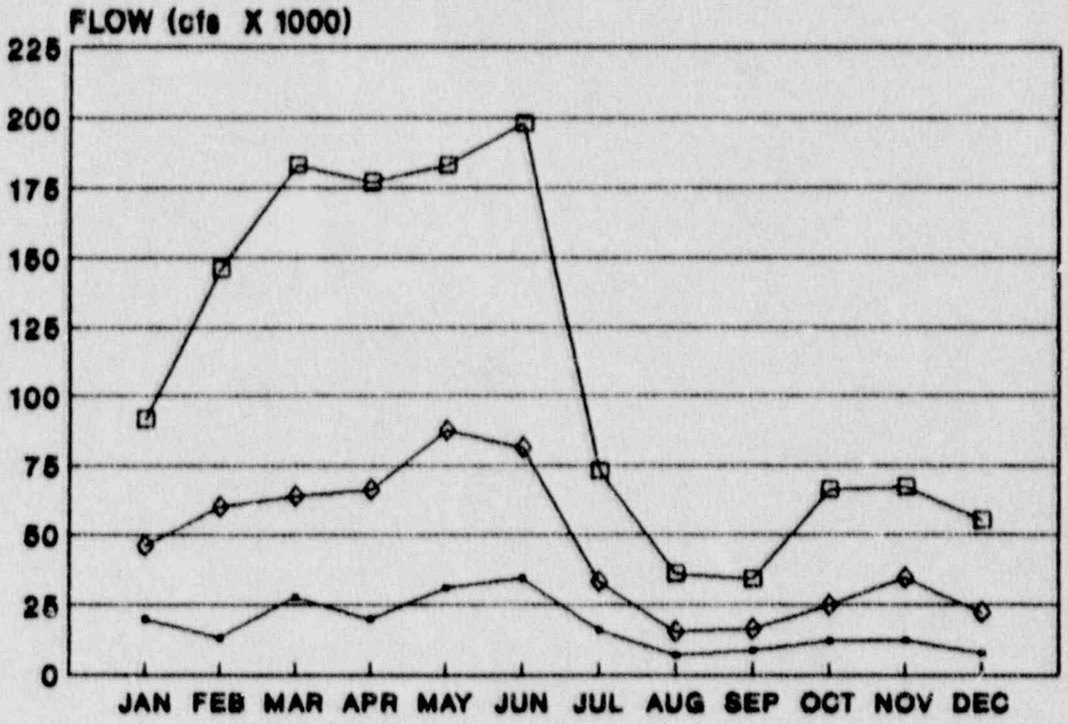


FIGURE I-2

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



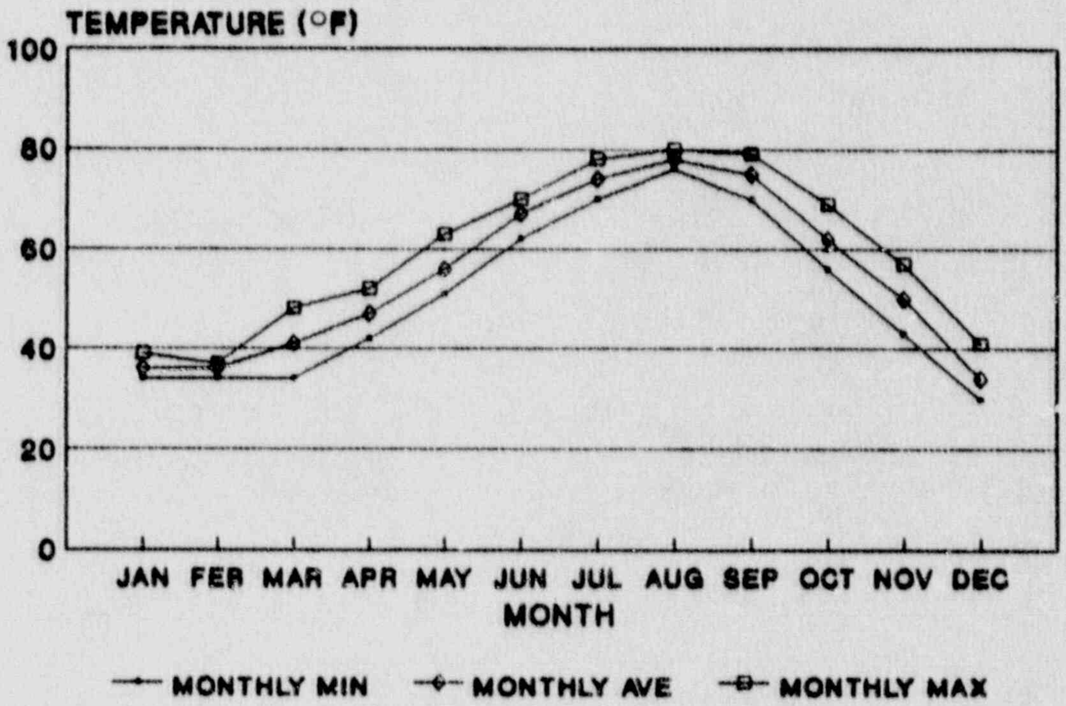


FIGURE I-3

OHIO RIVER FLOW (cfs) AND TEMPERATURE (°F)
RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS
FOR THE NEW CUMBERLAND POOL, 1989
BVPS

TABLE I-1

OHIO RIVER FLOW (cfs) AND TEMPERATURE (°F) RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS FOR THE NEW CUMBERLAND POOL, 1989, BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow (cfs x 10^3)												
Monthly Maximum	91.5	146.0	183.0	177.0	183.0	198.0	73.0	36.0	34.0	66.0	67.0	55.0
Monthly Average	46.1	59.9	63.8	66.2	87.3	81.4	23.1	15.5	16.4	24.6	34.3	22.3
Monthly Minimum	20.0	13.0	27.5	20.0	31.0	34.5	16.0	7.0	8.5	12.0	12.5	7.5
Temperature (°F)												
Monthly Maximum	39	37	48	52	63	70	78	80	79	69	57	41
Monthly Average	36	36	41	47	56	67	74	78	75	62	50	34
Monthly Minimum	34	34	34	42	51	62	70	76	70	56	43	30

BVPS Units 1 and 2 have a thermal rating of 2,660 megawatts (Mw). Units 1 and 2 have a 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 Ohic River. Commercial operation of BVPS Unit 1 began in 197C and Unit 2 began in 1987.

II. SUMMARY AND CONCLUSIONS

The 1989 BVPS Units 1 and 2 Non-Radiological Environmental Monitoring Program included surveillance and field sampling of Ohio River aquatic life. This is the fourteenth year of operational monitoring for Unit 1 and the second for Unit 2 and, as in the previous operational monitoring years, no evidence of adverse environmental impact to the aquatic life in the Ohio River near BVPS was observed.

The Aquatic Environmental Monitoring Program included studies of: benthos, fish, ichthyoplankton, impingement, plankton entrainment, and Corbicula. Sampling was conducted for benthos and fish upstream and downstream of the plant during 1989 to assess potential impacts of BVPS discharges. These data were also compared to preoperational and other operational data to assess long term trends. Impingement and entrainment data were examined to determine the impact of withdrawing river water for in-plant use. Corbicula studies were initiated to determine the presence of these clams in the Ohio River and their growth and reproduction inside the plant. The following paragraphs summarize these findings:

BENTHOS. Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft muck-type substrates along the shoreline were conducive to worm and midge proliferation, while limiting macroinvertebrates which require a more stable bottom. At the shoreline stations, Oligochaeta accounted for 89% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 6% and 3%, respectively. Community structure has changed little since preoperational years and there was no evidence that BVPS operations were affecting the benthic community of the Ohio River.

PHYTOPLANKTON. The phytoplankton community of the Ohio River near BVPS during 1989, exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. Total cell densities and diversity indices were within the range observed during previous years. Diatoms, green algae, and microflagellates were the most abundant groups in the phytoplankton during 1989.

ZOOPLANKTON. Zooplankton densities throughout 1989 were typical of the temperate zooplankton community found in large river habitats. Populations developed the highest densities in September. Except during August, protozoans and rotifers were always predominant. Common and abundant taxa observed in 1989 were similar to those reported during preoperational and other operational years. Based on the data collected during the fourteen operating years (1976 through 1989) and the three preoperational years (1973 through 1975), it is concluded that the overall abundance and species composition of the zooplankton in the Ohio River near BVPS has remained stable and possibly improved slightly over the seventeen year period from 1973 to 1989. Increased turbidity and current from high water conditions have the strongest effects of delaying the population peaks and temporarily decreasing total zooplankton densities in the Ohio River near BVPS.

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

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

Differences in the 1989 electrofishing and gill net catches, between the Control and Non-Control Transects were similar to previous years (both operational and preoperational) and were probably caused by habitat preferences of individual species. This habitat preference is probably the most influential factor that affects where the different species of fish are collected and in what relative abundance.

Data collected from 1970 through 1989 indicate that fish in the vicinity of the power plant have not been adversely affected by BVPS operation.

ICHTHYOPLANKTON. Gizzard shad, and freshwater drum dominated the 1989 ichthyoplankton catch from the back channel of Phillis Island. Peak densities occurred in July and consisted mostly of eggs. No spawning was noted in April. The month of May showed little spawning activity. There was a decrease in larvae density after July.

FISH IMPINGEMENT. The results of the 1989 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has very little effect on the fish populations. Five hundred and fifty (550) fishes were collected, which was the fourth highest annual collection since initial operation of BVPS in 1976. Gizzard shad were the most numerous fish, comprising 79.5% of the total annual catch. The total weight of all fishes collected in 1989 was 4.05 kg (8.9 lbs). Of the 550 fishes collected, 41 (7.5%) were alive and returned via the discharge pipe to the Ohio River.

PLANKTON ENTRAINMENT. Entrainment studies were performed to investigate the impact on the plankton community by withdrawing river water for in-plant use. Entrainment-river transect surveys for ichthyoplankton were conducted to ascertain any changes in spawning activity occurring in the

Ohio River adjacent to the BVPS intake. The greatest abundance of ichthyoplankton collected occurred during the month of July. Assuming actual entrainment rates were similar to those found in 1976 through 1979, and adjusting for the water withdrawn for Unit 2 no substantial entrainment losses should have occurred in 1989 due to the operation of BVPS. Assessment of monthly phytoplankton and zooplankton data of past years indicated that under conditions of minimum low river flow, approximately 5% of the phytoplankton and zooplankton passing the intake would be withdrawn by the BVPS circulating water system. This is considered to be a negligible loss of phytoplankton and zooplankton relative to the river populations.

Corbicula MONITORING PROGRAM. The results of the 1989 Corbicula Monitoring Program show that no live clams were collected from the upper reservoir of Unit 1 cooling tower. Since the water entering this area comes directly from the condensers, it is suspected that elevated water temperatures make this area unsuitable for the clams. The Corbicula population in the lower reservoir was estimated at 300 million (98% alive) at the time of the September 7 survey. The estimated population of Corbicula in the Unit 2 reservoir on March 21 was 18.5 million (42% alive).

The river surveys conducted in 1989 demonstrate that Corbicula inhabiting the upper Ohio drainage provides an extremely large number of clams to the BVPS. Cleaning of the intake bays by divers resulted in removing many live clams from the innerbays; this along with the weekly impingement data show that adult clams move into the plant with the water currents.

The results of the growth study obtained show that growth of Corbicula was initially more rapid in the cooling tower than in the intake structure. Growth was more uniform for clams held in the cooling tower.

The period of potential larvae release from gravid adult clams occurred in late June through September 1989 in the intake structure. Unit 1 cooling tower had a larval release period in the month of August.

Results of the larval cage study for the intake structure indicated that spawning activity in the Ohio River occurred from August through December of 1989. Chlorination of the cooling tower water may be a factor in the larvae study results.

III. ANALYSIS OF SIGNIFICANT ENVIRONMENTAL CHANGE

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

IV. MONITORING NON-RADIOLOGICAL EFFLUENTS

A. MONITORING CHEMICAL EFFLUENTS

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

B. HERBICIDES

Monitoring and reporting of herbicides used for weed control during 1989, is no longer required as stated in Amendment No. 64; thus, this information is not included in this report.

V. AQUATIC MONITORING PROGRAM

A. INTRODUCTION

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

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

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

B. BENTHOS

Objectives

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

Methods

Benthic surveys were performed in May and September, 1989. Benthos samples were collected at Transects 1, 2A, 2B, and 3 (Figure V-B-1), using a Ponar grab sampler. Duplicate samples were taken off the south shore at Transects 1, 2A, and 3. Sampling at Transect 2B, in the back channel of Phillis Island, consisted of a single Ponar grab at the south, middle and north side of the channel.

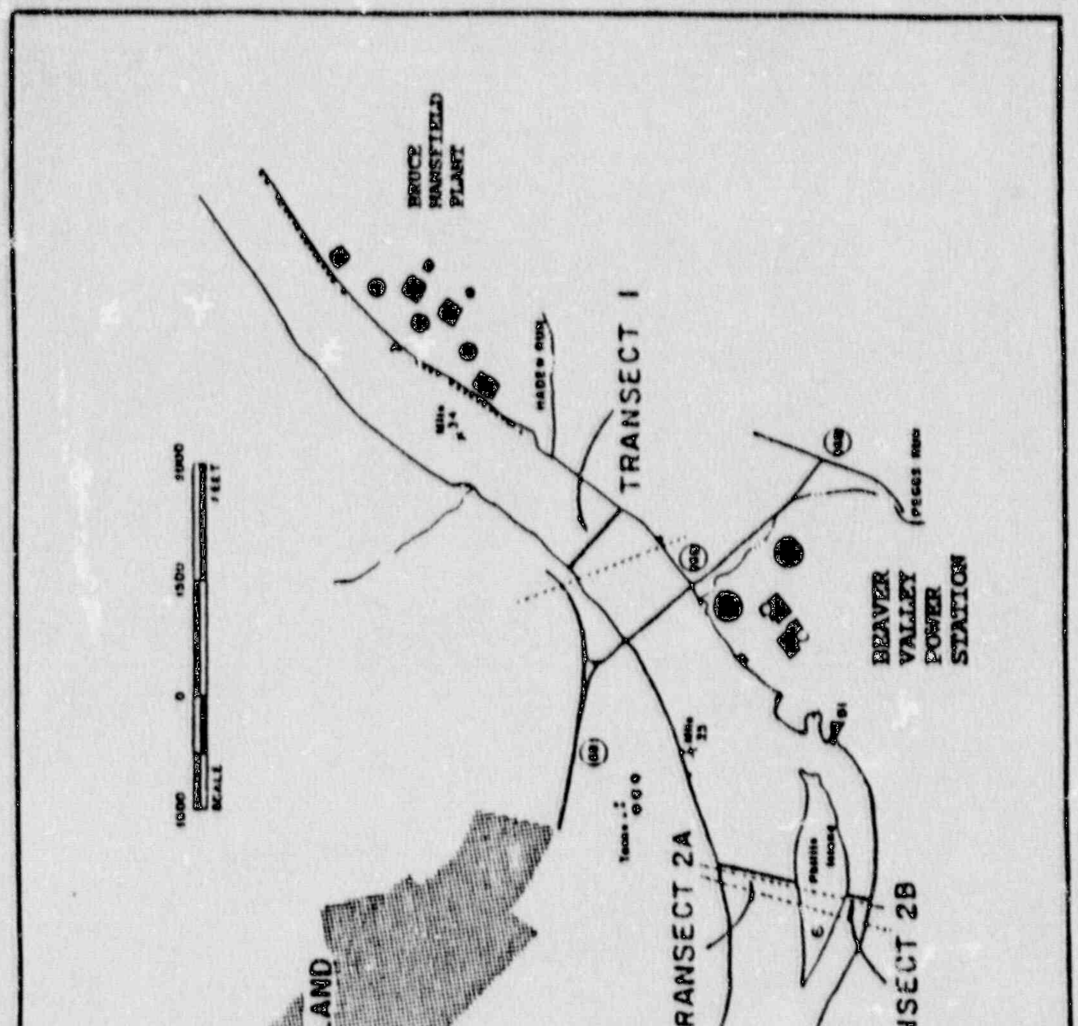


FIGURE V-A-1

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

TABLE V-A-1

AQUATIC MONITORING PROGRAM SAMPLING DATES
1989 BVPS

Month	Benthos	*Corbicula* Monitoring[a]	Fish	Impingement	Ichthyoplankton Day	Ichthyoplankton Night	Phyto- and Zooplankton
January		13, 27		6, 13, 20, 27			13
February		10, 17, 24		3, 10			24
March		10, 17, 20, 21, 22		3, 10, 17, 24			17
April		7, 14, 21		7, 14, 21, 28,	13		14
May	23	5, 12, 19, 23	23, 24	5, 12	23	24	19
June		2, 16, 30		2, 9, 16, 23, 30	19		16
July		13, 28	12, 13	7, 14, 21, 28	12	13	13
August		11, 18, 25		4, 11, 18, 25	15		18
September	14	6, 7, 8, 14, 15, 22	18, 19	1, 8, 15, 22, 29			15
October		6, 13, 20		6, 13, 20, 27			13
November		2, 10, 17	6, 7	24			17
December		1, 15, 29		29			15

[a] *Corbicula* Monitoring also includes all Impingement dates.

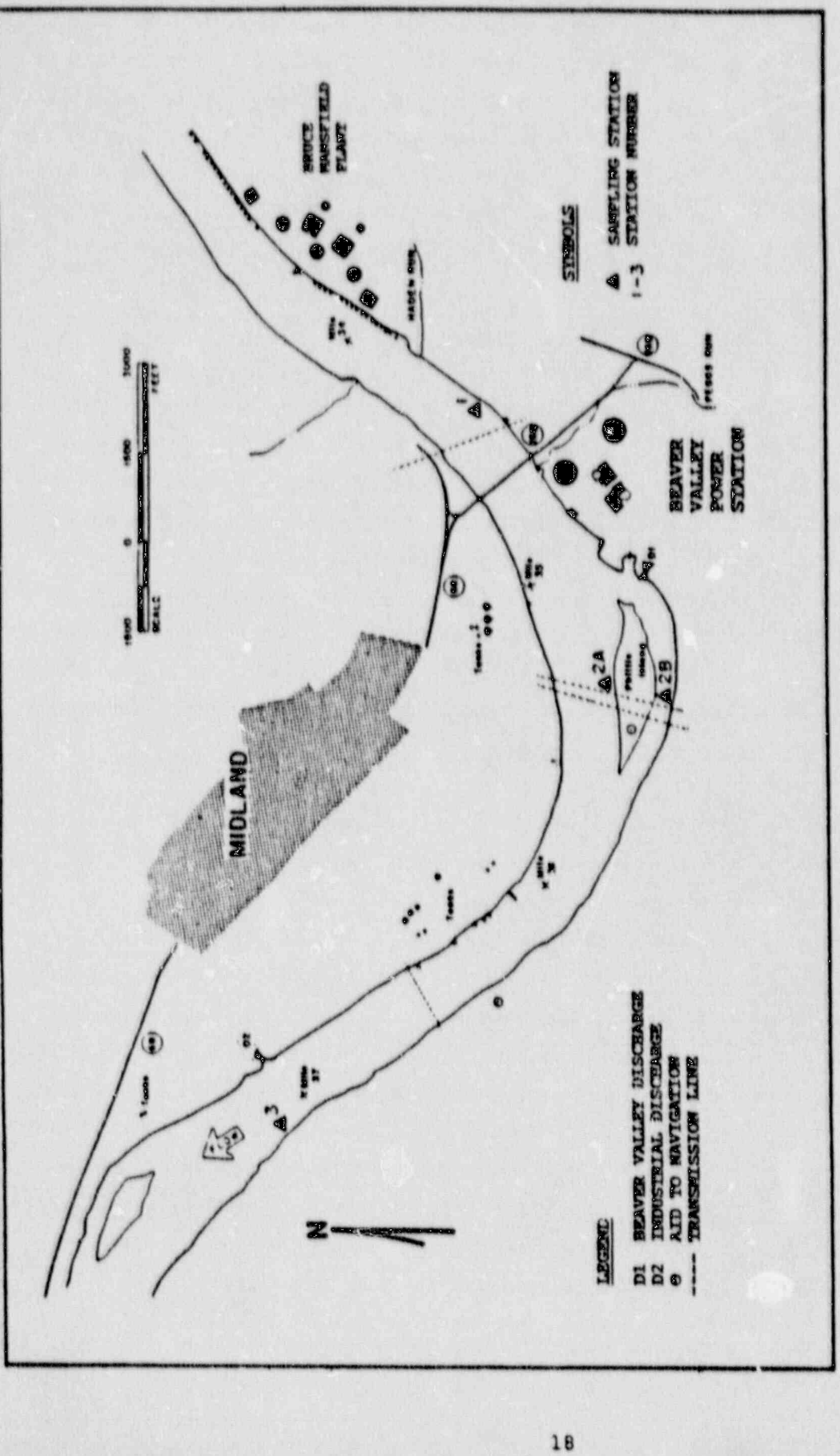


FIGURE V-B-1

BENTHOS SAMPLING STATIONS
BVPS

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

Habitats

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

Fifty macroinvertebrate taxa were identified during the 1989 Monitoring Program (Table V-B-1). Species composition during 1989 was similar to that observed during previous preoperational (1973 through 1975) and operational (1976 through 1988) years. However, three new taxa (Nais behningi, Pristina longisoma, and Asellus sp.) were encountered during 1989. The macroinvertebrate assemblage during 1989 was composed primarily of burrowing organisms typical of soft unconsolidated substrates. Oligochaetes (worms) and chironomid (midge) larvae were abundant (Tables V-B-2, V-B-3, and V-B-4). Common genera of oligochaetes were Limnodrilus, Nais, and Paranais. Common genera of chironomids were Cryptochironomus, Polypedilum, and Chironomus. The Asiatic clam (Corbicula), was collected from 1974 through 1978, and 1981 through 1989 surveys. None were collected during 1979 or 1980 surveys.

TABLE V-B-1

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

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

TABLE V-B-1
(Continued)

	Preoperational			Operational													
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
N. variabilis						X							X			X	X
Nais sp.	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Ophidonais serpentina								X		X			X		X	X	X
Paranais frici	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Paranais sp.							X										
Pristina longisoma																	X
P. osborni				X			X					X		X	X		
P. sima				X						X	X		X		X		X
Pristina sp.				X											X		
Slavina appendiculata					X												
Stephensoniana trivandrana				X	X	X			X	X		X					
Stylaria fossularis																X	
S. lacustris				X						X		X	X				
Uncinais uncinata			X														
Vejdovskyella intermedia											X		X		X		X
Vejdovskyella sp.																X	
Tubificidae																	
Aulodrilus limnobius	X	X	X	X	X	X	X	X	X				X	X			X
A. pigueti	X		X	X	X	X	X	X	X	X	X	X		X	X		
A. pluriseta	X			X	X	X	X	X		X	X				X		X
Borthrioneurum vejdovskyanum				X	X	X	X	X		X							
Branchiura sowerbyi		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ilyodrilus templetoni	X	X	X	X	X	X	X	X	X	X		X					
Limnodrilus cervix	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. cervix (variant)	X	X	X	X		X		X	X	X			X				
L. claparedeianus	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X
L. hoffmeisteri	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. spiralis		X	X			X											
L. udekemianus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Limnodrilus sp.						X											
Peloscolex multisetosus longidentus		X			X	X	X										
P. m. multisetosus	X	X	X	X	X	X	X	X	X	X	X		X		X		
Potamothrix moldaviensis	X								X	X							
P. vejdovskyi											X	X	X		X	X	X
Psammoryctides curvisetosus		X															
Tubifex tubifex	X	X			X	X	X	X									
Unidentified immature forms:																	
with hair chaetae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
without hair chaetae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lumbriculidae																	
Hirudinea																	
Glossiphoniidae																	X
Helobdella elongata										X	X						
H. stagnalis				X													
Helobdella sp.	X																
Erpobdellidae																	
Erpobdella sp.	X																
Mooreobdella microstoma		X				X											

TABLE V-B-1
(Continued)

	Preoperational			Operational													
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Arthropoda																	
Acarina				X		X		X		X	X					X	
Ostracoda				X	X	X											
Isopoda																	
Asellus sp.																	X
Amphipoda																	
Talitridae																	
Hyallela azteca						X	X										
Gammaridae																	
Crangonyx pseudogracilis		X															
Crangonyx sp.		X															
Gammarus fasciatus						X		X		X							
Gammarus sp.	X	X		X		X	X	X	X	X	X	X	X	X	X		X
Decapoda							X										
Collembolla		X															
Ephemeroptera																	
Heptageniidae	X		X														
Stenacron sp.				X							X						
Stenonema sp.								X									
Ephemeridae																	
Hexagenia sp.												X		X	X	X	X
Baetidae																	X
Caenidae																	
Caenis sp.				X			X									X	
Tricorythodes sp.	X																
Ephemeridae																	
Ephemera sp.							X										
Megloptera																	
Sialis sp.							X										
Odonata																	
Gomphidae																	
Dromogomphus spoliatus		X															
Dromogomphus sp.							X										
Gomphus sp.		X				X	X	X					X				
Libellulidae																	
Libellula sp.																X	
Trichoptera																	
Hydropsychidae							X										
Cheumatopsyche sp.	X			X													
Hydropsyche sp.						X											
Hydroptilidae																	
Hydroptila sp.						X											
Oxyethira sp.	X																
Leptoceridae																	
Oecetis sp.		X		X						X	X		X	X			X
Polycentropodidae																	
Polycentropus sp.						X											X

TABLE V-B-1
(Continued)

	Preoperational			Operational													
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Coleoptera		X														X	
Hydrophilidae						X											
Elmidae																	
Ancyronyx variegatus						X											
Dubiraphia sp.	X	X				X											
Helichus sp.	X																
Stenelmis sp.	X				X	X											
Psephenidae																	
Diptera																	
Unidentified Diptera		X		X	X	X	X	X				X	X		X	X	
Psychodidae				X													
Pericoma sp.						X											
Psychoda sp.						X											
Telmatoscopus sp.		X															
Unidentified Psychodidae pupae						X											
Chaoboridae																	
Chaoborus sp.	X	X	X	X		X	X		X								
Simulidae																	
Similium sp.				X													
Chironomidae																	
Chironominae							X						X				
Chironominae pupa							X			X	X		X		X	X	X
Chironomus sp.		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Cladopelma sp.											X		X	X			
Cryptochironomus sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dicrotendipes nervosus	X																
Dicrotendipes sp.	X	X		X							X				X		X
Glyptotendipes sp.						X	X				X						
Harnischia sp.		X	X	X		X	X	X	X	X	X	X		X	X		X
Micropsectra sp.				X													
Microtendipes sp.						X											
Parachironomus sp.		X										X					
Polypedilum (s.s.) convictum type						X											
P. (s.s.) simulans type						X											
Polypedilum sp.	X	X					X			X	X	X	X	X	X	X	X
Rheotanytarsus sp.	X				X	X	X		X		X		X		X	X	
Stenochironomus sp.		X			X	X		X									
Stictochironomus sp.				X													
Tanytarsus sp.			X			X	X			X	X			X		X	
Xenochironomus sp.												X					
Tanypodinae																	
Tanypodinae pupae													X		X		
Ablabesmyia sp.	X	X		X								X					
Coelotanypus scapularis		X	X	X		X			X	X	X	X	X	X	X	X	X
Djalmabatista pulcher															X		
Procladius (Procladius)							X	X				X					
Procladius sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Thienemannimyia group	X		X		X	X	X										
Zavrelimyia sp.						X											

TABLE V-B-1
(Continued)

	Preoperational			Operational													
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Orthocladiinae							X										
Orthocladiinae pupae											X						
Cricotopus bici...us						X											
C. (s.s.) *trifascia*						X											
Cricotopus (*Isocladius*) *sylvestris* Group							X										
C. (*Isocladius*) sp.						X											
Cricotopus (s.s.) sp.	X	X		X		X					X				X		X
Eukiefferiella sp.					X	X	X										
Hydrobaenus sp.						X											
Limnophyes sp.						X											
Nannocladius (s.s.) *distinctus*			X	X	X	X			X								
Nannocladius sp.							X						X				
Orthocladius sp.	X	X	X	X	X		X			X	X	X					X
Parametriocnemus sp.		X				X											
Paraphaenocladius sp.						X	X										
Psectrocladius sp.	X	X															
Pseudorthocladius sp.						X											
Pseudosmittia sp.				X	X												
Smittia sp.		X			X	X	X	X									
Diamesinae																	
Diamesa sp.		X															
Potthastia sp.	X																
Ceratopogonidae	X	X		X	X	X				X	X	X		X	X		X
Dolichopodidae					X	X											
Empididae		X		X	X	X				X							
Wiedemannia sp.		X															
Ephydridae						X											
Muscidae				X	X												
Rhagionidae						X											
Tipulidae						X											X
Stratiomyiidae					X										X		X
Syrphidae						X											
Lepidoptera				X	X			X									
Mollusca																	
Gastropoda																	
Ancylidae																	
Ferrissia sp.	X	X			X	X											
Planorbidae							X										
Valvatidae																	
Valvata perdepressa																	
Pelecypoda							X										
Corbiculidae																	
*Corbicula manilensis**		X	X	X	X	X			X	X	X	X	X	X	X	X	X
Sphaeridae							X	X	X								
Pisidium sp.	X			X										X			X
Sphaerium sp.	X			X	X	X	X			X	X	X	X	X	X		X
Unidentified immature Sphaeriidae				X	X	X				X							
Unionidae																	
Anodonta grandis						X											
Elliptio sp.						X											
Unidentified immature Unionidae	X				X	X			X	X							

*Recent literature relegated all North American *Corbicula* to be *Corbicula fluminea*.

TABLE V-B-2

MEAN NUMBER OF MACROINVERTEBRATES (Number/m^2) AND PERCENT COMPOSITION
OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA AND OTHER ORGANISMS, 1989
BVPS

	STATION							
	1		2A		2B		3	
	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%
May 23								
Oligochaeta	3,390	98	0	0	1,827	78	3,471	93
Chironomidae	49	1	40	57	238	10	228	6
Mollusca	0	0	0	0	39	2	10	<1
Others	20	1	30	43	231	10	30	1
Totals	3,459	100	70	100	2,335	100	3,739	100
September 14								
Oligochaeta	1,440	92	20	14	3,586	85	2,198	91
Chironomidae	90	6	0	0	309	7	109	5
Mollusca	20	1	118	80	224	5	108	4
Others	10	1	10	7	93	2	10	<1
Totals	1,560	100	148	101	4,212	99	2,425	100

TABLE V-B-3

BENTHIC MACROINVERTEBRATE DENSITIES (Number/m^2), MEAN OF TRIPLICATE FOR BACK CHANNEL AND DUPLICATE SAMPLES COLLECTED IN THE MAIN CHANNEL OHIO RIVER, MAY 23, 1989
BVPS

Taxa	STATION 1	2A	2B	3
Nematoda				10
Ectoprocta unidentified	+		+	
Entoprocta				
Urnatella gracilis				+
Annelida				
Enchytraeidae			7	20
Oligochaeta eggs	+			+
Arcteonais lomondi	10			10
Dero sp.				10
Nais behningi			59	
Nais communis	20		125	30
Nais simplex			7	10
Nais variabilis			33	
Ophidonais serpentina			13	
Paranais frici	89		33	798
Pristina longisoma			7	
Pristina sima			7	
Vejdovskyella intermedia	20		7	128
Aulodrilus pluriseta				10
Branchiura sowerbyi	20		7	10
Limnodrilus cervix	30		7	40
Limnodrilus claparedianus	20			
Limnodrilus hoffmeisteri	640		144	355
Limnodrilus udekemianus			144	98
Potamothrix vejdovskyi			26	20
Immatures w/o capilliform chaeta	2,108		1,149	1,724
Immatures w/ capilliform chaeta	433		59	228
Arthropoda				
Isopoda				
Asellus sp.			13	
Amphipoda				
Gammarus sp.		20	197	
Ephemeroptera				
Baetidae		10		
Hexagenia sp.			7	
Diptera				
Chironominae pupae		10		
Chironomus sp.			7	30
Cryptochironomus sp.	39		105	49
Dicrotendipes sp.			7	

TABLE V-B-3
(Continued)

Taxa	STATION 1	2A	2B	3
Polypedilum sp.	10		92	89
Coelotanypus scapularis				20
Procladius sp.			7	40
Cricotopus sp.		20	7	
Orthocladius sp.		10	13	
Tipulidae			7	
Stratiomyidae	20			
Mollusca				
Corbicula fluminea			39	10
Total	3,459	70	2,335	3,739

+ Indicates organisms present.

TABLE V-B-4

BENTHIC MACROINVERTEBRATE DENSITIES (Number/m^2), MEAN OF TRIPLICATE FOR BACK CHANNEL AND DUPLICATE SAMPLES COLLECTED IN THE MAIN CHANNEL
OHIO RIVER, SEPTEMBER 14, 1989
BVPS

Taxa	STATION			
	1	2A	2B	3
Cnidaria				
Hydra sp.			7	
Nematoda			13	10
Entoprocta				
Urnatella gracilis			+	+
Annelida				
Oligochaeta eggs	+		+	
Arcteonais lomondi			7	
Nais communis			13	
Nais sp.			7	
Paranais frici			7	
Aulodrilus pluriseta			13	
Branchiura sowerbyi			26	
Limnodrilus cervix	20	10	33	40
Limnodrilus hoffmeisteri	404		361	424
Limnodrilus udekemianus	20			207
Immatures w/o capilliform chaeta	828	10	2,915	1,458
Immatures w/ capilliform chaeta	168		204	69
Hirudinea				
Glossiphoniidae			7	
Arthropoda				
Isopoda				
Asellus sp.			13	
Amphipoda				
Gammarus sp.		10	20	
Plecoptera				
Unidentified Immature	10			
Tricoptera				
Oecetis sp.			7	
Polycentropus sp.			13	
Diptera				
Chironominae pupae			7	
Chironomus sp.	10		59	10
Cryptochironomus sp.	60		66	
Harnischia sp.			13	
Polypedilum sp.	20		112	99
Coelotanypus scapularis			39	
Procladius sp.			13	
Ceratopogonidae			13	
Mollusca				
Corbicula fluminea	20	118	197	108
Pisidium sp.			7	
Sphaerium sp.			20	
Total	1,560	148	4,212	2,425

+ Indicates organisms present.

No ecologically important additions of species were encountered during 1989 nor were any threatened or endangered species collected.

Community Structure and Spatial Distribution

Oligochaetes accounted for the highest percentage of the macroinvertebrates at all sampling stations in both May and September (Figure V-B-2).

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

In general, the density of macroinvertebrates during 1989 was lowest at Transect 2A and higher at Transects 1, 2B, and 3 where substrates near the shore were composed of soft mud or various combinations of sand and silt. The lower abundance at Transect 2A was probably related to substrate conditions (clay and sand) along the north shore of Phillis Island.

Comparison of Control and Non-Control Stations

No adverse impact to the benthic community was observed during 1989. This conclusion is based on a comparison of data collected at Transect 1 (Control) and 2B (Non-Control) and on analyses of species composition and densities.

Data indicate that oligochaetes were usually predominant throughout the study area (Figure V-B-2). Most abundant taxa at Transects 1 and 2B in both May and September were immature tubificids without capilliform chaetae (Tables V-B-3 and V-B-4). In May, common or abundant taxa at both stations were the oligochaetes *Limnodrilus hoffmeisteri*, *Paranais frici*, and the midge *Cryptochironomus*. In September, the oligochaete *Limnodrilus hoffmeisteri*, the midge *Cryptochironomus*, and the clam *Corbicula fluminea* were the common organisms collected at both stations.

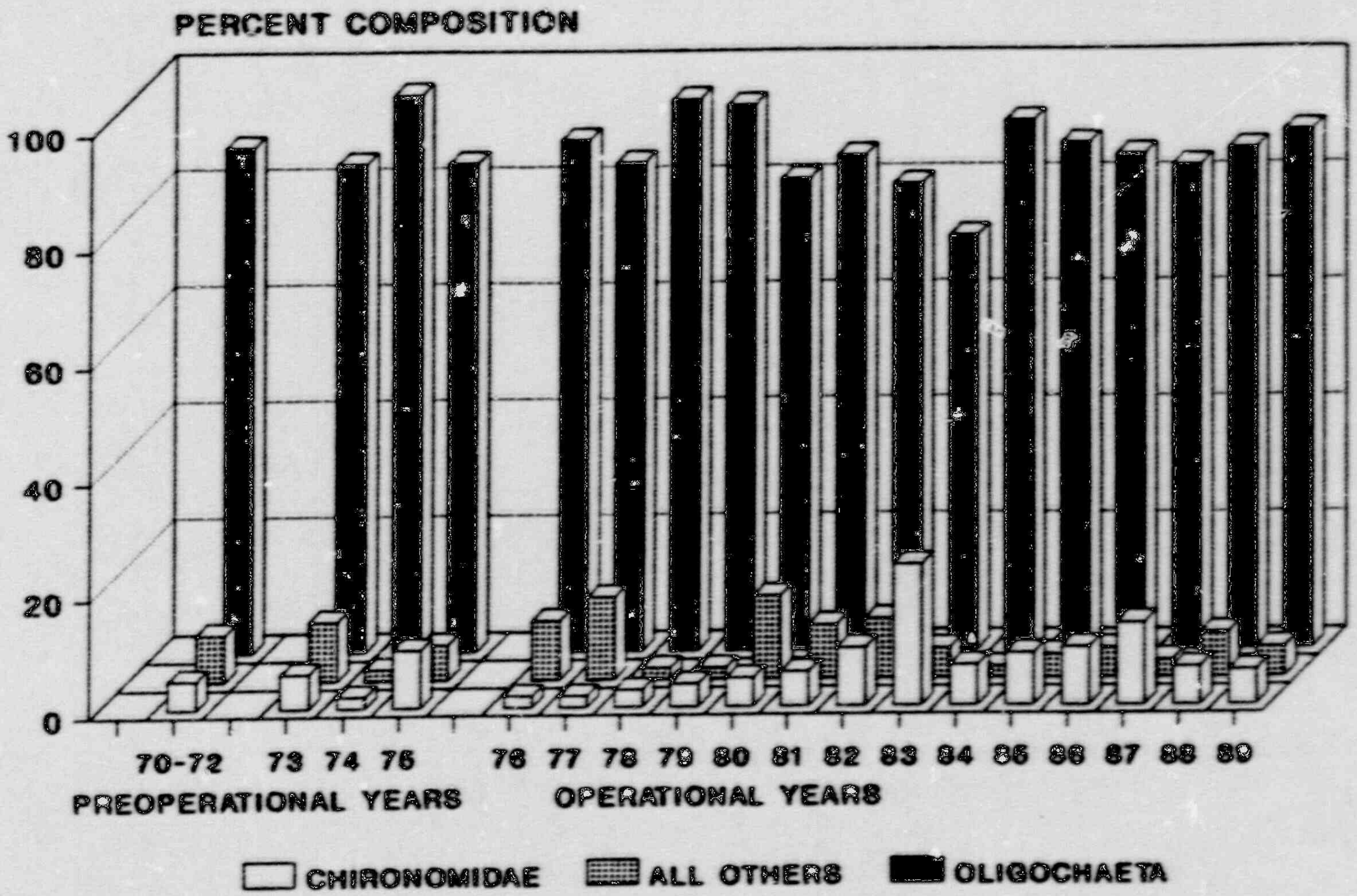


FIGURE V-B-2

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

In May and September 1989, a greater diversity of organisms were collected at Non-Control station 2B than at Control station 1 (Table V-B-5). This has occurred several times during past surveys. The mean number of taxa and Shannon-Weiner indices for the back channel were within the range of values observed for other stations in the study area. Differences observed between Transect 1 (Control) and 2B (Non-Control) and between other stations could be related to differences in habitat. None of the differences were attributed to BVPS operation.

Comparison of Preoperational and Operational Data

Composition, percent occurrence and overall abundance of macroinvertebrates has changed little from preoperational years through the current study year. Oligochaetes have been the predominant macroinvertebrate in the community each year and they comprised approximately 89% of the individuals collected in 1989 (Figure V-B-2). A similar oligochaete assemblage has been reported each year. Chironomids and mollusks have composed most of the remaining fractions of the community each year. The potential nuisance clam, Corbicula, increased in abundance from 1974 through 1976, but declined in number during 1977. Since 1981, Corbicula have been collected in the benthic surveys including 1989.

Total macroinvertebrate densities for Transect 1 (Control) and 2B (Non-Control) for each year since 1973 are presented in Table V-B-6. Mean densities of macroinvertebrates gradually increased from 1973 through 1976 (BVPS Unit 1 start-up) to 1983. In 1989, total densities were greater than those of recent years. These densities were similar to those observed in 1982 and 1983 and they are well within the range of preoperational and operational year data. Mean densities have frequently been higher in the back channel of Phillis Island (Non-Control 2B) when compared to densities at Transect 1 (Control). In years such as 1986 (also 1984, 1983, 1981, 1980, 1979) when mean densities were lower at Transect 2B than at Transect 1 the differences were negligible. These differences could be related to substrate variability and randomness of sample grabs. Higher total densities of macroinvertebrates in the back channel (Transect 2B) when compared to Transect 1 was probably due to the

TABLE V-B-5

MEAN DIVERSITY VALUES FOR BENTHIC MACROINVERTEBRATES
COLLECTED IN THE OHIO RIVER, 1989
BVPS

	STATION			
	1	2A	2B	3
DATE: May 23				
No. of Taxa	10	2	13	18
Shannon-Weiner Index	1.78	1.25	2.14	2.46
Evenness	0.53	0.96	0.62	0.60
DATE: September 14				
No. of Taxa	8	2	15	8
Shannon-Weiner Index	1.87	0.88	2.95	1.86
Evenness	0.64	0.65	0.78	0.60

TABLE V-B-6

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

	Preoperational Years						Operational Years											
	1973		1974		1975		1976		1977		1978		1979		1980		1981	
	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
January																		
February	205	0	703	311			358	200	312	1,100	1,499	2,545			1,029	1,296		
March													425	457				
April																		
May	248	508	1,116	2,197			927	3,660	674	848	351	126	1,004	840	1,041	747	209	456
June	5	40	507	686														
July	653	119	421	410														
August	99	244	143	541	1,017	1,124	851	785	591	3,474	601	1,896	1,185	588				
September			175	92											1,523	448	2,185	912
October	256	239																
November	149	292	318	263	75	617	388	1,295	108	931	386	1,543	812	806				
December																		
Mean	231	206	483	643	546	871	631	1,485	421	1,588	709	1,528	857	673	1,198	830	1,197	684

TABLE V-B-6
(Continued)

	Operational Years															
	1982		1983		1984		1985		1986		1987		1988		1989	
	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
January																
February																
March																
April																
May	3,490	3,026	3,590	1,314	2,741	621	2,256	867	601	969	1,971	2,649	1,804	1,775	3,459	2,335
June																
July																
August																
September	2,956	3,364	4,172	4,213	1,341	828	1,024	913	849	943	2,910	2,780	1,420	1,514	1,560	4,212
October																
November																
December																
Mean	3,223	3,195	3,881	2,764	2,041	725	1,640	890	725	956	2,440	2,714	1,612	1,645	2,510	3,274

morphology of the river. Mud, silt, and slow current were predominant at Transect 2B creating conditions more favorable for burrowing macroinvertebrates in comparison to Transect 1, which has little protection from river currents and turbulence caused by commercial boat traffic.

Summary and Conclusions

Substrate was probably the most important factor controlling the distribution and abundance of the benthic macroinvertebrates in the Ohio River near BVPS. Soft muck-type substrates along the shoreline were conducive to worm and midge proliferation, while limiting macroinvertebrates which require a more stable bottom. At the shoreline stations, Oligochaeta accounted for 89% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 6% and 3% respectively.

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

C. PHYTOPLANKTON

Objectives

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

Methods

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

In the laboratory, a measured aliquot of the sample was settled in an inverted microscope chamber. A minimum of 250 cells were identified and counted at 400X magnification. For each collection date, the volume of

sample settled and examined was adjusted depending on cell density. A Hyrax diatom slide was also prepared monthly from each sample. This slide was examined at 1000X magnification to make positive identification of the diatoms.

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

Seasonal Distribution

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

During 1989, the January through May samples had phytoplankton densities of 1,570 to 6,502 cells/ml (Table V-C-1 and Figure V-C-1). Total mean densities increased in June and peaked in July at 15,464 cells/ml. After July, densities displayed a general decreasing trend to a low of 2,760 cells/ml in December (Table V-C-1 and Figure V-C-1). A small peak of 5,956 cells/ml occured in October.

Diatoms (Chrysophyta), green algae (Chlorophyta) and microflagellates were generally the most abundant groups of phytoplankton during 1989 (Table V-C-1 and Figure V-C-2). The relative abundance for the group Cyanophyta was high only in January, when two colonies accounted for 78% of the total cell numbers counted. Relative densities of Cryptophyta was highest in April (5%) (Table V-C-1).

Diversity indices for the phytoplankton during 1989 are presented in Table V-C-2. Shannon-Weiner indices ranged from 1.36 to 4.32, evenness values from 0.29 to 0.81, and richness values from 2.85 to 6.12. High ($\geq$ 2.00) diversity values occurred in 9 of the 12 months. The lowest value for Shannon-Weiner Index occurred in January when two colonies of

TABLE V-C-1

MONTHLY PHYTOPLANKTON GROUP DENSITIES (Number/ml) AND PERCENT COMPOSITION
FROM ENTRAINMENT SAMPLES, 1989
BVPS

Group	Jan #/ml	Jan %	Feb #/ml	Feb %	Mar #/ml	Mar %	Apr #/ml	Apr %	May #/ml	May %	Jun #/ml	Jun %
Chlorophyta	39	1	322	21	50	3	204	10	26	1	57	1
Chrysophyta	321	5	947	60	369	18	850	40	402	22	1,607	35
Cyanophyta	5,071	78	28	2	220	11	8	<1	23	1	0	0
Cryptophyta	5	<1	21	1	12	1	115	5	28	2	51	1
Microflagellates	1,061	16	252	16	1,348	67	876	41	1,311	73	2,815	62
Other Groups	5	<1	0	0	0	0	68	3	14	1	6	<1
Total	6,502	100	1,570	100	1,999	100	2,121	99	1,804	100	4,536	99

Group	Jul #/ml	Jul %	Aug #/ml	Aug %	Sep #/ml	Sep %	Oct #/ml	Oct %	Nov #/ml	Nov %	Dec #/ml	Dec %
Chlorophyta	2,148	14	2,051	25	1,549	34	1,348	23	248	8	161	6
Chrysophyta	10,203	66	3,298	41	1,823	40	2,794	47	888	27	614	22
Cyanophyta	0	0	14	<1	0	0	67	1	0	0	12	<1
Cryptophyta	501	3	23	<1	155	3	260	4	69	2	50	2
Microflagellates	2,539	16	2,743	34	1,059	23	1,479	25	2,088	63	1,923	70
Other Groups	73	<1	9	<1	6	<1	8	<1	5	<1	0	0
Total	15,464	99	8,138	100	4,592	100	5,956	100	3,293	100	2,760	100

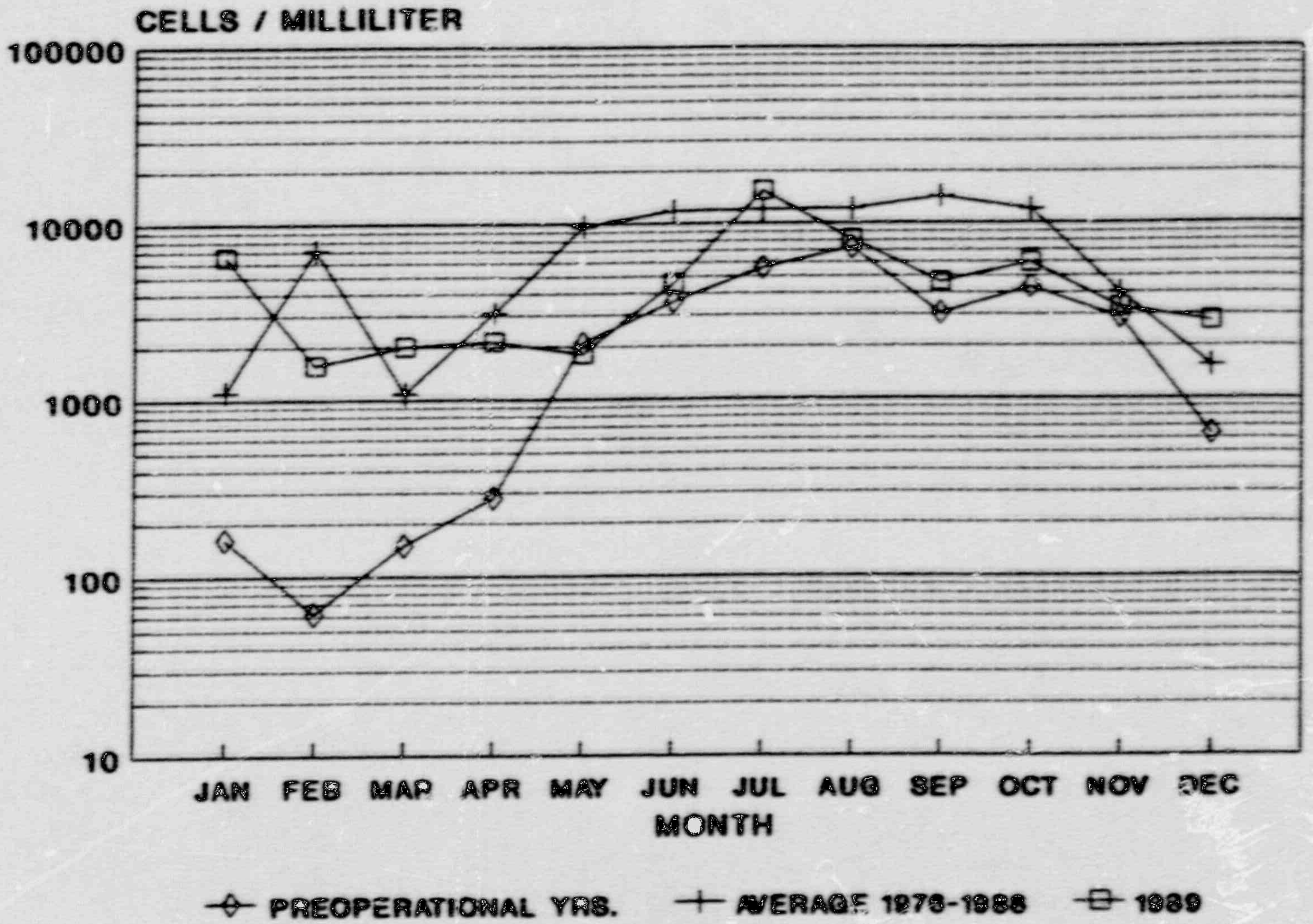


FIGURE V-C-1

MONTHLY PHYTOPLANKTON DENSITIES IN THE OHIO RIVER DURING PREOPERATIONAL (1974-1975) AND OPERATIONAL (1976-1989) YEARS BVPS

TABLE V-C-2

PHYTOPLANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1989
BVPS

	Jan	Feb	Mar	Apr	May	Jun	
No. of Species	27	46	25	45	26	25	
Shannon-Weiner Index	1.36	4.32	2.00	3.26	1.81	2.11	
Evenness	0.29	0.78	0.43	0.60	0.38	0.45	
Richness	2.96	6.12	3.16	5.74	3.33	2.85	
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**$\bar{X}$**
No. of Species	37	29	24	30	34	29	31
Shannon-Weiner Index	2.80	3.01	3.70	3.53	2.16	1.95	2.67
Evenness	0.54	0.62	0.81	0.72	0.42	0.40	0.54
Richness	3.73	3.11	2.85	3.34	4.07	3.53	3.73

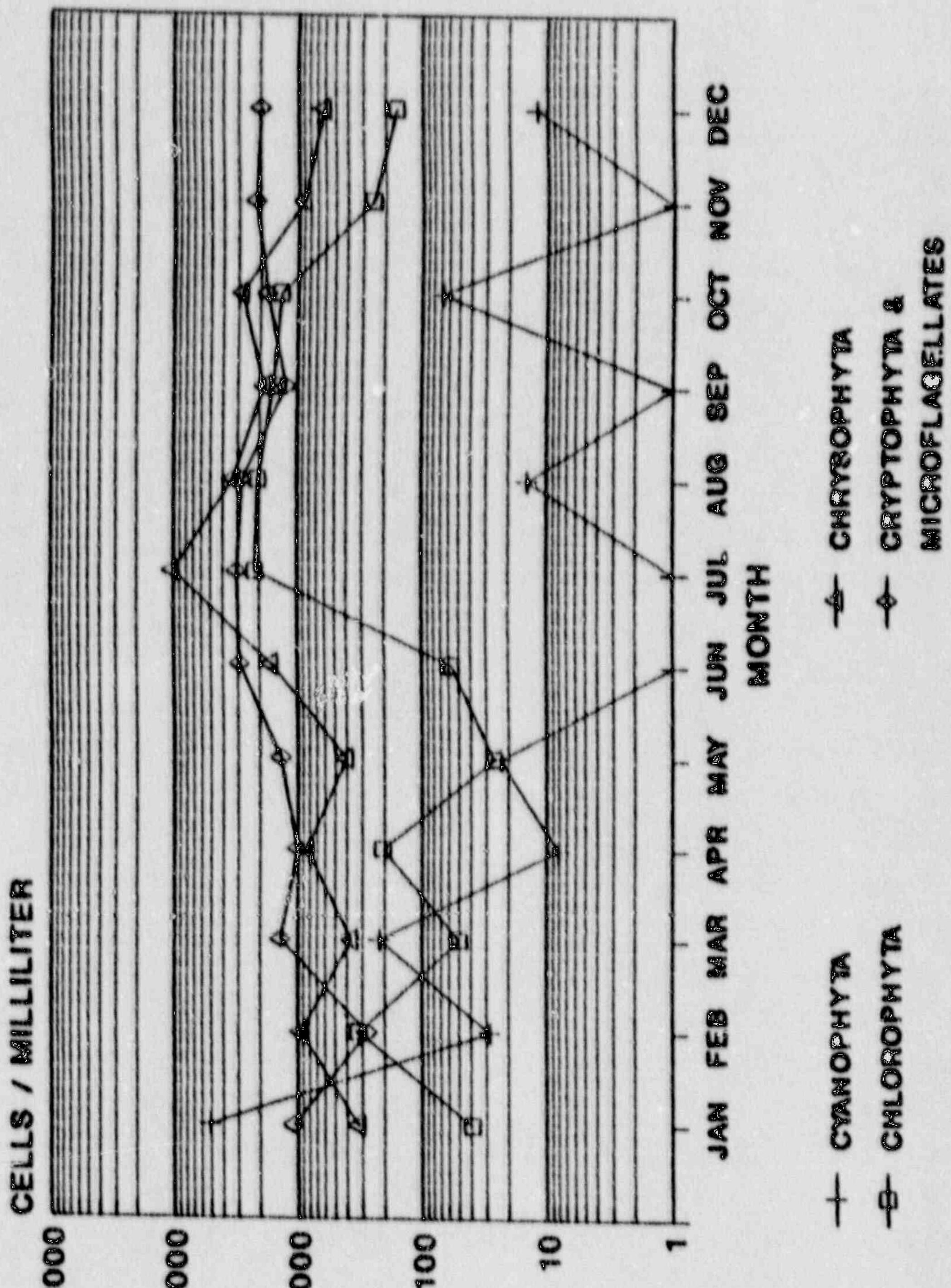


FIGURE V-C-2

PHYTOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1989
BVPS

blue-green algae dominated the cell counts; however, the lowest number of species occurred in September when microflagellates and small centrics were most predominant. Highest number of taxa (46) occurred in February.

Phytoplankton communities were generally dominated by different taxa each season. The most abundant taxa during winter (January through April) were microflagellates and small centric diatoms (Table V-C-3). Microflagellates continued to be most abundant in June and July. Skeletonema potamos a diatom was dominant in August. Microflagellates and small centrics were most abundant during fall and winter.

Comparison of Control and Non-Control Transects

Plankton samples were not collected at any river stations after April 1, 1980, due to a reduction in the scope of the Aquatic Monitoring Program, therefore, comparison of data was not possible in 1989.

Comparison of Preoperational and Operational Data

The seasonal succession of phytoplankton varied from year to year, but, in general, the phytoplankton taxa has remained consistent. Phytoplankton communities in running waters respond quickly to changes in water temperature, turbidity, nutrients, velocity, and turbulence (Hynes 1970). The phytoplankton from the Ohio River near BVPS generally exhibited a bimodal pattern of annual abundance. During the preoperational year 1974, total densities peaked in August and October, while in operational years of 1976 through 1979, mean peak densities occurred in June and September (DLC 1980). Total phytoplankton densities also displayed a bimodal pattern in 1989, when peaks occurred in July and October. The increased density in January was not a true reflection of a phytoplankton peak because two blue-green colonies accounted for 78% of the total cell density.

In general, the phytoplankton community in 1989 was similar to those of preoperational and operational years. No major change in species composition or community structure was observed during 1989. The small dif-

TABLE V-C-3

DENSITIES (Number/ml) OF MOST ABUNDANT PHYTOPLANKTON TAXA
(Fifteen Most Abundant On Any Date)
COLLECTED FROM ENTRAINMENT SAMPLES
JANUARY THROUGH DECEMBER 1989
BVPS

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CYANOPHYTA												
Aphanotheca nidulans	4,862											
Oscillatoria formose	18											
Schizothrix calcicola	14		21		23							12
Schizothrix spp.												
Coccoid cyanophyta	177		199									
CHLOROPHYTA												
Ankistrodesmus convolutus	9	7	7	11	5	34	100	99	161	302	21	44
Ankistrodesmus falcatus	12	14	25	47	16	17	300	180	12	185	21	55
Chlorophyta I		240		120			773	189	331	128	43	
Coelastrum microporum								45				
Crucigenia tetrapedia									25			9
Dictyosphaerium pulchellum							73	126	149			23
Micractinium pusilium							36			168		
Pediastrum boryanum											74	
Pediastrum duplex							127					
Scenedesmus acuminatus							73		50	67	18	
Scenedesmus bicellularis							221	757	132	153		
Scenedesmus denticulatus	9	7	9	7			91	108	50	84		
Scenedesmus opolensis							36	68				
Scenedesmus quadricauda	9	14	9		5		55	216	279	101	32	5
Scenedesmus spinosus								18	99	67	9	18
Scenedesmus spp.									149			
Sphaerocystis schroeteri							73	180				
Ulothrix subtilissima		21										
CHRYSOPHYTA												
Achnanthes minutissima	66	108	22	12	83	276					43	46
Asterionella formosa	23	21	32	65	5	23	228	5		6	5	122
Cymbella ventricosa		28		11	9	29				8	5	5
Diatoma tenue		28										
Diatoma vulgare	9	35	9	4	2	29					35	7
Dinobryon bavaricum	5			4	14	6						
Fragiliaria capucina				32								
Fragilaria crotonensis					18		218					94
Fragilaria vaucheriae		28	5	11								
Melosira ambigua	18				9		55	387	304	50		
Melosira distans										420	23	21
Melosira granulata	9			22		51	73	45	211	134	5	
Melosira varians	9	70	5	14	9	29			236	17	18	5

TABLE V-C-3
(Continued)

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Navicula cryptocephala	16	112	32	43	32	51		5	6		12	7
Navicula viridula	9	84	21	36	51	314	18		6		30	12
Nitzschia acicularis				4	5	34	9			8	18	7
Nitzschia dissipata	9	21	2	22		6						
Nitzschia filiformis			16			17						
Nitzschia palea	16	14		7			46	9			7	
Rhoicosphenia curvata			5	4	2	23						
Skeletonema potamos		12	44	36			7,066	1,324	199	714	72	
Surirella ovata	9	14	2	4	7	23						
Synedra planktonica	5		7	4	7	6	9			17		2
Synura uvella				50							5	2
Small centrics	111	204	155	444	149	662	2,318	1,514	861	1,326	576	265
CRYPTOPHYTA												
Cryptomonas erosa	5	21	12	32	5	17	155	9	81	25	30	32
Rhodomonas minuta				83		34	346	14	74	235	39	18
MICROFLAGELLATES	111	252	1,348	876	1,311	2,815	2,539	2,743	1,059	1,479	2,088	1,923
Total Phytoplankton	6,502	1,570	1,999	2,121	1,804	4,536	15,464	8,138	4,592	5,956	3,293	2,760
Total of Most Abundant Taxa	5,540	1,355	1,987	2,005	1,767	4,496	15,038	8,041	4,474	5,694	3,229	2,732
Percent Composition of Most Abundant Phytoplankton	85	86	99	95	98	95	97	99	97	96	98	99

ferences in the phytoplankton community between 1989 and the previous years were due to natural fluctuations and were not a result of BVPS operations.

Shannon-Weiner, evenness, and richness diversity values were unusually low in January when the phytoplankton counts were dominated by two colonies of blue-green algae. Yearly mean Shannon-Weiner diversity indices from 1973 through 1989 were similar (except during 1973 when the value was much reduced) ranging from a low 2.67 in 1989 to a maximum of 4.36 in 1975 (Table V-C-4). Yearly mean evenness values were also similar, except during 1973 when the value was low. From 1974 through 1989, evenness ranged from 0.29 to 0.90. The maximum evenness diversity value is 1.0 and occurs when each species is represented by the same number of individuals. The mean number of taxa each year ranged from 19 in 1973 to 49 in 1986 (31 in 1989). The highest number of taxa (68) in phytoplankton samples occurred during November, 1986.

Summary and Conclusions

The phytoplankton community of the Ohio River near BVPS exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. Total cell densities were within the range observed during previous years. Diversity indices of phytoplankton were within the range of those previously observed near BVPS. Diatoms, green algae, and microflagellates were the most abundant phytoplankton groups in 1989.

D. ZOOPLANKTON

Objectives

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

TABLE V-C-4

PHYTOPLANKTON DIVERSITY INDICES (MEAN OF ALL SAMPLES 1973 TO 1989)
NEW CUMBERLAND POOL OF THE OHIO RIVER
BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
1973													
Number of Species	7	2	(d)	13	24	27	28	30		24	17	16	19
Shannon Index[a]	1.55	0.54		0.63	1.64	2.28	3.55	3.72		3.37	3.25	3.27	2.38
Evenness	0.33	0.15		0.11	0.25	0.35	0.55	0.52		0.50	0.54	0.53	0.38
Richness	1.24	0.29		1.50	2.63	3.17	3.61	3.46		3.24	2.89	2.80	2.48
1974													
Number of Species	12	8	17	22	44	46	47	60	34	47			34
Shannon Index	2.96	2.23	3.18	3.50	4.89	4.40	4.03	4.25	3.85	5.02			3.83
Evenness	0.55	0.46	0.57	0.58	0.62	0.62	0.56	0.55	0.54	0.58			0.56
Richness	2.55	1.82	3.05	3.74	5.56	5.45	5.46	6.49	4.77	5.44			4.43
1975													
Number of Species								52	34	43	32	40	40
Shannon Index								4.53	4.22	4.37	4.22	4.48	4.36
Evenness								0.80	0.83	0.81	0.87	0.85	0.83
Richness								5.57	3.96	4.98	[illegible]	6.19	4.91
1976													
Number of Species	31	35	31	38	47	49	46	43	38	33	35	38	39
Shannon Index	3.98	4.36	3.90	4.25	4.14	4.27	4.28	4.30	3.93	4.16	4.24	4.45	4.19
Evenness	0.80	0.85	0.78	0.81	0.75	0.76	0.78	0.80	0.75	0.83	0.83	0.85	0.80
Richness	5.15	5.89	4.92	4.70	4.68	4.79	4.72	4.34	3.85	4.17	4.95	5.79	4.83
1977													
Number of Species	20	28	31	24	36	30	44	39	37	32	33	27	32
Shannon Index	1.96	3.31	3.00	2.78	4.16	3.52	4.36	4.26	4.29	3.92	4.12	4.00	3.64
Evenness	0.44	0.70	0.61	0.60	0.80	0.72	0.80	0.81	0.82	0.78	0.82	0.83	0.73
Richness	3.14	4.57	4.44	2.95	3.53	2.77	4.63	4.26	3.87	3.98	4.18	3.72	3.84
1978													
Number of Species	37	29	32	42	28	42	36	37	35	37	34	32	35
Shannon Index	4.08	3.68	3.77	4.67	3.30	4.16	3.95	4.17	3.81	3.99	3.80	4.44	3.99
Evenness	0.78	0.76	0.76	0.87	0.69	0.78	0.77	0.80	0.76	0.77	0.76	0.90	0.78
Richness[b]													
1979													
Number of Species	18	16	19	36	34	27	34	24	29	25	28	38	27
Shannon Index	3.49	3.36	3.79	3.22	3.78	3.84	4.10	3.88	4.12	4.07	3.68	4.32	3.80
Evenness	0.84	0.82	0.88	0.62	0.74	0.81	0.80	0.84	0.84	0.88	0.77	0.83	0.81
Richness	2.97	2.64	3.36	4.69	4.08	2.90	3.46	2.72	3.26	3.52	3.57	5.19	3.54
1980 (c)													
Number of Species	28	18	24	25	21	18	30	16	32	24	33	37	24
Shannon Index	3.88	2.64	3.78	3.82	3.28	3.26	3.61	3.45	4.10	3.54	3.73	4.56	3.57
Evenness	0.81	0.64	0.83	0.82	0.75	0.78	0.74	0.86	0.82	0.77	0.74	0.87	0.78
Richness	4.07	2.65	3.49	4.02	2.50	2.38	2.96	1.94	3.33	2.59	4.01	5.40	3.15

TABLE V-C-4
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
1981													
Number of Species	22	35	37	39	34	33	33	51	35	27	40	32	35
Shannon Index	3.92	4.39	4.39	2.29	3.66	4.56	4.13	4.59	4.07	3.90	4.00	4.32	3.95
Evenness	0.88	0.85	0.84	0.43	0.72	0.90	0.82	0.81	0.79	0.82	0.75	0.86	0.79
Richness	3.91	5.84	6.10	4.58	3.69	4.61	3.73	5.76	3.85	3.56	5.00	5.55	4.60
1982													
Number of Species	51	41	46	22	55	45	66	54	53	35	50	49	47
Shannon Index	4.68	4.80	4.96	1.88	4.79	4.33	4.72	4.54	4.22	3.97	4.09	4.56	4.30
Evenness	0.82	0.90	0.90	0.42	0.83	0.79	0.78	0.79	0.74	0.77	0.72	0.83	0.77
Richness	7.17	6.43	6.88	2.36	6.15	4.96	6.65	5.33	5.23	3.61	5.36	4.23	5.53
1983													
Number of Species	36	42	51	52	25	42	37	40	37	45	37	52	41
Shannon Index	4.27	4.01	4.60	4.74	3.67	4.41	4.16	4.28	3.56	3.51	4.17	4.72	4.18
Evenness	0.82	0.74	0.81	0.83	0.79	0.82	0.80	0.80	0.68	0.64	0.80	0.83	0.78
Richness	5.17	6.45	7.35	6.64	2.98	4.18	3.63	4.17	3.83	4.46	4.38	6.48	4.98
1984													
Number of Species	31	50	36	46	41	51	57	54	51	53	54	44	48
Shannon Index	4.02	4.89	4.30	3.06	4.37	4.48	4.34	4.03	4.38	4.00	4.59	4.10	4.21
Evenness	0.80	0.83	0.82	0.55	0.81	0.79	0.74	0.70	0.77	0.70	0.80	0.75	0.76
Richness	5.05	8.95	6.54	6.98	5.55	6.41	7.29	5.97	5.43	5.70	7.10	6.71	6.47
1985													
Number of Species	41	38	53	39	46	52	53	58	50	61	50	39	48
Shannon Index	3.80	3.31	4.44	3.88	4.24	2.95	4.16	4.28	3.59	2.57	3.15	3.26	3.56
Evenness	0.71	0.63	0.78	0.56	0.77	0.52	0.72	0.73	0.63	0.43	0.55	0.61	0.64
Richness	6.42	5.75	8.48	5.25	4.71	5.12	6.83	6.14	5.40	6.09	6.70	5.88	6.06
1986													
Number of Species	31	39	42	34	45	60	56	48	60	54	68	48	49
Shannon Index	3.79	4.48	3.73	1.50	4.04	3.78	4.04	3.94	4.21	4.01	4.44	4.40	3.86
Evenness	0.77	0.85	0.69	0.29	0.74	0.64	0.69	0.70	0.71	0.70	0.73	0.79	0.69
Richness	4.54	6.40	6.32	3.72	4.54	7.37	6.20	4.75	5.96	6.34	9.58	7.99	6.14
1987													
Number of Species	42	44	29	33	33	36	50	39	33	36	35	31	37
Shannon Index	2.99	2.28	2.51	1.89	3.38	3.56	3.76	3.44	2.12	2.52	2.54	2.41	2.78
Evenness	0.55	0.41	0.52	0.37	0.67	0.69	0.67	0.65	0.42	0.48	0.50	0.48	0.53
Richness	5.24	5.58	3.24	3.71	3.36	3.67	4.80	3.77	3.11	3.93	3.80	3.79	4.00

TABLE V-C-4
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{x}$
1988													
Number of Species	31	34	27	40	45	26	42	42	37	37	36	27	35
Shannon Index	3.20	1.90	1.72	2.68	2.83	2.88	3.76	3.13	3.76	2.30	2.61	2.65	2.78
Evenness	0.64	0.37	0.36	0.50	0.51	0.61	0.70	0.58	0.72	0.44	0.50	0.56	0.54
Richness	3.43	4.21	3.28	4.65	4.75	2.66	4.20	4.12	3.70	3.25	3.83	3.00	3.76
1989													
Number of Species	27	46	25	45	26	25	37	29	24	30	34	29	31
Shannon Index	1.36	[illegible].32	2.00	3.26	1.81	2.11	2.80	3.01	3.70	3.53	2.16	1.95	2.67
Evenness	0.29	0.78	0.43	0.60	0.38	0.45	0.54	0.62	0.81	0.72	0.42	0.40	0.54
Richness	2.96	6.12	3.16	5.74	3.33	2.85	3.73	3.11	2.85	3.34	4.07	3.53	3.73

(a) Shannon-Weiner Index
(b) No data
(c) Data for period April 1980-December 1989 represents single entrainment samples collected monthly.
(d) Blanks represent periods when no collections were made.

Methods

The zooplankton analyses were performed on one liter aliquots taken from the preserved one-gallon samples obtained from the intake bay. (see Phytoplankton methods, in Part C). One liter from each sample was filtered through a 35 micrometer (.035 mm) mesh screen. The portion retained was washed into a graduated cylinder and allowed to settle for a minimum of 24 hours. The concentrate was adjusted to a known volume by removing the supernatant. One ml of this thoroughly mixed concentrate was placed in an inverted microscope cell and examined at 100X magnification. All zooplankters within the cell were identified to the lowest practicable taxon and counted. Total density (individuals/liter), Shannon-Weiner (log base 2) and evenness diversity indices (Pielou 1969), and richness index (Dahlberg and Odum 1970) were calculated based upon one sample, which was collected below the skimmer wall from one operating intake bay.

Seasonal Distribution

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

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

During 1989, protozoans and rotifers accounted for 73% or more of all zooplankton on all sample dates (Table V-D-1). Total organism densities during the winter and early spring (January through May) were less than 900/liter (Figure V-D-1, Table V-D-1). Total organism densities did not peak until September (5,420/liter); thereafter densities decreased gradually until December. The maximum zooplankton density in the Ohio

TABLE V-D-1

MONTHLY ZOOPLANKTON GROUP DENSITIES (Number/liter) AND PERCENT COMPOSITION FROM ENTRAINMENT SAMPLES, 1989 BVPS

Group	Jan		Feb		Mar		Apr		May		June	
	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%
Protozoa	680	96	795	93	780	95	780	88	705	96	2200	94
Rotifera	30	4	60	7	45	5	90	10	30	4	140	6
Crustacea	0	0	0	0	0	0	15	2	0	0	0	0
Total	710	100	855	100	825	100	885	100	735	100	2340	100

Group	Jul		Aug		Sep		Oct		Nov		Dec	
	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%	#/L	%
Protozoa	2910	87	400	22	3000	55	1575	79	900	94	430	91
Rotifera	420	13	920	51	2360	44	390	20	60	6	40	9
Crustacea	0	0	480	27	60	1	30	2	0	0	0	0
Total	3330	100	1800	100	5420	100	1995	101	960	100	470	100

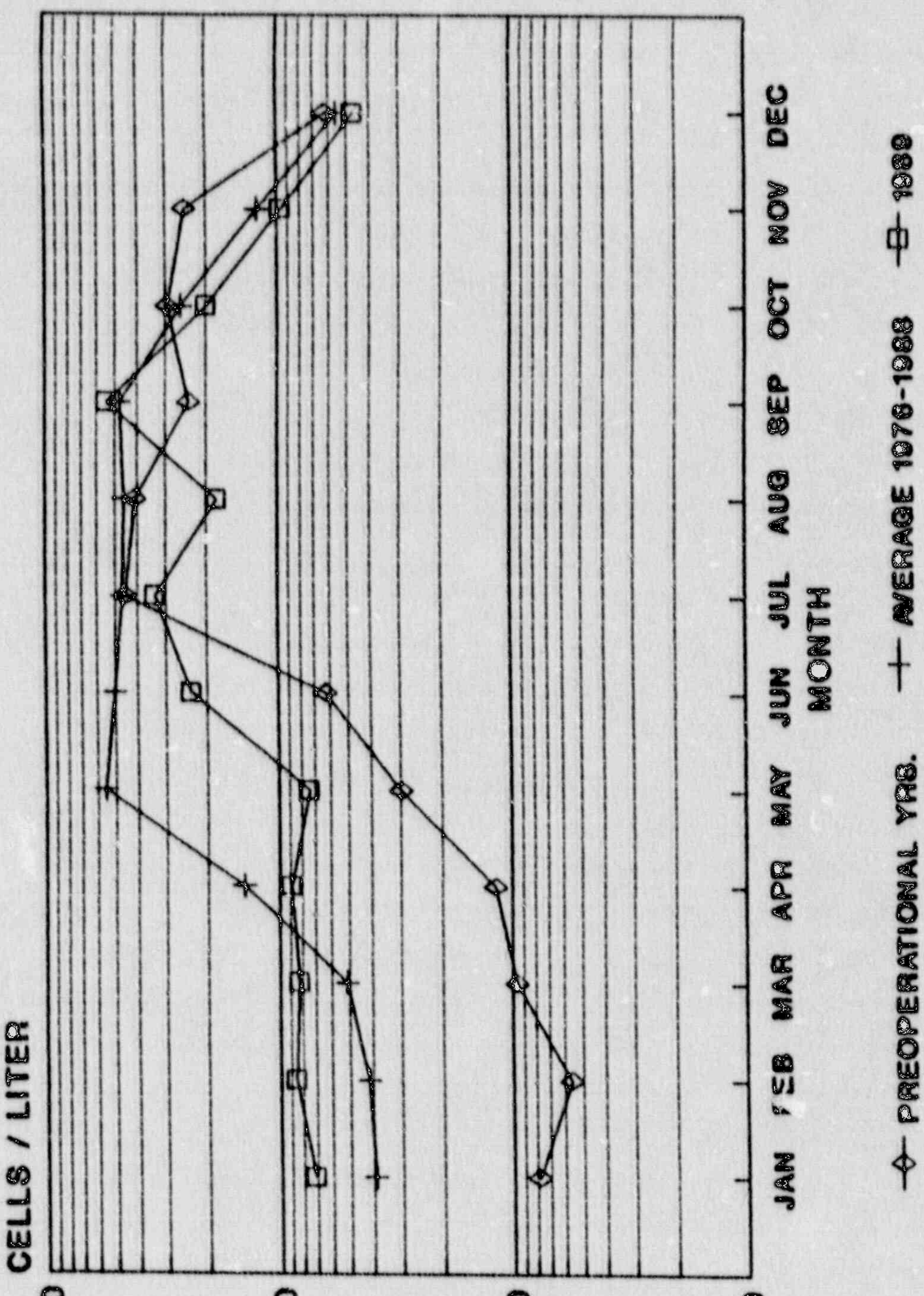


FIGURE V-D-1

MONTHLY ZOOPLANKTON DENSITIES IN THE OHIO RIVER
DURING PREOPERATIONAL (1974-1975) AND
OPERATIONAL (1976-1989) YEARS
BVPS

River near BVPS frequently occurs in the spring, although it is sometimes delayed until summer or early fall (Table V-D-2, Figure V-D-1). Optimum conditions of low precipitation and warm weather did not occur until late summer when the peak occurred in 1989. The effect of a dry year and low river discharges was noted by Hynes (1970) to favor plankton populations.

The seasonal pattern of zooplankton densities observed in the Ohio River near BVPS is typical of those in temperate climates (Hutchinson 1967). Zooplankton densities in winter are low due primarily to low water temperatures and limited food availability (Winner 1975). In the spring, food availabililty and water temperatures increase, which stimulates growth and reproduction. Zooplankton populations decrease during the fall and winter from the summer maximum because optimum conditions for growth and reproduction decrease during this period.

Densities of protozoans during January through May of 1989 were between 680 and 795/liter (Table V-D-1). Protozoans increased in June and July; decreased in August and developed the highest densities of 1989 in September. Protozoans gradually decreased in the fall to densities of 430/liter in December. Vorticella sp., Tintinnidium fluvitale, Strombidium sp. and Difflugia sp. were the common protozoans throughout the year. Vorticella sp. or Difflugia sp. dominated the protozoan assemblage during nine months (Table V-D-3). The most abundant protozoans in the other months were Tintinnidium, Tintinnopsis and Strombidium. These taxa have been a main part of the protozoan assemblage of the Ohio River near BVPS since environmental studies were initiated in 1972 by DLC.

The rotifer assemblage in 1989 (Figure V-D-2) displayed a typical pattern of rotifer populations in temperate inland waters (Hutchinson 1967). Rotifer densities increased from a minimum of 30/liter in January to a maximum of 2,360/liter in September; a secondary peak did not occur in 1989 (Table V-D-2). Rotifer populations decreased after September to densities of 40/liter in December. Rotifers were the second most abundant group during 1989. Keratella cochlearis and Polyarthra dolichoptera were the most abundant rotifers during most of the year (Table V-D-3).

TABLE V-D-2

MEAN ZOOPLANKTON DENSITIES (Number/liter) BY MONTH FROM 1973 THROUGH 1989, OHIO RIVER AND BVPS

Total Zooplankton	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	(a)	50	-	90	154	588	945	1,341	-	425	180	87
1974	78	56	96	118	299	625	4,487	3,740	1,120	4,321	-	-
1975	-	-	-	-	-	-	-	4,426	3,621	1,591	2,491	623
1976	327	311	347	10,948	2,516	5,711	3,344	3,296	3,521	518	446	577
1977	147	396	264	393	5,153	4,128	1,143	1,503	3,601	553	934	486
1978	31	30	20	35	403	1,861	1,526	800	1,003	435	297	60
1979	357	96	228	534	2,226	599	2,672	4,238	950	370	542	550
1980	320	265	389	270	530	420	3,110	490	2,020	3,820	1,030	700
1981	190	360	220	580	840	310	3,800	1,940	4,490	1,850	760	370
1982	400	320	340	880	4,650	1,020	5,630	5,170	5,520	6,410	2,300	1,030
1983	285	330	1,415	540	480	8,220	4,780	6,010	3,280	2,880	950	560
1984	270	290	295	290	560	1,520	610	1,380	6,700	6,080	570	390
1985	410	485	255	365	6,520	6,280	1,920	10,000	4,680	4,760	740	570
1986	350	350	360	860	14,280	1,650	6,390	11,040	14,760	1,815	590	350
1987	550	1,330	1,850	600	36,000	14,080	11,550	7,800	3,920	1,400	4,640	900
1988	1,120	400	370	2,520	4,440	18,420	15,040	8,160	6,320	6,020	2,160	770
1989	710	855	825	885	735	2,340	3,330	1,800	5,420	1,995	960	470
Protozoa												
1973	-	45	-	63	82	188	56	331	-	346	135	58
1974	50	42	72	91	138	409	1,690	716	1,306	4,195	-	-
1975	-	-	-	-	-	-	-	835	3,295	1,141	2,239	452
1976	278	274	305	10,774	1,698	6	1,903	1,676	808	425	396	492
1977	135	365	236	312	4,509	2,048	808	947	2,529	401	825	344
1978	18	14	14	27	332	1,360	407	315	256	222	227	26
1979	312	64	188	380	2,052	459	340	712	609	326	454	328
1980	244	250	354	190	390	370	1,620	380	1,180	3,010	760	640
1981	130	310	180	510	480	230	730	1,250	4,020	1,580	550	330
1982	350	310	310	820	1,300	870	2,360	1,560	1,590	4,850	2,060	980
1983	250	320	315	500	390	6,940	1,320	5,030	1,100	1,670	890	490
1984	225	280	285	260	500	1,190	530	1,210	5,000	5,300	530	360
1985	365	455	230	355	3,280	4,440	1,340	6,680	1,860	4,080	670	520
1986	330	330	300	760	11,220	1,290	5,970	7,520	9,780	1,680	490	305
1987	500	1,260	1,725	480	36,000	9,360	10,080	6,750	3,520	1,030	4,320	725
1988	1,080	345	330	2,360	4,020	8,580	10,720	7,000	5,000	5,720	2,040	710
1989	680	795	780	780	705	2,200	2,910	400	3,000	1,575	900	430

TABLE V-D-2
(Continued)

Rotifera	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	-	5	-	25	64	388	859	1,001	-	75	43	27
1974	26	12	22	24	155	213	2,783	2,939	115	120	-	-
1975	-	-	-	-	-	-	-	3,339	313	444	250	164
1976	48	36	38	169	808	4,864	1,398	1,597	2,643	89	48	78
1977	12	31	26	76	631	1,984	328	539	1,022	147	108	136
1978	29	33	15	14	16	24	72	61	67	47	22	48
1979	44	33	37	151	172	135	2,255	3,482	324	42	86	220
1980	72	14	33	80	140	50	1,470	110	790	780	260	50
1981	40	50	40	70	340	80	2,800	630	470	260	210	40
1982	50	10	30	50	3,340	130	3,250	1,550	3,840	1,520	240	40
1983	30	10	1,100	40	90	1,270	3,440	880	1,930	1,190	60	70
1984	45	10	10	30	40	330	80	160	1,700	780	40	30
1985	40	30	25	10	3,240	1,820	580	2,880	2,740	660	70	40
1986	20	20	60	100	3,060	300	330	3,280	4,560	120	100	45
1987	40	70	125	120	0	4,720	1,400	950	280	370	320	175
1988	40	45	40	160	420	9,540	4,240	1,000	1,320	260	120	60
1989	30	60	45	90	30	140	420	920	2,360	390	60	40
Crustacea												
1973	-	1	-	1	3	12	29	9	-	3	2	2
1974	2	2	3	3	6	3	14	85	7	6	-	-
1975	-	-	-	-	-	-	-	51	12	6	3	6
1976	2	1	5	4	10	141	43	23	69	3	2	8
1977	-	-	2	5	13	96	7	17	50	5	1	6
1978	4	6	3	2	6	48	12	27	75	9	5	5
1979	1	0	3	3	2	4	78	44	17	2	2	2
1980	3	1	1	0	0	0	20	0	50	30	10	10
1981	20	0	0	0	20	0	270	60	0	10	0	0
1982	0	0	0	10	10	20	20	60	90	40	0	10
1983	5	0	0	0	0	10	20	100	250	20	0	0
1984	0	0	0	0	20	0	0	10	0	0	0	0
1985	5	0	0	0	0	20	0	440	80	20	0	10
1986	0	0	0	0	0	60	90	240	420	15	0	0
1987	10	0	0	0	0	0	70	100	120	0	0	0
1988	0	10	0	0	0	300	80	160	0	40	0	0
1989	0	0	0	15	0	0	0	480	60	30	0	0

(a) No sample collected.

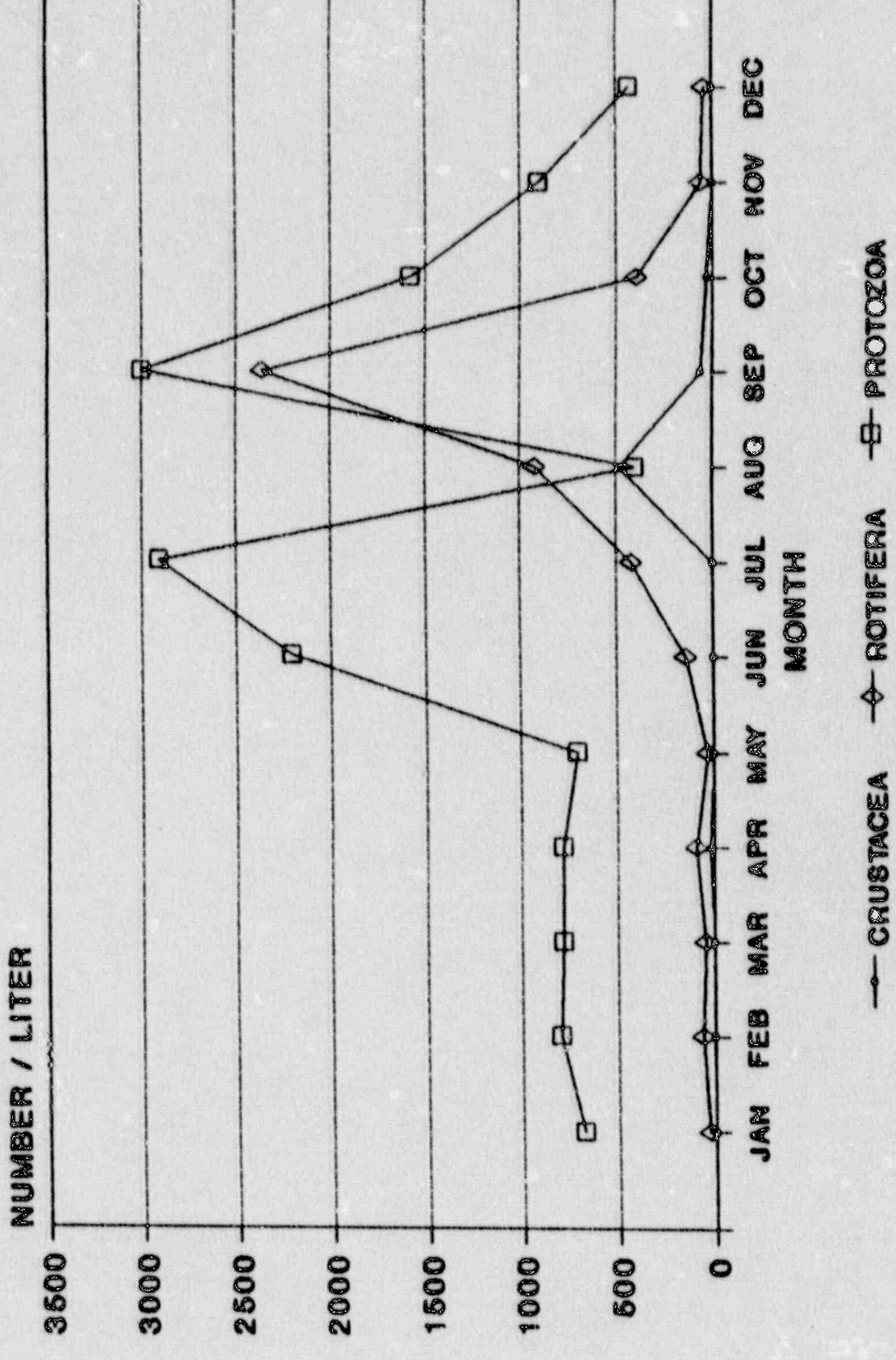


FIGURE V-D-2

ZOOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1989
BVPS

TABLE V-D-3

DENSITIES (Number/liter) OF MOST ABUNDANT ZOOPLANKTON TAXA
(Greater than 2% on any date)
COLLECTED FROM ENTRAINMENT SAMPLES
JANUARY THROUGH DECEMBER, 1989
BVPS

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PROTOZOA												
Arcella sp.	10			15	15	20	30			30	140	10
Centropyxis sp.		30				20		20				
Ciliate #1				15		40	360		180			
Codonella cratera		90	30	60	75	340	330	40	20	15	60	20
Cyclotrichium sp.												10
Cyphoderia ampulla	10	75	15		30	40					140	
Difflugia sp.	180	345	45	165	270	440	60	140	380		160	20
Epistylis sp.	20									120		
Euglypha sp.	10										60	
Holophyrid ciliate	10		15	30	15	120	210		80			
Nuclearia simplex							30			180		
Strobilidium gyrans			15				60	80	40	165	20	10
Strobilidium sp.		15	90	30	60	160	90	80	40	390	80	230
Strombidium sp.	20	30	15	15	45	640	360	80	1,080	135	40	
Tintinnidium fluvitale	30		210	120	90	200	390	20	1,120	75	40	20
Tintinnopsis cylindrica										30		10
Urothricha sp.			30	30		20	90				40	20
Vorticella sp.	350	165	255	255	90	140	900			390	100	50
Ciliate unidentified	30	45	45	45	15	20		20		45	20	30
ROTIFERA												
Cephalodella sp.						60						
Conochilus unicornis								100	320			
Keratella cochlearis		30			15	20		220	740			10
Keratella cochlearis f. *tecta*								40	100			
Keratella quadrata			15	30								
Polyarthra dolichoptera	10	15		45	15		90	440	680	30		10
Synchaeta sp.						20	150	20	340	360	40	10
Rotifer unidentified	10	15	15				60		20		20	10
CRUSTACEA												
Diaphanusoma brachyurum								60	20			
Nauplii				15				380	40	30		
TOTAL ZOOPLANKTON	710	855	825	885	735	2,340	3,330	1,800	5,420	1,995	960	470
TOTAL of Most Abundant Taxa	690	855	795	870	735	2,300	3,210	1,740	5,200	1,995	960	470
Percentage Composition of Most Abundant Zooplankton	97	100	96	98	100	98	96	97	96	100	100	100

Crustacean densities were low (0 to 480/liter) throughout 1989 (Table V-D-1). Most crustaceans were collected during summer especially August when densities were 480/liter (Figure V-D-2). Except during August, crustacean densities never exceeded protozoan or rotifer densities and constituted from 0 to 2% of the total zooplankton density each month (Table V-D-1). Copepod nauplii were the most numerous crustaceans collected during 1989. Crustacean populations did not develop high densities due to unfavorable flow and turbidity conditions in the river during most of 1989. Crustaceans are rarely numerous in the open waters of rivers and many are eliminated by silt and turbulent water (Hynes 1970).

The highest Shannon-Weiner diversity value of 3.49 occurred in November while the maximum number of species (22) occurred in September (Table V-D-4). Evenness ranged from 0.62 in January to 0.92 in November. Richness varied from a low of 1.48 in February to a high of 2.67 in August. The number of species ranged from 11 in February to 22 in September. Diversity indices were relatively high during all months of 1989.

Comparison of Control and Non-Control Transects

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

Comparison of Preoperational and Operational Data

Population dynamics of the zooplankton community during the seasons of preoperational and operational years are displayed in Figure V-D-1. Total zooplankton densities were lowest in winter, usually greatest in summer, and transitional in spring and autumn. This pattern in the Ohio River sometimes varies from year to year which is normal for zooplankton populations in other river habitats. Hynes (1970) concluded that the zooplankton community of rivers is inherently unstable and subject to constant change due to variations of temperature, flow, current, turbidity, and food source. Total densities of zooplankton during 1989 were within the range established during the preoperational years (1973 through 1975) and operational years (1976 through 1988) (Figure V-D-1).

TABLE V-D-4

ZOOPLANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1989
BVPS

	Jan	Feb	Mar	Apr	May	Jun
No. of Species	14	11	15	15	12	18
Shannon-Weiner Index	2.37	2.68	3.02	3.22	2.91	3.21
Evenness	0.62	0.77	0.77	0.82	0.81	0.77
Richness	1.98	1.48	2.08	1.92	1.67	2.19

	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
No. of Species	18	21	22	14	14	15	16
Shannon-Weiner Index	3.43	3.46	3.35	3.20	3.49	2.82	3.10
Evenness	0.82	0.79	0.75	0.84	0.92	0.72	0.78
Richness	2.10	2.67	2.33	1.71	1.89	2.28	2.03

The data for 1989 indicate that the peak zooplankton densities were delayed until September due to unfavorable flow and turbidity conditions in the river.

The species composition of zooplankton in the Ohio River near BVPS has remained stable during preoperational and operational years. The common or abundant protozoans since 1972 have been Vorticella, Codonella, Difflugia, Strobilidium, Cyclotrichium, Arcella and Strombidium. The most numerous and frequently occurring rotifers have been Keratella, Polyarthra, Synchaeta, Branchionus and Trichocerca. Copepod nauplii have been the only crustacean taxon found consistently.

Community structure, as compared by diversity indices, has been similar since 1972 (Table V-D-5). In previous years, low diversity indices and number of species occurred in winter; high diversities and number of species usually occurred in late spring and summer.

In 1989, the diversity indices and species numbers were relatively low in January and February which was typical for months of winter and early spring. Shannon-Wiener diversity indices in 1989 ranged from 2.37 to 3.49 and were slightly higher than the range of 1.80 to 3.28 that occurred during preoperational years from 1973 to 1975. The variation in evenness during 1989 (0.62 to 0.92) was at the upper portion of the range reported from 1973 to 1988 (0.21 to 0.93).

Summary and Conclusions

Zooplankton densities throughout 1989 were typical of the temperate zooplankton community found in large river habitats. Total densities were within the range of those reported in preoperational and several operational years. Populations developed highest densities in September. Except during August, protozoans and rotifers were always predominant. Common and abundant taxa in 1989 were similar to those reported during preoperational and operational years. Shannon-Weiner diversity, number of species, and evenness were within the ranges of preceding years. Based on the data collected during the 14 operating years (1976 through 1989) and the three preoperational years (1973 through 1975), it is

TABLE V-D-5

MEAN ZOOPLANKTON DIVERSITY INDICES BY MONTH FROM 1973 THROUGH 1989 IN THE OHIO RIVER NEAR BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	(a)											
Number of Species		8.44		15.29	21.28	25.07	21.96	22.86		16.33	14.40	14.30
Shannon Index[b]		1.80		3.06	3.08	2.79	2.25	2.20		2.21	2.31	3.10
Evenness		0.37		0.63	0.58	0.46	0.39	0.36		0.37	0.44	0.61
1974												
Number of Species	14.64	9.18	14.92	17.75	23.25	15.56	21.14	18.89	9.56	14.47		
Shannon Index	3.18	2.53	2.91	3.06	3.25	2.32	3.28	2.24	2.15	1.84		
Evenness	0.62	0.56	0.57	0.58	0.55	0.41	0.60	0.41	0.42	0.30		
1975												
Number of Species								24.75	18.75	14.38	17.44	15.38
Shannon Index								3.20	1.86	2.90	2.01	3.20
Evenness								0.69	0.44	0.77	0.49	0.82
1976												
Number of Species	7.00	9.13	8.69	17.56	19.19	23.56	28.06	23.50	23.56	11.19	8.75	11.75
Shannon Index	1.67	2.64	2.24	0.89	3.06	2.33	3.36	3.63	2.76	2.73	1.60	2.64
Evenness	0.60	0.84	0.73	0.21	0.72	0.51	0.70	0.80	0.61	0.79	0.51	0.75
1977												
Number of Species	4.00	10.00	12.00	13.31	21.00	25.62	22.88	25.50	36.75	16.88	20.31	15.31
Shannon Index	1.53	2.59	3.01	2.98	3.15	3.45	3.32	3.60	3.71	3.35	3.42	3.42
Evenness	0.78	0.79	0.87	0.81	0.72	0.74	0.73	0.77	0.71	0.82	0.79	0.86
1978												
Number of Species	0.12	7.12	4.31	5.12	7.62	6.25	10.25	11.25	12.50	0.25	10.88	10.38
Shannon Index	2.48	2.41	1.53	1.70	1.53	1.33	2.50	2.44	2.53	2.28	2.15	2.00
Evenness	0.83	0.85	0.74	0.71	0.52	0.50	0.76	0.70	0.70	0.73	0.62	0.83
1979												
Number of Species	10.62	6.00	10.25	15.88	17.25	14.25	16.88	21.50	18.12	12.00	14.62	14.00
Shannon Index	2.51	2.52	3.05	3.42	2.36	3.02	2.42	3.30	3.36	2.99	2.84	3.10
Evenness	0.74	0.93	0.90	0.86	0.58	0.80	0.60	0.74	0.80	0.84	0.74	0.83
1980[c]												
Number of Species	11.62	11.00	12.50	10.00	8.00	15.00	21.00	15.00	18.00	22.00	18.00	18.00
Shannon Index	2.51	2.70	3.03	2.41	2.00	2.91	3.63	2.79	3.23	2.88	3.26	3.36
Evenness	0.70	0.78	0.84	0.72	0.66	0.74	0.82	0.71	0.77	0.64	0.78	0.80
1981												
Number of Species	8.00	12.00	7.00	11.00	19.00	12.00	23.00	24.00	20.00	21.00	17.00	10.00
Shannon Index	2.14	3.02	2.28	2.32	3.44	2.73	2.96	3.55	2.62	3.05	2.66	2.47
Evenness	0.71	0.84	0.81	0.67	0.81	0.76	0.65	0.77	0.60	0.69	0.65	0.74

TABLE V-D-5
(Continued)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1982												
Number of Species	10.00	9.00	11.00	22.00	27.00	20.00	37.00	36.00	40.00	34.00	19.00	17.00
Shannon Index	2.99	2.22	2.89	3.59	2.46	3.20	3.82	4.28	3.86	3.09	3.54	3.14
Evenness	0.90	0.70	0.83	0.80	0.52	0.74	0.73	0.83	0.72	0.61	0.83	0.77
1983												
Number of Species	18.00	10.00	23.00	14.00	17.00	24.00	34.00	30.00	37.00	33.00	17.00	18.00
Shannon Index	3.20	2.39	2.41	3.09	3.54	2.36	3.56	2.65	3.92	3.43	3.28	3.54
Evenness	0.76	0.71	0.53	0.81	0.86	0.51	0.70	0.54	0.75	0.68	0.89	0.85
1984												
Number of Species	17.00	10.00	7.00	10.00	13.00	18.00	12.00	18.00	23.00	19.00	14.00	11.00
Shannon Index	3.29	2.64	0.82	2.10	2.26	2.63	2.40	2.28	3.62	2.84	2.89	2.52
Evenness	0.80	0.79	0.28	0.63	0.61	0.63	0.67	0.54	0.80	0.67	0.74	0.72
1985												
Number of Species	13.00	12.00	9.00	10.00	16.00	19.00	18.00	32.00	27.00	20.00	19.00	13.00
Shannon Index	2.32	1.98	1.72	1.64	2.90	2.91	3.35	3.60	3.72	3.27	3.25	1.97
Evenness	0.62	0.55	0.53	0.49	0.72	0.68	0.80	0.72	0.78	0.76	0.76	0.53
1986												
Number of Species	12.00	13.00	15.00	19.00	21.00	22.00	23.00	26.00	32.00	17.00	15.00	21.00
Shannon Index	2.97	2.84	3.13	3.15	2.26	3.74	2.94	3.69	4.19	2.90	2.83	3.10
Evenness	0.83	0.76	0.80	0.74	0.74	0.84	0.65	0.78	0.84	0.71	0.72	0.70
1987												
Number of Species	13.00	14.00	16.00	14.00	9.00	20.00	28.00	25.00	20.00	20.00	16.00	16.00
Shannon Index	2.64	1.76	3.40	3.54	0.89	3.15	3.53	3.50	3.29	3.37	2.32	3.48
Evenness	0.71	0.46	0.85	0.93	0.28	0.73	0.73	0.75	0.76	0.78	0.58	0.87
1988												
Number of Species	8.00	17.00	17.00	13.00	13.00	24.00	14.00	24.00	26.00	22.00	16.00	21.00
Shannon Index	2.45	2.57	2.70	2.30	2.60	3.30	2.25	3.20	3.48	2.35	2.97	2.68
Evenness	0.82	0.62	0.65	0.62	0.70	0.72	0.60	0.70	0.74	0.53	0.74	0.61
1989												
Number of Species	14.00	11.00	15.00	15.00	12.00	18.00	18.00	21.00	22.00	14.00	14.00	15.00
Shannon Index	2.37	2.68	3.02	3.22	2.91	3.21	3.43	3.46	3.35	3.20	3.49	2.82
Evenness	0.62	0.77	0.77	0.82	0.81	0.77	0.82	0.79	0.75	0.84	0.92	0.72

(a) Blanks represent periods when no collections were made.
(b) Shannon-Weiner Index
(c) Data for period April 1980-December 1989 represents single entrainment samples collected monthly.

concluded that the overall abundance and species composition of the zooplankton in the Ohio River near BVPS has remained stable and possibly improved slightly over the seventeen year period from 1973 through 1989. The data indicate that increased turbidity and current from high water conditions have the strongest effects of delaying the populations' peaks and temporarily decreasing total zooplankton densities in the Ohic River near BVPS.

E. FISH

Objective

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

Methods

Adult fish surveys were performed in May, July, September, and November 1989. During each survey, fish were collected at the three study transects (Figure V-E-1) using gill nets, electrofishing and minnow traps.

The gill nets consisted of five 25-ft. panels of 1.0, 2.0, 2.5, 3.0, and 3.5 inch square mesh. Two nets were positioned close to shore at each transect, with the small mesh inshore. As Transect 2 is divided by Phillis Island into two separate water bodies consisting of the main river channel (2A) and the back channel (2B), south of the island, a total of eight gill nets were set per sampling month. Nets were set for approximately 24 hours. All captured fish were identified, counted, measured for total length (mm), and weighed (g).

Electrofishing was conducted with a boat-mounted boom electroshocker. Direct current of 220 volts and one to two amps was generally used. Shocking time was maintained at 10 minutes per transect for each survey. The shoreline areas of each transect were shocked and large fish processed as described above for the gill net collections. Small fish were immediately preserved with 10% formalin and returned to the laboratory

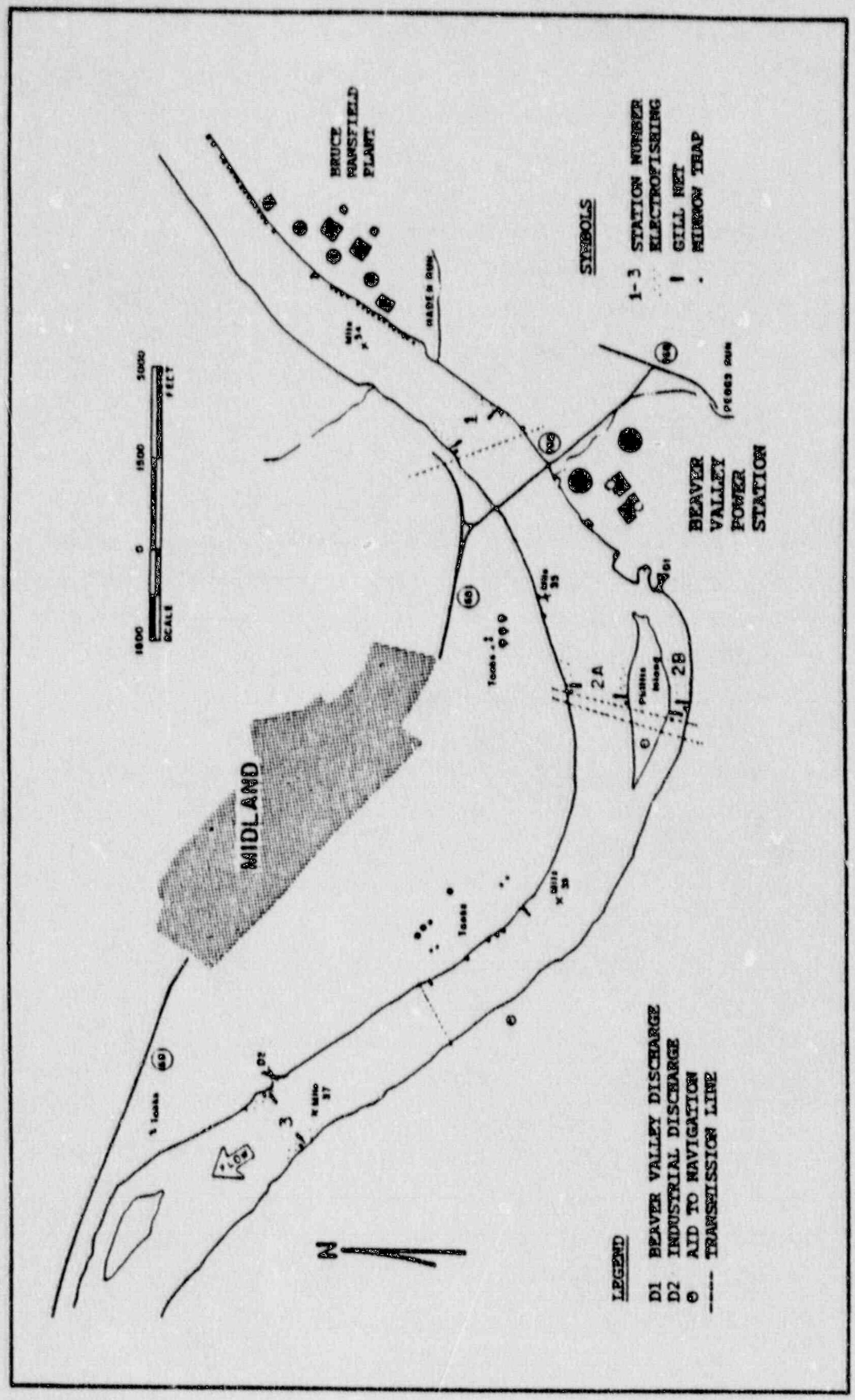


FIGURE V-E-1

FISH SAMPLING STATIONS
BVPS

for analysis. Non-game fish were counted and a batch weight obtained for the entire sample. The length range was determined by visual inspection and measurement of the largest and smallest fish.

Minnow traps were baited with bread, cheese, and sucrose and placed next to the inshore side of each gill net on each sampling date. These traps were painted black and brown with a camouflage design and were set for 24 hours. All captured fish were preserved and processed in the laboratory in the manner described for electrofishing.

Results

Fish population studies have been conducted in the Ohio River near BVPS from 1970 through 1989. These surveys have collected 64 fish species and two hybrids (Table V-E-1). In 1989, 31 fish species were collected. Grass carp, which had not been collected in previous years, was collected in 1989. A combined total of 865 individuals were collected in 1989 by gill netting, electrofishing and minnow traps (Table V-E-2).

A total of 706 fishes, representing 19 species were collected by electrofishing (Table V-E-3). Collectively, shiners accounted for 54.7% of the total electrofishing catch in 1989. Gizzard shad, also a forage species, represented 31.4% of the catch. Carp and white bass accounted for 2.3% and 3.3% of the catch. Smallmouth bass and golden redhorse accounted for 1.7% and 1.3% (combined bass spp. accounted for 7.2% of total catch). Each of the other taxa accounted for less than 1% of the total. Most of the fish sampled by electrofishing were collected in September (44.5%). The fewest fish were collected in July (15.3%).

It should be noted that "observed" fishes were included in the catch per unit effort. This was sometimes necessary because of the turbidity and swiftness of the high water. Since the netters could not physically collect these stunned fishes, they were identified to the genus level and recorded as "observed".

TABLE V-E-1

(SCIENTIFIC AND COMMON NAME)[1]
FAMILIES AND SPECIES OF FISH COLLECTED IN THE NEW CUMBERLAND
POOL OF THE OHIO RIVER, 1970-1989
BVPS

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

TABLE V-E-1
(Continued)

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

TABLE V-E-1
(Continued)

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

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

TABLE V-E-2

NUMBER OF FISH COLLECTED AT VARIOUS TRANSECTS BY GILL NET (G), ELECTROFISHING (E) AND MINNOW TRAP (M) IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1989
BVPS

Taxa	1			2A			2B			3			Grand Total			Annual Total	Percent Annual Total
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M		
Longnose gar	2						1			2			5			5	0.6
Gizzard shad		62			97			44			19			222		222	25.7
Muskellunge				1						1			2			2	0.2
Tiger muskellunge	1			3						4	1		8	1		9	1.0
Pike sp.		1			1									2		2	0.2
Grass carp	1												1			1	0.1
Common carp	8	5		15	1		2	2		14	8		39	16		55	6.4
Golden shiner											1			1		1	0.1
Emerald shiner		6			10			3	3		1			20	3	23	2.7
Spottail shiner		1									2			3		3	0.3
Spotfin shiner									1						1	1	0.1
Shiner sp.		14			64			204			80			362		362	41.8
River carpsucker		1		1							3		1	4		5	0.6
Quillback										1	1		1	1		2	0.2
White sucker										1			1			1	0.1
Smallmouth buffalo										1			1			1	0.1
Silver redhorse										1	1		1	1		2	0.2
Golden redhorse	2	5			1		1	1		3	2		6	9		15	1.7
Shorthead redhorse				1						1			2			2	0.2
Redhorse sp.		3												3		3	0.3
Channel catfish	1	1		7			4			17			29	1		30	3.5
Flathead catfish				2									2			2	0.2
White bass	1	2		2	2			1		5	18		8	23		31	3.6
Rock bass			4	1									1		4	5	0.6
Pumpkinseed		1												1		1	0.1
Bluegill								1						1		1	0.1
Sunfish sp.		1												1		1	0.1
Smallmouth bass		2			7			1			2			12		12	1.4
Spotted bass	7			5	1		10	4		8	3	1	30	8	1	39	4.5
Bass sp.					2			1			5			8		8	0.9
White crappie										1			1			1	0.1
Black crappie										1			1			1	0.1
Banded darter		1												1		1	0.1
Sauger	1	1			1					4			5	2		7	0.8
Walleye	1									2			3			3	0.3
Freshwater drum		1			1			1		2			2	3		5	0.6
Total	25	108	4	38	188		18	263	4	69	147	1	150	706	9	865	

TABLE V-E-3

NUMBER OF FISH COLLECTED PER MONTH BY GILL NET (G), ELECTROFISHING (E), AND MINNOW TRAP (M)
IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1989
BVPS

Taxa	May			Jul			Sep			Nov			Grand Total			Annual Total	Percent Annual Total
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M		
Longnose gar	2			1			2						5			5	0.6
Gizzard shad		79			79			28			36			222		222	25.7
Muskellunge	1			1									2			2	0.2
Tiger muskellunge	8	1											8	1		9	1.0
Pike sp.		1						1						2		2	0.2
Grass carp				1									1			1	0.1
Common carp	10	2		14	12		13			2	2		39	16		55	6.4
Golden shiner		1												1		1	0.1
Emerald shiner		9						1			10	3		20	3	23	2.7
Spottail shiner		3												3		3	0.3
Spotfin shiner									1						1	1	0.1
Shiner sp.		16			2			280			64			362		362	41.8
River carpsucker		4								1			1	4		5	0.6
Quillback	1	1											1	1		2	0.2
White sucker				1									1			1	0.1
Smallmouth buffalo							1						1			1	0.1
Silver redhorse				1	1								1	1		2	0.2
Golden redhorse	2	5		1	2		1			2	2		6	9		15	1.7
Shorthead redhorse				1			1						2			2	0.2
Redhorse sp.		2			1									3		3	0.3
Channel catfish	9	1		13			6			1			29	1		30	3.5
Flathead catfish							2						2			2	0.2
White bass	4	23		3			1						8	23		31	3.6
Rock bass			3	1					1				1		4	5	0.6
Pumpkinseed		1												1		1	0.1
Bluegill					1									1		1	0.1
Sunfish sp.		1												1		1	0.1
Smallmouth bass		3			4			3			2			12		12	1.4
Spotted bass	19	7	1	5	1		6						30	8	1	39	4.5
Bass sp.		3			3			1			1			8		8	0.9
White crappie							1						1			1	0.1
Black crappie										1			1			1	0.1
Banded darter											1			1		1	0.1
Sauger	1	1		1	1					3			5	2		7	0.8
Walleye	1			1						1			3			3	0.3
Freshwater drum		2		2	1								2	3		5	0.6
TOTAL	58	166	4	47	108		34	314	2	11	118	3	150	706	9	865	

The gill net results varied by month with the highest catch in the month of May (58 fish). July was the next highest month with 47 fish. The November catch resulted in 11 fish. Gill net sampling typically results in catching more fish in warmer weather when fish are usually more active, thus the low sample numbers encountered from November are to be expected (Table V-E-4).

A total of nine fish were captured using minnow traps in 1989 (Table V-E-2). May had the highest catch with four fish.

The most common species (i.e., those which contributed more than 1% to the annual total catch) collected through the use of gill nets, electrofishing and minnow traps included the following: gizzard shad, common carp, emerald shiner, golden redhorse, channel catfish, white bass, smallmouth bass, spotted bass, and unidentified shiner species (observed). The remaining species each accounted for 1% or less of the total.

Comparison of Control and Non-Control Transects

Comparisons of the data obtained from the Control Transect (1) with that from the Non-Control Transects indicate that the fish populations have fluctuated slightly since 1974 (Table V-E-5). However, comparisons between years include many natural variables and can be misleading. Fluctuations in catches occur with changes in the physical and chemical properties of the river's ambient water quality. Since electrofishing efficiency depends largely on the water's conductivity, any sampling conducted during extremes in this parameter will affect catch-per-unit-effort. In addition, turbidity and current affects the collectors' ability to observe the stunned fish. Direct sunlight also influences where fishes congregate, thus determining their susceptibility to being shocked. Electrofishing collects mostly small forage species (minnows and shad) and their highly fluctuating annual populations were reflected in differences in catch-per-unit-effort from year to year and station to station. However, gill nets catch mostly game species and are more indicative of changes in fish abundance. When comparing gill net data (Table

TABLE V-E-4

NUMBER OF FISH COLLECTED BY GILL NET, ELECTROFISHING AND MINNOW TRAP AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1989
BVPS

	Transect					
Gill Net	1	2A	2B	3	Total	Average
May	10	14	8	26	58	14.5
July	9	3	6	29	47	11.8
September	5	17	3	9	34	8.5
November	1	4	1	5	11	2.8
Total	25	38	18	69	150	
Average	6.3	9.5	4.5	17.3		
Electrofishing						
May	57	48	15	46	166	41.5
July	33	38	21	16	108	27.0
September	4	12	215	83	314	78.5
November	14	90	12	2	118	29.5
Total	108	188	263	147	706	
Average	27.0	47.0	65.8	36.8		
Minnow Trap						
May	3	0	0	1	4	1.0
July	0	0	0	0	0	0
September	1	0	1	0	2	0.5
November	0	0	3	0	3	0.8
Total	4	0	4	1	9	
Average	1.0	0	1.0	0.3		

TABLE V-E-5

ELECTROFISHING CATCH (FISH/HOUR) MEANS ($\bar{X}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1974-1989
BVPS

Species	Transect 1															
	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]
Longnose gar	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	-
Gizzard shad	-	2.1	1.2	2.0	-	-	3.1	3.0	0.8	69.0	31.5	27.0	16.0	76.5	175.5	93.0
Tiger muskellunge	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-
Muskellunge	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-
Northern pike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pike sp.	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	1.5
Goldfish	-	-	0.7	-	-	-	2.3	-	0.8	-	-	-	-	-	-	-
Carp	5.9	-	-	1.0	12.5	-	20.8	15.8	1.5	30.0	66.0	13.5	9.0	15.0	18.0	7.5
River chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Golden shiner	-	-	-	-	-	-	-	0.8	-	-	1.5	-	-	-	-	-
Emerald shiner	42.0	441.7	18.7	57.0	22.8	58.4	51.5	151.5	114.8	279.0	12.0	6.0	46.5	58.5	40.5	9.0
Striped shiner	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	-
Spottail shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	3.0	1.5
Spotfin shiner	0.9	-	4.8	7.0	0.5	-	-	-	3.0	4.5	1.5	-	-	-	-	-
Sand shiner	57.6	129.1	52.5	95.3	8.8	93.6	32.3	23.2	19.5	6.0	3.0	-	4.5	9.0	-	-
Mimic shiner	-	-	3.5	7.0	0.5	1.6	6.2	3.0	6.0	-	-	-	19.5	1.5	-	-
Bluntnose minnow	33.3	72.3	53.2	57.8	12.8	89.4	15.4	18.0	21.8	9.0	4.5	1.5	4.5	-	1.5	-
Creek chub	0.9	-	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-
Blacknose dace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shiner sp.	-	-	-	-	-	-	-	-	-	-	78.0	3.0	528.0	114.0	78.0	21.0
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-
White sucker	-	-	-	-	0.3	-	-	-	-	-	1.5	1.5	3.0	-	-	-
Northern hog sucker	0.7	-	-	1.0	0.3	-	-	-	-	1.5	-	-	-	1.5	-	-
Redhorse sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5
Silver redhorse	-	-	-	-	-	-	-	-	0.0	1.5	-	3.0	-	-	-	-
Black redhorse	-	-	-	-	0.8	1.0	-	-	-	-	-	-	-	-	-	-
Golden redhorse	-	-	-	-	-	-	1.5	1.5	-	1.5	6.0	1.5	-	-	-	7.5
Shorthead redhorse	-	-	-	-	-	-	-	0.8	0.0	-	1.5	-	-	3.0	3.0	-
Yellow bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	-	-	-	-	0.3	-	-	0.8	-	-	-	-	-	1.5	-	1.5
Catfish sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trout-perch	-	-	-	-	-	-	1.5	-	0.8	-	1.5	-	-	-	-	-
Banded killifish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

TABLE V-E-5
(Continued)

Transect 1

Species	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]
Brook silverside	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	4.5	3.0
Rock bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sunfish (Lepomis) hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green sunfish	-	-	-	-	0.3	0.5	-	-	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	-	-	0.3	0.5	-	-	-	1.5	-	-	-	-	-	1.5
Bluegill	6.6	-	1.5	-	3.0	0.5	-	1.5	0.8	1.5	1.5	-	1.5	-	3.0	-
Sunfish sp.	-	-	-		-	-	-	-	-	-	1.5	-	-	-	-	1.5
Smallmouth bass	0.9	-	2.3	3.0	0.3	0.5	4.6	3.0	3.8	4.5	9.0	3.0	1.5	6.0	3.0	3.0
Spotted bass	0.9	-	-	2.7	-	2.6	4.6	1.5	-	4.5	9.0	1.5	3.0	7.5	4.5	-
Largemouth bass	1.1	-	-	1.0	1.0	-	0.8	-	0.8	-	-	-	3.0	-	1.5	-
Bass sp.	-	-	-	-	-	-	-	-	-	-	4.5	3.0	3.0	4.5	18.0	-
White crappie	-	-	-	-	-	-	1.5	-	-	-	-	-	1.5	-	-	-
Black crappie	-	-	-	-	-	-	-	-	-	1.5	-	1.5	-	-	-	-
Johnny darter	-	-	-	-		0.5	-	-	-	-	-	-	-	-	-	-
Banded darter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Yellow perch	-	-	-	-	0.3	0.5	-	0.8	-	-	3.0	-	-	-	-	-
Logperch	-	-	-	-	0.3	0.5	-	-	-	-	-	-	1.5	-	3.0	-
Sauger	-	-	-	-	-	-	-	-	-	-	-	1.5	1.5	1.5	-	1.5
Walleye	-	-	0.5	-	-	-	-	-	-	-	3.0	-	-	-	-	-
Freshwater drum	-	-	-	-	-	-	-	-	-	-	-	-	3.0	3.0	1.5	1.5
Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	150.8	665.2	139.4	235.9	65.6	250.6	146.9	225.2	176.0	418.5	241.5	67.5	670.5	304.5	361.5	162.0

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

TABLE V-E-5
(Continued)

Species	Transect 2A, 2B, 3															
	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1980[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]	1988[d]	1989[d]
Longnose gar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
Gizzard shad	0.9	1.0	1.4	0.7	0.3	2.1	2.5	21.5	19.2	19.5	76.5	33.0	57.5	136.0	315.0	80.0
Tiger muskellunge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5
Muskellunge	-	-	-	-	-	-	0.3	-	-	-	0.5	-	-	-	-	-
Northern pike	-	-	-	-	0.3	-	-	0.2	-	-	-	-	-	-	-	-
Pike sp.	-	-	-	-	-	-	-	-	-	-	1.0	1.0	0.5	-	-	0.5
Goldfish	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-
Carp	3.3	0.5	0.7	1.2	6.6	1.2	4.2	6.0	4.8	3.0	20.2	10.0	9.5	5.0	5.0	5.5
River chub	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
Golden shiner	-	-	-	-	-	-	-	-	0.2	0.5	-	-	0.5	-	-	0.5
Emerald shiner	67.7	239.9	13.1	33.8	23.9	53.7	37.0	163.5	21.8	493.5	23.5	21.5	36.5	31.0	13.0	7.0
Striped shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail shiner	-	-	-	-	-	-	-	-	-	-	-	-	0.5	3.5	-	1.0
Spotfin shiner	4.3	2.0	6.1	4.9	0.5	0.5	1.0	0.8	1.0	4.0	1.5	-	2.0	0.5	0.5	-
Sand shiner	17.4	81.0	52.6	26.2	13.3	45.2	25.8	13.2	22.8	26.0	-	-	0.5	1.5	0.5	-
Mimic shiner	-	-	1.8	1.1	0.3	2.2	1.0	3.2	4.8	7.0	-	-	1.5	0.5	-	-
Bluntnose minnow	6.1	31.2	45.3	44.9	21.4	40.8	10.2	5.2	14.2	38.5	0.5	1.0	0.5	0.5	0.5	-
Creek chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-
Blacknose dace	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-
Shiner sp.	-	-	-	-	-	-	-	-	-	-	40.0	42.5	566.5	299.5	12.5	174.0
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
Quillback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
White sucker	-	0.5	-	0.3	0.1	0.3	-	-	-	0.5	-	-	-	-	-	-
Northern hog sucker	-	-	-	0.3	0.3	0.3	0.2	0.8	-	-	-	0.5	-	-	-	-
Redhorse sp.	-	-	-	0.3	-	-	-	-	-	-	0.5	1.5	0.5	-	0.5	-
Silver redhorse	-	-	-	-	0.3	-	-	0.2	0.2	-	1.0	-	-	-	-	0.5
Black redhorse	-	-	-	0.3	0.3	-	-	-	-	-	-	2.0	-	-	-	-
Golden redhorse	-	-	-	-	-	-	0.8	0.2	1.5	1.5	-	1.0	2.0	0.5	0.5	2.0
Shorthead redhorse	-	-	-	-	0.4	-	-	0.2	1.5	0.5	-	-	-	0.5	-	-
Yellow bullhead	0.4	-	0.2	-	0.2	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	0.4	-	0.2	-	0.1	-	-	0.1	-	-	-	0.5	-	-	-	-
Channel catfish	-	1.0	0.2	1.1	0.3	0.7	0.5	1.2	1.0	0.5	0.5	-	1.5	1.0	-	-
Catfish sp.	-	-	-	-	-	-	-	-	-	-	0.5	1.0	-	-	-	-
Trout-perch	-	-	-	-	0.1	0.5	0.2	-	0.2	5.0	-	-	-	-	-	-
Banded killifish	-	-	-	-	0.1	-	-	-	-	-	0.5	-	-	-	-	-
Brook silverside	-	-	-	-	-	-	-	-	-	3.0	-	-	-	-	-	-
White bass	-	-	-	-	0.1	-	0.5	-	-	-	-	-	-	-	15.0	10.5
Rock bass	-	-	0.4	-	0.1	-	-	0.5	-	-	-	-	0.5	0.5	0.5	-

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

TABLE V-E-5
(Continued)

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

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

V-E-6), little change is noticed either between Control and Non-Control Transects or between preoperational and operational years. The 1989 gill net catch-per-unit-effort (fish/24 hours) is a high catch compared with previous collections with 3.1 and 5.1-5.9 for the Control and Non-Control Transects respectively. Contributing to these yields are notably high catches of carp, channel catfish, and spotted bass.

Comparison of Preoperational and Operational Data

Electrofishing and gill net data, expressed as catch-per-unit-effort, for the years 1974 through 1989 are presented in Tables V-E-5 and V-E-6. These sixteen years represent two preoperational years (1974 and 1975) and fourteen operational years (1976 through 1989). Fish data for Transect 1 (Control Transect) and the averages of Transects 2A, 2B, and 3 (Non-Control Transects) are tabulated separately. These data indicate that new species are continuing to inhabit the study area and that, in general, the water quality of the Ohio River has steadily improved.

Summary and Conclusions

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

TABLE V-E-6

GILL NET CATCH (FISH/24 HOUR) MEANS ($\bar{x}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL

THE OHIO RIVER, 1974-1989

BVPS

Transect 1

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

TABLE V-E-6
(Continued)

Transect 2A, 2B, 3

Species	1974[a]	1975[b]	1976[c]	1977[d]	1978[d]	1979[d]	1980[e]	1981[e]	1982[e]	1983[e]	1984[e]	1985[f]	1986[e]	1987[e]	1988[e]	1989[e]
Longnose gar	-	-	-	-	-	-	-	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	-	0.1
Gizzard shad	0.2	0.1	-	0.1	-	<0.1	-	<0.1	0.7	0.1	-	0.4	0.8	0.1	0.3	-
Mooneye	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-
Rainbow trout	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern pike	-	-	-	0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
Muskellunge	-	-	-	-	<0.1	-	-	-	<0.1	0.1	-	<0.1	0.2	-	-	<0.1
Tiger muskellunge	-	-	-	-	<0.1	-	<0.1	-	-	<0.1	-	<0.1	-	-	0.2	0.3
Goldfish	-	-	<0.1	0.1	-	-	<0.1	-	-	-	-	-	-	-	-	-
Carp	0.9	0.3	0.2	0.6	0.3	0.3	0.2	0.3	0.9	0.9	0.3	0.5	1.0	0.4	2.1	1.3
Goldfish x Carp hybrid	-	0.1	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
River carpsucker	-	-	-	-	-	-	-	-	-	-	-	<0.1	0.1	0.1	0.2	<0.1
Quillback	-	-	<0.1	0.2	0.1	<0.1	<0.1	-	<0.1	0.2	-	0.1	-	-	0.1	<0.1
White sucker	0.1	-	-	<0.1	-	<0.1	<0.1	-	-	0.1	<0.1	-	<0.1	-	-	<0.1
Smallmouth buffalo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
Black redhorse	-	-	-	<0.1	0.1	<0.1	-	-	-	-	-	-	-	-	-	-
Silver redhorse	-	-	-	-	-	<0.1	-	-	<0.1	-	0.2	0.1	-	-	<0.1	<0.1
Golden redhorse	-	-	-	-	-	-	-	-	<0.1	-	<0.1	0.2	0.1	0.2	0.2	0.2
Shorthead redhorse	-	-	-	-	-	-	-	-	<0.1	<0.1	0.1	-	-	<0.1	0.1	0.1
Redhorse sp.	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	<0.1	-	-	-
Black bullhead	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brown bullhead	0.2	-	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-
Yellow bullhead	0.1	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-
White catfish	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel catfish	0.3	1.3	0.4	1.0	0.4	0.5	0.4	0.6	0.7	0.5	0.3	0.8	1.1	0.6	0.7	1.2
Flathead catfish	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	0.1	-	0.1	0.1
White bass	-	-	-	-	-	-	-	-	-	0.1	-	-	<0.1	0.1	0.8	0.3
Rock bass	-	0.1	-	<0.1	<0.1	<0.1	-	-	<0.1	0.1	<0.1	0.2	<0.1	0.2	<0.1	<0.1
Green sunfish	-	-	-	0.1	-	-	-	<0.1	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	-	0.1	-	-	-	-	-	-	-	<0.1	-	-	-	-
Bluegill	-	-	-	0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Smallmouth bass	-	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	-
Largemouth bass	0.2	0.1	0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	-	-	-	-	<0.1	-
Spotted bass	-	-	0.2	0.1	<0.1	<0.1	0.1	<0.1	0.3	1.4	0.2	0.5	0.1	0.7	2.2	1.0
White crappie	-	-	<0.1	<0.1	-	0.1	0.1	-	<0.1	0.2	-	0.2	-	0.1	<0.1	<0.1
Black crappie	-	-	<0.1	0.1	-	<0.1	-	-	-	0.1	<0.1	-	-	0.1	<0.1	<0.1
Yellow perch	-	0.7	0.5	0.7	0.1	0.1	-	<0.1	-	<0.1	<0.1	-	<0.1	-	-	-
Walleye	0.2	0.2	0.1	0.2	0.1	<0.1	0.2	0.1	0.7	0.1	0.1	0.1	<0.1	-	0.2	0.1
Sauger	-	0.1	-	<0.1	0.2	0.3	<0.1	0.2	0.2	0.5	0.4	0.2	0.3	0.2	0.7	0.2
Freshwater drum	-	-	-	-	-	-	-	0.1	0.3	0.2	-	-	<0.1	-	0.2	0.1
Total	2.2	3.1	1.5-2.2	3.6-4.3	1.3-1.9	1.3-1.9	1.2-1.6	1.5	4.4	5.2	2.0	3.3-4.0	3.8-4.8	2.8-3.1	8.1-8.7	5.1-5.9

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

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

Differences in the 1989 electrofishing and gill net catches, between the Control and Non-Control Transects were similar to previous years (both operational and preoperational) and were probably caused by habitat preferences of individual species. This habitat preference is probably the most influential factor that affects where the different species of fish are collected and in what relative abundance.

Data collected from 1970 through 1989 indicate that fish in the vicinity of the power plant have not been adversely affected by BVPS operation.

F. ICHTHYOPLANKTON

Objective

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

Methods

The 1989 program had five day surveys (April 13, May 23, June 19, July 12 and August 15) and two night surveys (May 24, and July 13) conducted during the spring and summer, which is the primary spawning season for most resident fish species. One surface and one bottom collection were taken at Transect 2B (back channel of Phillis Island) during each survey (Figure V-F-1). Tows were made in a zig-zag fashion across the channel utilizing a conical 505 micron mesh plankton net with a 0.5 m mouth diameter.

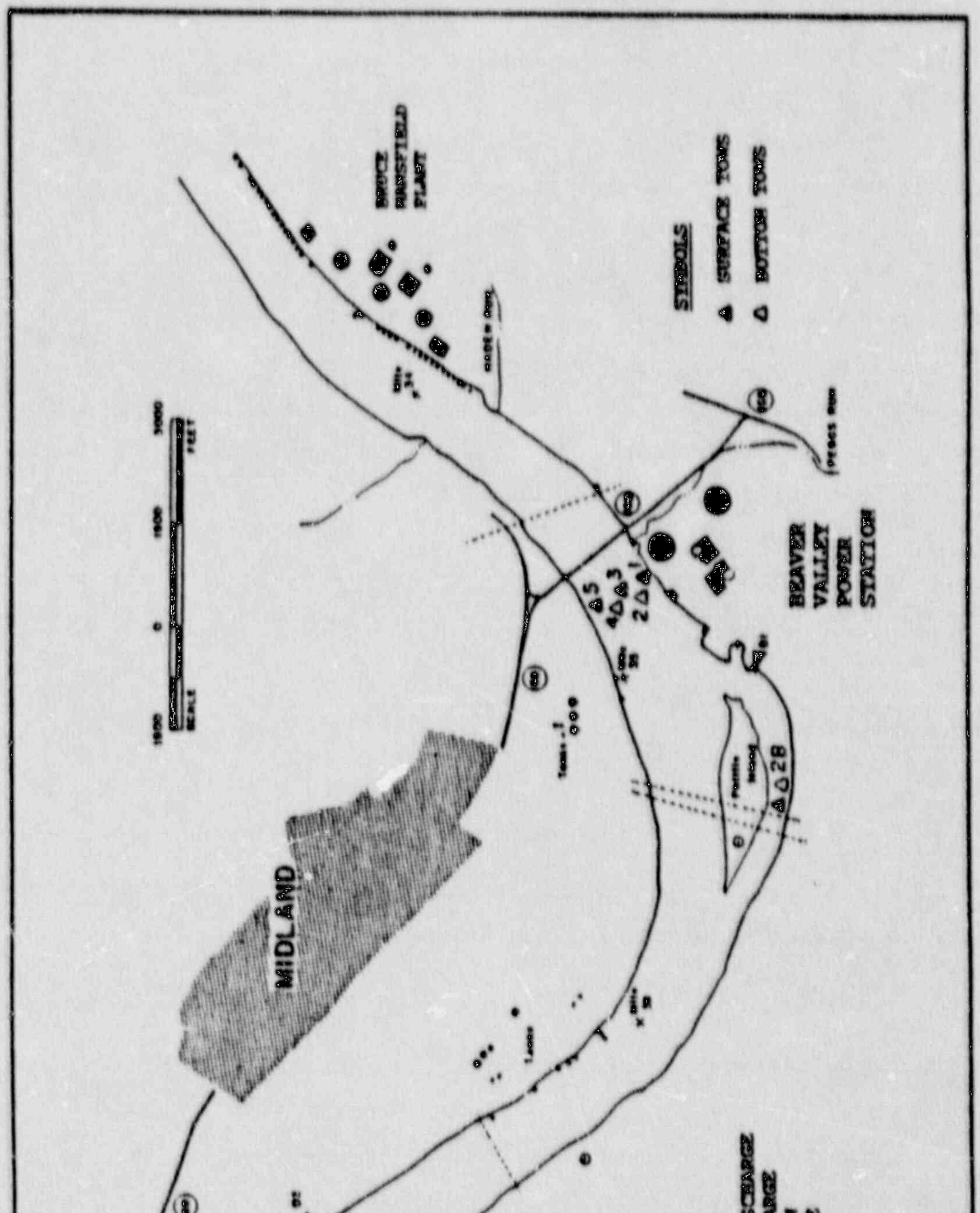


FIGURE V-F-1

ICHTHYOPLANKTON SAMPLING STATIONS
BVPS

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

In the laboratory, ichthyoplankton was sorted from the sample and enumerated. Each specimen was identified as to its stage of development (egg, yolk-sac larvae, early larvae, juvenile, or adult) and to the lowest possible taxon. Densities of ichthyoplankton (numbers/100 m^3) were calculated for each sample using flowmeter data.

Results

A total of 1,586 eggs and 621 larvae were collected in 1989 from 1,659.3 m^3 of water sampled (Table V-F-1). Nine taxa representing six families were identified. Gizzard shad (Dorosoma cepedianum) accounted for 16.3% of the total catch. Freshwater drum eggs (Aplodinotus grunniens) represented 99.2% of the eggs collected in 1989. For 1989, the night collections produced a total density of 381.60 individuals per 100 m^3 compared to those from day collections which were 21.72 individuals per 100 m^3. Of the day collections, densities on July 12 were most abundant with a total density of 96.60 individuals per 100 m^3 (mostly gizzard shad larvae). The most abundant densities for the night collections were on July 13 with a total density of 707.82 individuals per 100 m^3 (freshwater drum eggs and larvae, and gizzard shad larvae). No ichthyoplankton were collected in April (Table V-F-1), whereas total catch in May yielded two eggs and three larvae.

Comparison of Preoperational and Operational Data

Species abundance and composition were similar to that found in previous years. Gizzard shad, and freshwater drum dominated the catch and other taxa were represented by only a few individuals. Densities of ichthyoplankton collected in the backchannel (Station 2B) from 1973-1974, 1976-1989, are presented in Table V-F-2.

TABLE V-F-1

NUMBER AND DENSITY OF FISH EGGS, LARVAE, JUVENILES, AND ADULTS (Number/100 m^3) COLLECTED WITH A 0.5 m PLANKTON NET IN THE OHIO RIVER BACK CHANNEL OF PHILLIS ISLAND (STATION 2B) NEAR BVPS, 1989

Date	Depth of Collection				Total Collection and Taxa Density
	Surface		Bottom		
	Day	Night	Day	Night	
April 13					
Vol. water filtered (m^3)	137.3		153.6		290.9
Number eggs collected	0		0		0
Number larvae collected	0		0		0
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Density (number collected)	0		0		0
Total Density (number collected)	0		0		0
May 23/24					
Vol. water filtered (m^3)	166.7	128.8	147.1	108.1	550.7
Number eggs collected	0	1	1	0	2
Number larvae collected	0	1	1	1	3
Number juveniles collected	0	0	0	0	0
Number adults collected	0	0	0	0	0
Density (number collected)					
Eggs					
Unidentified egg (EE)	0	0.78(1)	0.68(1)	0	0.36(2)
Larvae					
Stizostedion spp.	0	0.78(1)	0.68(1)	0.93(1)	0.55(3)
Total Density (number collected)	0	1.55(2)	1.36(2)	0.93(1)	0.91(5)
June 19					
Vol. water filtered	61.1		48.7		109.8
Number eggs collected	0		11		11
Number larvae collected	5		12		17
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Density (number collected)					
Eggs					
Cyprinus carpio (EE)	0		10.27(5)		4.55(5)
Unidentified egg (EE)	0		12.32(6)		5.46(6)
Larva					
Dorosoma cepedianum (EL)	1.64(1)		0		0.91(1)
Cyprinus carpio (YL)	0		4.11(2)		1.82(2)
Cyprinus carpio (EL)	4.91(3)		12.32(6)		8.20(9)
Catostomidae (EL)	0		6.16(3)		2.73(3)
Etheostoma spp. (EL)	0		2.05(1)		0.91(1)
Unidentifiable (EL)	1.64(1)		0		0.91(1)
Total Density (number collected)	8.18(5)		47.23(23)		25.50(28)

TABLE V-F-1
(Continued)

Date	Depth of Collection: Surface Day	Surface Night	Bottom Day	Bottom Night	Total Collection and Taxa Density
July 12/13					
Vol. water filtered (m^3)	136.8	144.7	80.6	131.5	493.6
Number eggs collected	11	780	2	778	1571
Number larvae collected	129	215	68	182	594
Number juveniles collected	0	0	0	0	0
Number adults collected	C	0	0	0	0
Density (number collected)					
Eggs					
Aplodinotus grunniens (EE)	8.04(11)	539.05(780)	2.48(2)	591.63(778)	318.27(1571)
Larvae					
Cyprinidae (YL)	1.46(2)	1.38(2)	0	3.04(4)	1.62(8)
Dorosoma cepedianum (YL)	0.73(1)	6.91(10)	3.72(3)	1.52(2)	3.24(16)
Dorosoma cepedianum (EL)	74.56(102)	87.77(127)	63.28(51)	47.15(62)	69.29(342)
Cyprinus carpio (EL)	0.73(1)	7.60(11)	1.24(1)	0.76(1)	2.84(14)
Notropis spp. (EL)	6.58(9)	0.69(1)	3.72(3)	2.28(3)	3.24(16)
Pimephales spp. (EL)	2.92(4)	0.69(1)	0	0	1.01(5)
Pomoxis spp. (EL)	0	0	0	0.76(1)	0.20(1)
Aplodinotus grunniens (YL)	6.58(9)	38.70(56)	7.44(6)	74.52(98)	34.24(169)
Aplodinotus grunniens (EL)	0	2.76(4)	0	6.84(9)	2.63(13)
Unidentifiable (*L)	0.73(1)	2.07(3)	4.96(4)	1.52(2)	2.03(10)
Total Density (number collected)	102.34(140)	687.63(995)	86.85(70)	730.04(960)	438.61(2,165)
August 15					
Vol. water filtered (m^3)	110.0		104.3		214.3
Number eggs collected	0		2		2
Number larvae collected	0		7		7
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Densities (number collected)					
Eggs					
Aplodinotus grunniens (EE)	0		1.92(2)		0.93(2)
Larvae					
Aplodinotus grunniens (YL)	0		4.79(5)		2.33(5)
Aplodinotus grunniens (EL)	0		1.92(2)		0.93(2)
Total Density (number collected)	0		8.63(9)		4.20(9)

TABLE V-F-1
(Continued)

Yearly Totals	Depth of Collection: Surface Day	Surface Night	Bottom Day	Bottom Night	Total Collection and Taxa Density
Vol. water filtered (m^3)	611.9	273.5	534.3	239.6	1,659.3
Number eggs collected	11	781	16	778	1,586
Number larvae collected	134	216	88	183	621
Number juveniles collected	0	0	0	0	0
Number adults collected	0	0	0	0	0
Densities (number collected)					
Eggs					
Cyprinus carpio (EE)	0	0	0.94(5)	0	0.30(5)
Aplodinotus grunniens (EE)	1.80(11)	285.19(780)	0.75(4)	324.71(778)	94.80(1,573)
Unidentified egg (EE)	0	0.37(1)	1.31(7)	0	0.48(8)
Larvae					
Dorosoma cepedianum (YL)	0.16(1)	3.66(10)	0.56(3)	0.83(2)	0.96(16)
Dorosoma cepedianum (EL)	16.83(103)	46.4[illegible](127)	9.55(51)	25.88(62)	20.67(343)
Cyprinidae (YL)	0.33(2)	0.73(2)	0	1.67(4)	0.48(8)
Cyprinus carpio (YL)	0	0	0.37(2)	0	0.12(2)
Cyprinus carpio (EL)	0.65(4)	4.02(11)	1.31(7)	0.42(1)	1.39(23)
Notropis spp. (EL)	1.47(9)	0.37(1)	0.56(3)	1.25(3)	0.96(16)
Pimephales spp. (EL)	0.[illegible]5(4)	0.37(1)	0	0	0.30(5)
Pomoxis spp. (EL)	0	0	0	0.42(1)	0.06(1)
Catostomidae (EL)	0	0	0.56(3)	0	0.18(3)
Etheostoma spp. (EL)	0	0	0.19(1)	0	0.06(1)
Stizostedion spp. (EL)	0	0.37(1)	0.19(1)	0.42(1)	0.18(3)
Aplodinotus grunniens (YL)	1.47(9)	20.48(56)	2.06(11)	40.90(98)	10.49(174)
Aplodinotus grunniens (EL)	0	1.46(4)	0.37(2)	3.76(9)	0.90(15)
Unidentifiable (*L)	0.33(2)	1.10(3)	0.75(4)	0.83(2)	0.66(11)
Total Density (number collected)	23.70(145)	364.53(997)	19.46(104)	401.09(961)	133.01(2,207)

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

TABLE V-F-2

DENSITY OF ICHTHYOPLANKTON (Number/100m^3) COLLECTED IN THE OHIO RIVER BACK CHANNEL OF PHILLIS ISLAND (STATION 2B) NEAR BVPS, 1973-1974, 1976-1989

Date	Density
1973	
Apr 12	0
May 17	0
Jun 20	16.10
Jul 26	3.25

Date	Density
1974	
Apr 16	0
May 24	0
Jun 13	6.98
Jun 26	9.25
Jul 16	59.59
Aug 1	6.85

Date	Density
1976	
Apr 26	0.70
May 19	0
Jun 18	5.99
Jul 2	6.63
Jul 15	3.69
Jul 29	4.05

Date	Density
1977	
Apr 14	0
May 11	0.90
Jun 9	24.22
Jun 22	3.44
Jul 7	3.31
Jul 20	28.37

Date	Density
1978	
Apr 22	0
May 5	0
May 20	0.98
Jun 2	4.01
Jun 16	12.15
Jul 2	13.32

Date	Density
1979	
Apr 19	0
May 1	0
May 17	0.81
Jun 7	0.39
Jun 20	11.69
Jul 5	14.82

Date	Density
1980	
Apr 23	0.42
May 21	0.53
Jun 19	9.68
Jul 22	107.04

Date	Density
1981	
Apr 20	1.10
May 12	0
Jun 17	26.40
Jul 22	17.14

Date	Density
1982	
Apr 19	0
May 18	3.77
Jun 21	7.54
Jul 20	31.66

Date	Density
1983	
Apr 13	0
May 11	0.66
Jun 14	4.46
Jul 12	44.05

Date	Density
1984	
Apr 16	0
May 10	0
Jun 8	15.46
Jul 12	44.23

Date	Density
1985	
Apr 18	0
May 14	1.81
Jun 10	13.36
Jul 11	117.59

Date	Density
1986	
Apr 18	0.63
May 13[a]	5.93
Jun 19	34.52
Jul 15[a]	26.15
Aug 12	9.89

Date	Density
1987	
Apr 21	0
May 19[a]	16.22
Jun 19	40.02
Jul 14[a]	19.26
Aug 10	7.87

Date	Density
1988	
Apr 18	0
May 10[a]	0.42
Jun 14	162.43
Jul 14[a]	39.41
Aug 16	1.32

Date	Density
1989	
Apr 13	0
May 23[a]	0.91
Jun 19	25.50
Jul 12[a]	438.61
Aug 15	4.20

[a] Day and night survey was conducted.

Summary and Conclusions

Gizzard shad, and freshwater drum dominated the 1989 ichthyoplankton catch from the back channel of Phillis Island. Peak densities occurred in July and consisted mostly of eggs. No spawning was noted in April. The month of May showed little spawning activity. There was a decrease in larvae density after July.

G. FISH IMPINGEMENT

Objective

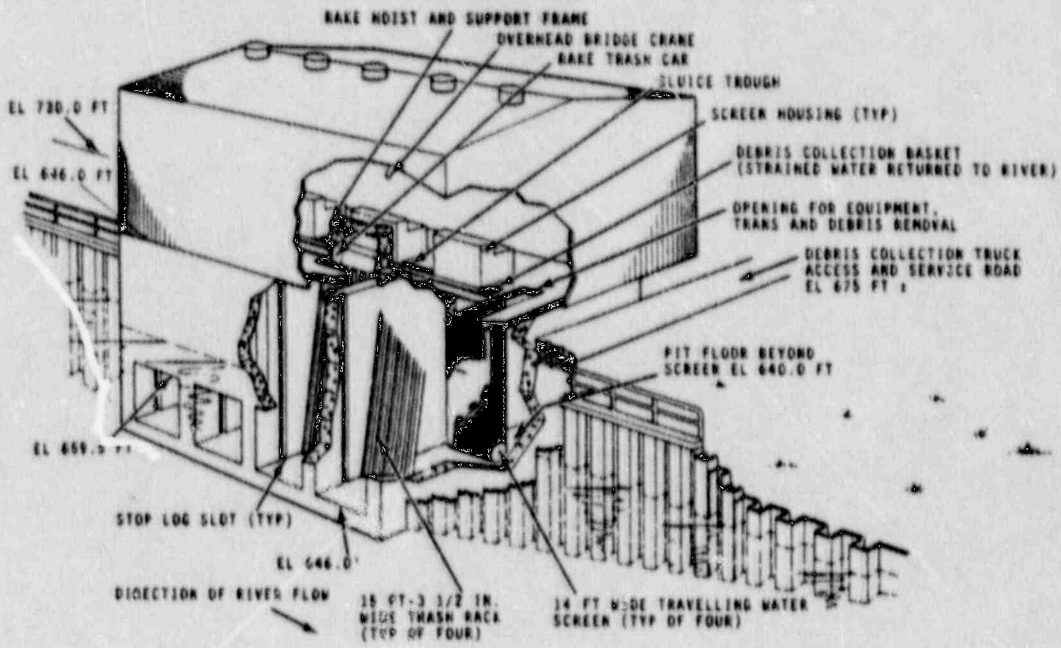
Impingement surveys were conducted to monitor the quantity of fish, other aquatic organisms and Corbicula impinged on the traveling screens.

Methods

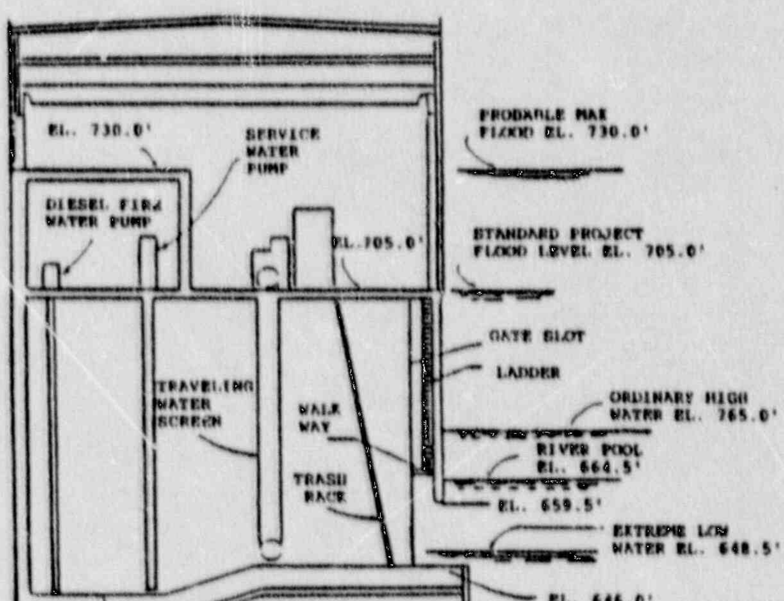
The surveys were conducted weekly throughout 1989 for a total of 40 weeks (Table V-A-1). Except when technical difficulties delayed the start of collections, weekly fish impingement sampling began on Thursday mornings when all operating screens were washed. A collection basket of 0.25 inch mesh netting was placed at the end of the screen washwater sluiceway (Figure V-G-1). On Friday mornings, after approximately 24 hours, each screen was washed individually for 15 minutes (one complete revolution of the screen) and all aquatic organisms collected. Fish were identified, counted, measured for total length (mm), and weighed (g). Data were summarized according to operating intake bays (bays that had pumps operating in the 24 hour sampling period) and non-operating intake bays.

Results

The BVPS impingement surveys of 1976 through 1989 have resulted in the collection of 39 species of fish representing ten families (Table V-G-1). A total of 550 fish, representing 14 species were collected in 1989 (Table V-G-2).



(Three dimensional: Cutaway View)



(Two dimensional: Side View)

FIGURE V-G-1

INTAKE STRUCTURE
BVPS

TABLE V-G-1

FISH COLLECTED DURING THE
IMPINGEMENT SURVEYS, 1976-1989
BVPS

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

TABLE V-G-1
(Continued)

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

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

TABLE V-G-2

SUMMARY OF FISH COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24 HOUR PERIOD PER WEEK DURING 1989
BVPS

Taxa	Number	Percent Frequency Occurrence	Percent Composition	Operating Intake Bays [1]: Alive Number	Operating Intake Bays [1]: Alive Weight (g)	Operating Intake Bays [1]: Dead Number	Operating Intake Bays [1]: Dead Weight (g)	Non-Operating Intake Bays [2]: Alive Number	Non-Operating Intake Bays [2]: Alive Weight (g)	Non-Operating Intake Bays [2]: Dead Number	Non-Operating Intake Bays [2]: Dead Weight (g)	Length Range (mm)
Gizzard shad	437	28	79.5			428	2852			9	52	46-260
Emerald shiner	1	3	0.2			1	1					35
Channel catfish	6	15	1.1	3	18	2	21	1	4			62-138
Flathead catfish	12	8	2.2	4	4	8	8					38-59
White bass	1	3	0.2			1	85					195
Rock bass	11	23	2.0	3	10	1	2	5	8	2	2	38-70
Green sunfish	6	15	1.1	4	31			1	17	1	4	60-97
Pumpkinseed	1	3	0.2	1	10							77
Bluegill	13	28	2.4	4	9	6	13	1	1	2	3	36-71
Smallmouth bass	2	5	0.4	1	148	1	62					173-220
Spotted bass	7	15	1.3	4	191	1	208	2	23			102-245
White crappie	5	13	0.9	1	2	4	14					53-93
Logperch	2	5	0.4	1	4	1	3					81-82
Freshwater drum	44	30	8.0	4	17	38	176	1	2	1	4	32-123
Unidentifiable	2	5	0.4			2	45					100-190
Total	550			30	444	494	3490	11	55	15	65	

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

Gizzard shad were the most numerous fish, comprising 79.5% of the total annual catch, followed by freshwater drum (8.0%), bluegill (2.4%), with all other species represented by less than 13 specimens. All fishes ranged in size from 32 mm to 260 mm, with the majority under 100 mm. The total weight of all fishes collected in 1989 was 4.05 kg (8.9 lbs). Approximately 71.6% of the total weight of fish collected (both alive and dead) was comprised of gizzard shad collected in December. No endangered or threatened species were collected (Commonwealth of Pennsylvania, 1985). The temporal distribution of the 1989 impingement catch closely follows the pattern of catches of previous years (1976 to 1988) (Tables V-G-3 and V-G-4). During each year, generally the largest numbers of fish have been collected in the winter months (December-February) and then the catch has gradually decreased until the late summer period when another, smaller peak has occurred.

Other organisms collected in the impingement surveys include 94 crayfish, 137 native clams, and 47 dragonflies (Tables V-G-6 and V-G-8). In addition, 16,577 Asiatic clams (Corbicula) were collected (Table V-G-7).

Comparison of Impinged and River Fish

A comparison of the numbers of fish collected in the river and traveling screens is presented in Table V-G-5. Of the 33 species collected, 12 were observed in both locations, two species were collected only in the impingement surveys, while 19 species were taken exclusively in the river. The major difference in species composition between the two types of collections is the absence of large species in the impingement collections. Seven species of suckers (river carpsucker, quillback, white sucker, smallmouth buffalo, silver redhorse, shorthead redhorse, golden redhorse) and five species of game fish (muskellunge, tiger muskellunge, black crappie, walleye, and sauger) were collected in the river studies, but were not collected in the impingement surveys. Game fish which were collected on the traveling screens (channel catfish, rock bass, and bluegill) were smaller than individuals of those species collected by river sampling.

TABLE V-G-3

SUMMARY OF IMPINGEMENT SURVEY DATA FOR 1989
BVPS

Date		Number of Fish Collected	Percent Annual Total	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water Temp °F	River Elevation Above Mean Sea Level (ft.)
Month	Day			Alive	Dead	Alive	Dead	A	B	C	D		
January	6	329	59.8	2	327			X		X	X	37.2	666.0
	13	23	4.2	1	22			X	X	X	X	39.0	667.5
	20	26	4.7	2	24			X	X	X	X	41.2	666.2
	27	13	2.4		9	1	3	X		X	X	40.1	666.8
February	3	8	1.5	2	5	1		X		X	X	43.2	666.1
	10	27	4.9	3	24			X	X	X	X	37.8	665.5
	17(3)	-	-					-	-	-	-	38.9	672.6
	24(3)	-	-					-	-	-	-	39.4	669.8
March	3	54	9.8		53		1	X	X	X		38.3	665.4
	10	14	2.5	2	7		5	X	X	X		41.8	667.6
	17	6	1.1	1	5			X	X	X		47.0	666.2
	24	4	0.7	2		1	1	X	X			46.0	667.8
	31(3)	-	-					-	-	-	-	54.0	674.9
April	7	3	0.5	2	1			X		X		49.8	671.1
	14	2	0.4		2			X		X	X	48.4	667.7
	21	2	0.4	2				X		X	X	55.0	666.2
	28	1	0.2				1			X	X	59.0	665.8
May	5	0	0.0						X	X	X	58.8	666.8
	12	2	0.4		1	1			X	X	X	51.6	675.5
	19(4)	-	-					-	-	-	-	57.2	670.9
	26(4)	-	-					-	-	-	-	61.0	667.0
June	2	1	0.2	1				X	X	X		71.2	666.3
	9	0	0.0					X	X	X	X	72.2	665.5
	16	0	0.0					X	X		X	68.0	672.0
	23	0	0.0					X	X	X	X	66.3	672.0
	30	1	0.2		1			X	X	X	X	71.3	668.2

TABLE V-G-3
(Continued)

Date		Number of Fish Collected	Percent Annual Total	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water Temp °F	River Elevation Above Mean Sea Level (ft.)
Month	Day			Alive	Dead	Alive	Dead	A	B	C	D		
July	7	3	0.5	2	1			X	X	X	X	75.0	666.9
	14	1	0.2	1				X	X	X	X	79.0	665.8
	21	0	0.0					X		X	X	78.4	666.2
	28	1	0.2	1				X	X	X	X	82.1	665.3
August	4	0	0.0					X	X	X	X	79.2	665.9
	11	0	0.0					X	X	X	X	78.5	666.1
	18	6	1.1	1	5			X	X	X	X	78.9	665.0
	25	6	1.1	3	3			X	X	X	X	79.8	666.3
September	1	1	0.2		1			X	X	X	X	79.0	666.0
	8	0	0.0					X	X	X		77.0	665.3
	15	2	0.4		2				X	X		76.1	665.8
	22	0	0.0						X	X		73.6	665.8
	29	4	0.7			4			X	X		66.8	665.6
October	6	2	0.4				2	X	X	X		66.0	665.4
	13	0	0.0					X	X	X		60.3	665.9
	20	2	0.4			2		X	X	X		60.2	667.2
	27	3	0.5		1	1	1	X		X	X	56.0	665.8
November	3 (4)	-	-					-	-	-	-	56.6	665.7
	10 (4)	-	-					-	-	-	-	54.0	666.0
	17 (4)	-	-					-	-	-	-	50.5	667.3
	24	2	0.4	2				X	X	X		42.6	665.9
December	1 (4)	-	-					-	-	-	-	43.5	665.2
	8 (5)	-	-					-	-	-	-	38.0	666.0
	15 (5)	-	-					-	-	-	-	35.6	665.7
	22 (5)	-	-					-	-	-	-	33.2	665.4
	29	1	0.2				1	X		X	X	33.7	665.7
Total		550		30	494	11	15						

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

TABLE V-G-4
SUMMARY OF FISH COLLECTED IN IMPINGEMENT SURVEYS, 1976-1989
BVPS

Number of Fish Collected Unit 1

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

Number of Fish Collected Unit 1

	1980			1981			1982			1983		
Month	Operating Intake Bays[1]	Non-operating Intake Bays[2]	Total	Operating Intake Bays	Non-operating Intake Bays	Total	Operating Intake Bays	Non-operating Intake Bays	Total	Operating Intake Bays	Non-operating Intake Bays	Total
January	5	0	5	5	1	6	30	16	44	9	0	9
February	5	7	12	21	1	22	24	42	66	10	1	11
March	16	13	29	4	2	6	4	7	11	5	5	10
April	0	11	11	8	0	8	3	6	9	11	7	18
May	0	2	2	7	2	9	1	1	2	16	3	19
June	0	4	4	3	0	3	0	2	2	3	6	9
July	3	10	13	5	2	7	4	5	9	1	3	4
August	10	4	14	12	1	13	14	0	14	2	5	7
September	4	0	4	15	4	19	13	3	16	16	13	29
October	2	2	4	10	2	12	7	12	19	15	8	23
November	3	1	4	4	0	4	4	4	8	9	9	18
December	6	0	6	28	4	32	16	9	25	49	10	59
Total	54	54	108	122	19	141	120	107	227	146	70	216

Number of Fish Collected Unit 1

	1984			1985			1986			1976 - 1986 Average		
Month	Operating Intake Bays[1]	Non-operating Intake Bays[2]	Total	Operating Intake Bays	Non-operating Intake Bays	Total	Operating Intake Bays	Non-operating Intake Bays	Total	Operating Intake Bays	Non-operating Intake Bays	Total
January	34	5	39	4	2	6	90	4	94	487	452	939
February	19	11	30	2	0	2	20	2	22	447	293	740
March	23	7	30	3	4	7	6	3	9	62	33	95
April	15	4	19	0	0	0	1	0	1	6	4	10
May	4	1	5	2	0	2	0	1	1	4	1	5
June	7	2	9	1	1	2	0	3	3	2	2	4
July	27	2	29	4	0	4	6	1	7	10	4	14
August	7	1	8	4	3	7	3	3	6	10	7	17
September	0	4	4	8	4	12	3	4	7	8	6	14
October	0	0	0	8	9	17	18	4	22	12	6	18
November	1	1	2	70	10	80	26	1	27	14	3	17
December	0	2	2	24	1	25	14	0	14	65	24	89
Total	137	40	177	130	34	164	187	26	213	1,127	835	1,962

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

TABLE V-G-4
(Continued)

Number of Fish Collected Unit 1 and 2

Month	1987 Operating Intake Bays	1987 Non-operating Intake Bays	1987 Total	1988 Operating Intake Bays	1988 Non-operating Intake Bays	1988 Total	1989 Operating Intake Bays	1989 Non-operating Intake Bays	1989 Total	1987-1989 Average Operating Intake Bays	1987-1989 Average Non-operating Intake Bays	1987-1989 Average Total
January	242	0	242	25	4	29	387	4	391	218	3	221
February	27	1	28	5	1	6	34	1	35	22	1	23
March	5	4	9	2	2	4	70	8	78	26	5	31
April	4	1	5	12	1	13	7	1	8	8	1	9
May	3	0	3	6	0	6	1	1	2	1	0	1
June	1	1	2	2	0	2	2	0	2	2	0	2
July	11	1	12	63	0	63	5	0	5	26	0	26
August	11	1	12	24	27	51	12	0	12	16	9	25
September	10	0	10	12	3	15	3	4	7	8	2	10
October	0	1	1	3	0	3	1	6	7	1	2	3
November	0	1	1	29	12	41	2	0	2	10	4	14
December	20	0	20	247	7	254	0	1	1	89	3	92
Total	334	11	345	424	57	481	524	26	550	427	30	457

TABLE V-G-5

NUMBER AND PERCENT OF ANNUAL TOTAL OF FISH COLLECTED
IN IMPINGEMENT SURVEYS AND IN THE NEW CUMBERLAND
POOL OF THE OHIO RIVER, 1989
BVPS

	Total Number of Fish Collected		Percent of Annual Total	
Species[a]	Impingement	River	Impingement	River
Longnose gar		5		1.0
Gizzard shad	437	222	79.7	45.4
Muskellunge		2		0.4
Tiger muskellunge		9		1.8
Grass carp		1		0.2
Common carp		55		11.2
Golden shiner		1		0.2
Emerald shiner	1	23	0.2	4.7
Spottail shiner		3		0.6
Spotfin shiner		1		0.2
River carpsucker		5		1.0
Quillback		2		0.4
White sucker		1		0.2
Smallmouth buffalo		1		0.2
Silver redhorse		2		0.4
Golden redhorse		15		3.1
Shorthead redhorse		2		0.4
Channel catfish	6	30	1.1	6.1
Flathead catfish	12	2	2.2	0.4
White bass	1	31	0.2	6.3
Rock bass	11	5	2.0	1.0
Green sunfish	6		1.1	
Pumpkinseed	1	1	0.2	0.2
Bluegill	13	1	2.4	0.2
Smallmouth bass	2	12	0.4	2.5
Spotted bass	7	39	1.3	8.0
White crappie	5	1	0.9	0.2
Black crappie		1		0.2
Banded darter		1		0.2
Logperch	2		0.4	
Sauger		7		1.4
Walleye		3		0.6
Freshwater drum	44	5	8.0	1.0
Total	548	489		

[a] Includes only those specimens identified to species or stocked hybrids.

TABLE V-G-6

SUMMARY OF CRAYFISH COLLECTED IN IMPINGEMENT SURVEYS
CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK, 1989
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	6	0	0	4	0
	13	1	0	0	0
	20	1	1	0	0
	27	3	0	0	0
February	3	3	0	0	0
	10	2	0	0	0
	17 (a)	-	-	-	-
	24 (a)	-	-	-	-
March	3	0	0	0	0
	10	1	0	2	1
	17	1	0	0	0
	24	0	0	1	0
	31 (a)	-	-	-	-
April	7	2	0	0	0
	14	0	0	0	0
	21	0	0	0	0
	28	0	0	1	0
May	5	0	0	0	0
	12	0	0	0	0
	19 (b)	-	-	-	-
	26 (b)	-	-	-	-
June	2	0	0	0	0
	9	0	0	0	0
	16	0	0	0	0
	23	0	0	0	0
	30	0	0	0	0
July	7	1	2	0	0
	14	4	2	0	0
	21	1	3	0	1
	28	4	6	0	0

TABLE V-G-6
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	4	1	5	0	0
	11	0	4	0	0
	18	3	1	0	0
	25	2	4	0	0
September	1	5	4	0	0
	8	0	2	0	1
	15	3	0	0	1
	22	0	0	0	1
	29	0	2	0	1
October	6	0	2	1	0
	13	0	0	0	0
	20	0	0	0	0
	27	1	1	0	0
November	3(b)	-	-	-	-
	10(b)	-	-	-	-
	17(b)	-	-	-	-
	24	0	1	0	0
December	1(b)	-	-	-	-
	8(c)	-	-	-	-
	15(c)	-	-	-	-
	22(c)	-	-	-	-
	29	0	0	0	0
Total		39	40	9	6

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

TABLE V-G-7

SUMMARY OF *Corbicula* COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1989
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	6	0	1	0	0
	13	1	1	0	0
	20	4	3	0	0
	27	1	5	0	1
February	3	0	5	0	0
	10	0	3	0	0
	17 (a)	-	-	-	-
	24	-	-	-	-
	31 (a)				
March	3	0	7	0	0
	10	0	3	2	0
	17	0	0	0	0
	24	0	2	0	0
	31 (a)	-	-	-	-
April	7	0	0	0	0
	14	0	1	0	2
	21	0	0	0	0
	28	0	1	0	0
May	5	0	0	0	0
	12	3	0	0	0
	19 (b)	-	-	-	-
	26 (b)	-	-	-	-
June	2	0	1	0	7
	9	0	3	0	0
	16	1	10	0	0
	23	0	0	0	0
	30	1	0	0	0
July	7	2	1	0	0
	14	4	3	0	0
	21	6	3	0	3
	28	5	8	0	0

TABLE V-G-7
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	4	5	12	0	0
	11	12	9	0	0
	18	50	40	0	0
	25	114	29	0	0
September	1	2,380	218	0	0
	8	3,351	48	173	4
	15	4,612	135	729	24
	22	0	0	62	4
	29	933	213	122	70
October	6	868	345	544	36
	13	227	41	47	17
	20	114	26	63	15
	27	232	134	168	124
November	3[b]	-	-	-	-
	10[b]	-	-	-	-
	17[b]	-	-	-	-
	24	28	31	[illegible]	0
December	1[b]	-	-	-	-
	8[c]	-	-	-	-
	15[c]	-	-	-	-
	22[c]	-	-	-	-
	29	32	31	0	1
TOTAL		12,986	1,373	1,910	308

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

TABLE V-G-8

SUMMARY OF MOLLUSKS (OTHER THAN *Corbicula*) AND DRAGONFLIES COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK, 1989
BVPS

Date		Number of Organisms in all Bays	
Month	Day	Mollusks	Dragonflies
January	6	0	0
	13	1	0
	20	1	0
	27	1	0
February	3	1	0
	10	3	0
	17 (a)	-	-
	24 (a)	-	-
March	3	1	0
	10	0	0
	17	0	0
	24	3	1
	31 (a)	-	-
April	7	0	0
	14	1	0
	21	0	0
	28	0	2
May	5	1	2
	12	3	0
	19 (b)	-	-
	26 (b)	-	-
June	2	0	0
	9	0	0
	16	3	3
	23	0	0
	30	0	1
July	7	0	1
	14	1	0
	21	0	1
	28	0	1

TABLE V-G-8
(Continued)

Date		Number of Organisms in all Bays	
Month	Day	Mollusks	Dragonflies
August	4	0	0
	11	1	0
	18	0	1
	25	3	7
September	1	6	6
	8	13	5
	15	12	2
	22	1	0
	29	5	3
October	6	4	0
	13	0	2
	20	6	3
	27	63	5
November	3 (b)	-	-
	10 (b)	-	-
	17 (b)	-	-
	24	1	1
December	1 (b)	-	-
	8 (c)	-	-
	15 (c)	-	-
	22 (c)	-	-
	29	2	0
Total		137	47

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

Comparison of Operating and Non-Operating Intake Bay Collections

Of the 550 fish collected during the 1989 impingement studies, 526 (95.3%) were collected from operating intake bays and 26 (4.7%) from non-operating intake bays (Table V-G-2). However, due to differences between the number of operating (120) and non-operating (28) screens washed in 1989, the impingement data were computed with catch expressed as fish per 1,000 m^2 of screen surface area washed. These results showed 24.5 and 5.2 fish for operating and non-operating screens, respectively. As in previous years, the numbers of fish collected in non-operating bays indicate that fish entrapment, rather than impingement, accounts for some of the catch. Entrapment occurred when fish were lifted out of the water on the frame plates as the traveling screen rotated. Alternatively, impingement occurred when fish were forced against the screen due to velocities created by the circulating water pumps.

Of the 94 crayfish collected in the 1989 impingement studies, 79 (84.0%) were collected from operating bays and 15 (16.0%) were collected from non-operating bays (Table V-G-6). Adjusting these data for screen surface area washed (crayfish per 1,000 m^2) the results show 3.7 and 3.0 crayfish for operating and non-operating screens, respectively.

Corbicula collected in the 1989 studies included 14,359 (86.6%) in the operating bays and 2,218 (13.4%) in the non-operating bays (Table V-G-7). Again, adjusting these data for the screen surface area washed (Corbicula per 1,000 m^2) the results show 671.0 and 444.2 Corbicula for operating and non-operating screens, respectively.

Summary and Conclusions

The results of the 1989 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has very little or no effect on the fish populations. Five hundred and fifty (550) fishes were collected, which was the fourth highest total collected since initial operation of BVPS in 1976. Gizzard shad were the most numerous fish, comprising 79.5% of the total annual catch. The total weight of all

fishes collected in 1989 was 4.05 kg (8.9 lbs). Of the 550 fishes collected, 41 (7.5%) were alive and returned via the discharge pipe to the Ohio River.

H. PLANKTON ENTRAINMENT

1. Ichthyoplankton

Objectives

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

Methods

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

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

Results

A total of 3,016 eggs, 3,139 larvae, and two adults representing eleven taxa and seven familes were collected from 4039.2 m^3 of water filtered during sampling along the river entrainment transects (Table V-H-1). Gizzard shad, freshwater drum, and shiners were the most common taxa, representing 27.3%, 56.6%, and 8.5% of the total catch. Gizzard shad comprised 53.5% of the larvae. Freshwater drum comprised 18.4% of the larvae. Eggs (3,016) made up 49% of the total ichthyoplankton catch.

Seasonal Distribution

No eggs were collected during the first survey (April 13). On the day and night surveys (May 23, 24) (Table V-H-1), two and three eggs were collected, respectively. The day collection of June 19 resulted in a total density of 15.56/100 m^3. The July 12 (day) collection yielded a total density of 229.73/100 m^3 of which freshwater drum, shiner sp., and gizzard shad comprised the majority of the catch. The August 15 (day) collection showed a decreased total density of 13.70 /100m^3 (Table V-H-1).

Greatest density (768.01/100 m^3) was obtained on the night of July 13. This was due to a large catch of freshwater drum eggs (Table V-H-1).

Spatial Distribution

Larvae were dominant at all stations; however, highest densities were collected at Stations 2, 4, and 5 during night tows. Most of the larvae collected were gizzard shad and freshwater drum. Stations 1, 2, 3, 4, and 5 yielded 701, 561, 310, 434, and 1,133 larvae, respectively.

TABLE V-B-1

NUMBER AND DENSITY OF FISH EGGS, LARVAE, JUVENILES, AND ADULTS
(Number/100 m^3) COLLECTED WITH A 0.5 m PLANKTON NET
AT THE ENTRAINMENT RIVER TRANSECT IN THE OHIO RIVER NEAR BVPS, 1989

Date	Station 1 Day	Station 1 Night	Station 2 Day	Station 2 Night	Station 3 Day	Station 3 Night	Station 4 Day	Station 4 Night	Station 5 Day	Station 5 Night	Total Collected and Taxa Density
April 13											
Vol. water filtered (m^3)	126.0		162.5		138.7		135.7		133.7		696.6
Number eggs collected	0		0		0		0		0		0
Number larvae collected	0		0		0		0		0		0
Number juveniles collected	0		0		0		0		0		0
Number adults collected	2		0		0		0		0		2
Density (number collected)											
Adults											
Notropis atherinoides	1.59 (2)		0		0		0		0		0.29 (2)
Total Station Density (number collected)	1.59 (2)		0		0		0		0		0.29 (2)
May 23/24											
Vol. water filtered (m^3)	109.5	96.2	134.3	112.6	126.4	125.2	126.6	129.7	95.7	111.9	1,168.1
Number eggs collected	1	1	1	0	0	0	0	2	0	0	5
Number larvae collected	2	4	0	3	1	1	3	2	8	12	36
Number juveniles collected	0	0	0	0	0	0	0	0	0	0	0
Number adults collected	0	0	0	0	0	0	0	0	0	0	0
Density (number collected)											
Eggs											
Morone spp.	0	0	0	0	0	0	0	0.77 (1)	0	0	0.09 (1)
Unidentified	0.91 (1)	1.04 (1)	0.74 (1)	0	0	0	0	0.77 (1)	0	0	0.34 (4)
Larvae											
Cyprinidae (EL)	0	0	0	0.89 (1)	0	0	0	0	0	0	0.09 (1)
Catostomidae (EL)	0	1.04 (1)	0	0.89 (1)	0.79 (1)	0	0	0.77 (1)	0	2.68 (3)	0.60 (7)
Morone chrysops (YL)	0	0	0	0	0	0	1.58 (2)	0.77 (1)	0	0	0.26 (3)
Pomoxis spp. (EL)	1.83 (2)	2.08 (2)	0	0	0	0	0	0	0	0	0.34 (4)
Etheostoma spp. (EL)	0	0	0	0	0	0	0	0	3.13 (3)	3.57 (4)	0.60 (7)
Stizostedion spp. (YL)	0	1.04 (1)	0	0.89 (1)	0	0.80 (1)	0.79 (1)	0	5.22 (5)	4.47 (5)	1.20 (14)
Total Station Density (number collected)	2.74 (3)	5.20 (5)	0.74 (1)	2.66 (3)	0.79 (1)	0.80 (1)	2.37 (3)	3.08 (4)	8.36 (8)	10.72 (12)	3.51 (41)

TABLE V-B-1
(Continued)

Date	Station 1 Day	Station 1 Night	Station 2 Day	Station 2 Night	Station 3 Day	Station 3 Night	Station 4 Day	Station 4 Night	Station 5 Day	Station 5 Night	Total Collected and Taxa Density
June 19											
Vol. water filtered (m^3)	59.3		54.5		77.6		78.1		84.0		353.5
Number eggs collected	2		1		1		0		1		5
Number larvae collected	4		3		5		14		24		50
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs											
Unidentified	3.37(2)		1.83(1)		1.29(1)		0		1.19(1)		1.41 (5)
Larvae											
Dorosoma cepedianum (EL)	0		0		0		5.12 (4)		4.76 (4)		2.26 (8)
Cyprinidae (EL)	0		0		0		1.28 (1)		0		0.28 (1)
Cyprinus carpio (YL)	0		0		0		2.56 (2)		0		0.57 (2)
Cyprinus carpio (EL)	6.75 (4)		5.50 (3)		6.44 (5)		8.96 (7)		7.14 (6)		7.07 (25)
Micropterus dolomieui (EL)	0		0		0		0		2.38 (2)		0.57 (2)
Etheostoma spp. (EL)	0		0		0		0		14.29 (12)		3.39 (12)
Total Station Density (number collected)	10.12 (6)		7.34 (4)		7.73 (6)		17.93 (14)		29.76 (25)		15.56 (55)
July 12/13											
Vol. water filtered (m^3)	122.0	114.5	133.6	118.5	123.9	120.3	136.9	120.1	127.4	112.4	1,229.6
Number eggs collected	12	107	22	243	24	199	6	1,516	8	819	2,956
Number larvae collected	324	362	110	441	168	135	156	251	649	426	3,022
Number juveniles collected	0	0	0	0	0	0	0	0	0	0	0
Number adults collected	0	0	0	0	0	0	0	0	0	0	0
Density (number collected)											
Eggs											
Aplodinotus grunniens (EE)	9.84 (12)	89.08 (102)	16.47 (22)	135.86 (161)	193.70 (24)	161.26 (194)	4.38 (6)	1,259.78 (1513)	6.28 (8)	726.87 (817)	232.51 (2859)
Unidentified	0	4.37(5)	0	69.29(82)	0	4.16(5)	0	2.50(3)	0	1.78(2)	7.89(97)
Larvae											
Dorosoma cepedianum (YL)	4.10(5)	11.35(13)	7.49(10)	24.47(29)	3.23(4)	18.29(22)	6.57(9)	36.64(44)	2.35(3)	3.56(4)	11.63(143)
Dorosoma cepedianum (EL)	173.77 (212)	192.14 (220)	28.44 (38)	124.89 (148)	99.27 (123)	45.72 (55)	48.94 (67)	79.93 (96)	299.84 (382)	165.48 (186)	124.19 (1,527)
Cyprinidae (YL)	0	0	0	4.22(5)	0	1.66(2)	0	4.16(5)	0	5.34(6)	1.46(18)
Cyprinidae (EL)	0	0	5.99(8)	0	4.84(6)	0	0	0	0	0	1.14(14)
Cyprinus carpio (EL)	0	25.33(29)	12.72(17)	1.69(2)	1.61(2)	4.99(6)	7.30(10)	2.50(3)	0.78(1)	64.06(72)	11.55(142)
Notropis atherinoides (EL)	0	4.37(5)	0	0	1.61(2)	0	0	0	1.57(2)	4.45(5)	1.14(14)
Notropis spp.	68.85(84)	31.44(36)	1.50(2)	5.91(7)	16.14(20)	4.99(6)	6.57(9)	5.00(6)	169.54(216)	96.98(109)	40.26(495)
Pimephales spp. (EL)	13.93(17)	7.86(9)	0	0	3.23(4)	0.83(1)	0	0	24.33(31)	8.01(9)	5.77(71)
Morone chrysops (YL)	2.46(3)	0	0	0	0	0	0	0	0	0	0.24(3)
Pomoxis spp. (EL)	0	0	0	0	0	0.83(1)	0	0	0	0	0.08(1)
Etheostoma spp. (EL)	1.64(2)	2.62(3)	0	0	0	0	0	0	1.57(2)	0	0.57(7)
Aplodinotus grunniens (YL)	0	32.31(37)	19.46(26)	191.56(227)	0.81(1)	29.09(35)	40.18(55)	77.44(93)	8.63(11)	16.90(19)	40.99(504)
Aplodinotus grunniens (EL)	0	6.11(7)	5.24(7)	16.03(19)	2.42(3)	4.16(5)	2.92(4)	2.50(3)	0	14.23(16)	5.20(64)

TABLE V-B-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
July 12/13 (cont'd)											
Unidentifiable (*L)	0.82(1)	2.62(3)	1.50(2)	3.38(4)	2.42(3)	1.66(2)	1.46(2)	0.83(1)	0.78(1)	0	1.55(19)
Total Station Density	275.41	409.61	98.80	577.22	154.96	277.64	118.33	1,471.27	515.70	1,107.65	486.17
(number collected)	(336)	(469)	(132)	(684)	(192)	(334)	(162)	(1,767)	(657)	(1,245)	(5,978)
August 15											
Vol. water filtered (m^3)	114.6		115.5		120.2		123.4		117.7		591.4
Number eggs collected	9		11		6		8		16		50
Number larvae collected	5		4		0		8		14		31
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs											
Aplodinotus grunniens	7.85(9)		8.66(10)		4.99(6)		6.48(8)		13.59(16)		8.29(49)
Unidentified	0		0.87(1)		0		0		0		0.17(1)
Larvae											
Dorosoma cepedianum (EL)	0		0.87(1)		0		0		0		0.17(1)
Notropis atherinoides (EL)	4.36(5)		0		0		0		8.50(10)		2.54(15)
Pimephales spp. (EL)	0		0		0		0		3.40(4)		0.68(4)
Aplodinotus grunniens (YL)	0		1.73(2)		0		1.62(2)		0		0.68(4)
Aplodinotus grunniens (EL)	0		0.87(1)		0		4.86(6)		0		1.18(7)
Total Station Density (number collected)	12.22(14)		12.99(15)		4.99(6)		12.97(16)		25.49(30)		13.70(81)
Yearly Total											
Vol. water filtered (m^3)	531.4	210.7	600.4	231.1	586.8	245.5	600.7	249.8	558.5	224.3	4,039.2
Number eggs collected	24	108	35	243	31	199	14	1,518	25	819	3,016
Number larvae collected	335	366	117	444	174	136	181	253	695	438	3,139
Number adults collected	2	0	0	0	0	0	0	0	0	0	2
Density (number collected)											
Eggs											
Morone spp.	0	0	0	0	0	0	0	0.40(1)	0	0	0.02(1)
Aplodinotus grunniens	3.95	48.41	5.33	69.67	5.11	79.02	2.33	605.68	4.30	364.24	71.99
	(21)	(102)	(32)	(161)	(30)	(194)	(14)	(1,513)	(24)	(817)	(2,908)
Unidentified	0.56(3)	2.85(6)	0.50(3)	35.48(82)	0.17(1)	2.04(5)	0	1.60(4)	0.18(1)	0.89(2)	2.65(1[illegible]7)
Larvae											
Dorosoma cepedianum (YL)	0.94(5)	6.17(13)	1.67(10)	12.55(29)	0.68(4)	8.96(22)	1.50(9)	17.61(44)	0.54(3)	1.78(4)	3.54(143)
Dorosoma cepedianum (EL)	39.89	104.41	6.50	64.04	20.96	22.40	11.82	38.43	69.11	82.92	38.03
	(212)	(220)	(39)	(148)	(123)	(55)	(71)	(96)	(386)	(186)	(1,536)
Cyprinidae (YL)	0	0	0	2.16(5)	0	0.81(2)	0	2.00(5)	0	2.67(6)	0.45(18)
Cyprinidae (EL)	0	0	1.33(8)	0.43(1)	1.02(6)	0	0.17(1)	0	0	0	0.40(16)
Cyprinus carpio (YL)	0	0	0	0	0	0	0.33(2)	0	0	0	0.05(2)
Cyprinus carpio (EL)	0.75(4)	13.76(29)	3.33(20)	0.87(2)	1.19(7)	2.44(6)	2.83(17)	1.20(3)	1.25(7)	32.10(72)	4.13(167)
Notropis atherinoides (EL)	0.94(5)	2.37(5)	0	0	0.34(2)	0	0	0	2.15(12)	2.23(5)	0.72(29)

TABLE V-B-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
Yearly Total (cont'd)											
Notropis spp. (EL)	15.81(84)	17.09(36)	0.33(2)	3.03(7)	3.41(20)	2.44(6)	1.50(9)	2.40(6)	38.68(216)	48.60(109)	12.25(495)
Pimephales spp. (EL)	3.20(17)	4.27(9)	0	0	0.68(4)	0.41(1)	0	0	6.27(35)	4.01(9)	1.86(75)
Catostomidae (EL)	0	0.47(1)	0	0.43(1)	0.17(1)	0	0	0.40(1)	0	1.34(3)	0.17(7)
Morone chrysops (YL)	0.56(3)	0	0	0	0	0	0.33(2)	0.40(1)	0	0	1.15(6)
Micropterus dolomieui (EL)	0	0	0	0	0	0	0	0	0.36(2)	0	0.05(2)
Pomoxis spp. (EL)	0.38(2)	0.95(2)	0	0	0	0.41(1)	0	0	0	0	0.12(5)
Etheostoma spp. (EL)	0.38(2)	1.42(3)	0	0	0	0	0	0	3.04(17)	1.78(4)	0.64(26)
Stizostedion spp. (YL)	0	0.47(1)	0	0.43(1)	0	0.41(1)	0.17(1)	0	0.90(5)	2.23(5)	0.35(14)
Aplodinotus grunniens (YL)	0	17.56(37)	4.66(28)	38.23(227)	0.17(1)	14.26(35)	9.49(57)	37.23(93)	1.97(11)	8.47(19)	12.58(508)
Aplodinotus grunniens (EL)	0	3.32(7)	1.33(8)	8.22(19)	1.02(3)	2.04(5)	1.66(10)	1.20(3)	0	7.13(16)	1.76(71)
Unidentifiable	0.19(1)	1.42(3)	0.33(2)	1.73(4)	0.51(3)	0.81(2)	0.33(2)	0.40(1)	0.18(1)	0	0.47(19)
Adults											
Notropis artherinoides	0.38(2)	0	0	0	0	0	0	0	0	0	0.05(2)
Total Station Density (number collected)	67.93 (361)	224.96 (474)	25.32 (152)	297.27 (687)	34.94 (205)	136.46 (335)	32.46 (195)	708.97 (1,771)	128.92 (720)	560.41 (1,257)	152.43 (6,157)

Developmental Stages

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

Summary and Conclusions

The similarity of species composition and relative abundance of ichthyoplankton taken in 1989 along the river transect to those of 1979-1988, combined with the close correlation between river sampling in front of the intake and actual entrainment sampling established in previous years (DLC 1976, 1977, 1978 and 1979) suggest little change in ichthyoplankton entrainment by BVPS in 1989.

2. Phytoplankton

Objectives

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

Methods

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

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

Comparison of Entrainment and River Samples

Plankton samples were not collected at any river stations after April 1, 1980 due to a reduction of the Aquatic Monitoring Program, therefore, comparison of entrainment and river samples was not possible for the 1989 phytoplankton program. Results of phytoplankton analyses for the entrainment sample collected monthly are presented in Section C, PHYTOPLANKTON.

During the years 1976 throught 1979, phytoplankton densities of entrainment samples were usually slightly lower than those of mean total densities observed from river samples (DLC 1980). However, the species composition of phytoplankton in the river and in the entrainment samples were similar (DLC 1976, 1977, 1979, and 1980). Studies from previous years indicate mean Shannon-Weiner indices, evenness and richness values of entrainment samples were very similar to the river samples (DLC 1979, and 1980).

Summary and Conclusions

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

3. Zooplankton

Objectives

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

Methods

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

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

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

Comparison of Entrainment and River Samples

Plankton samples were not collected at any river stations after April 1, 1980 due to a reduction of the Aquatic Monitoring Program, therefore, comparison of entrainment and river samples was not possible for the 1989 zooplankton program. Results of zooplankton analyses for the entrainment sample collected monthly are presented in Section D, ZOOPLANKTON.

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

Summary and Conclusions

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

I. Corbicula MONITORING PROGRAM

Introduction

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

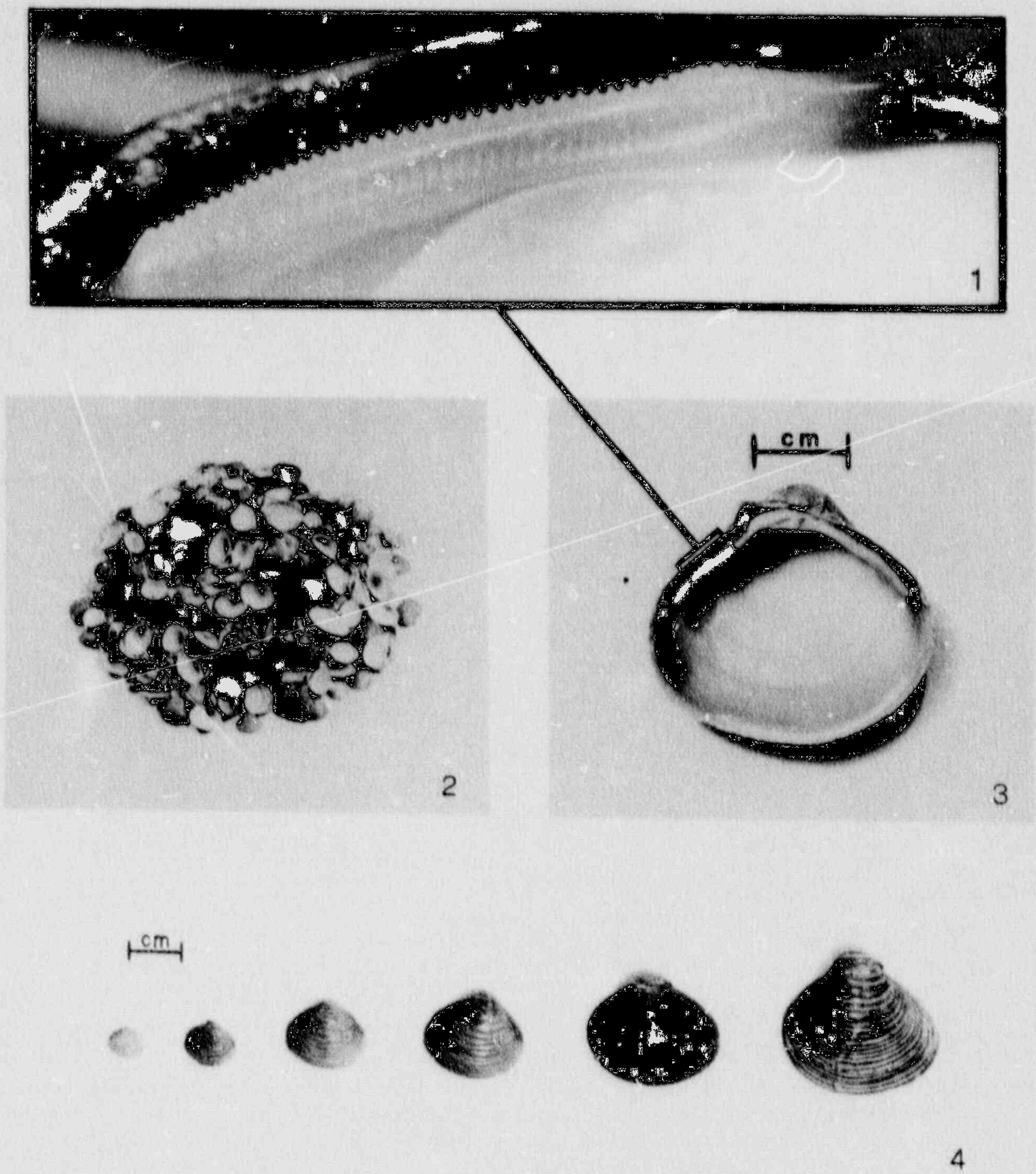
One adult clam is capable of producing many thousands of larvae called veligers. These veligers are very small (approximately 0.2 mm) and will pass easily through the water passages of a power plant. Once the veliger settles to the substrate, growth of the clam occurs rapidly. If clams develop within a power plant's water passages, they impair the flow of water through the plant. Reduction of flow may be so severe that a plant shutdown is necessary, as occurred in 1980 at Arkansas Nuclear One Power Plant. The clams 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 includes the Ohio River and the circulating cooling water system of the BVPS (intake structure and cooling towers). This report describes this Monitoring Program and the results obtained during field and plant surveys conducted through 1989.

1. Monitoring

Objectives

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



Cody 1985, Aquatic Systems Corporation

Photographs 1 and 3 show key characteristic (serrated hinges) for genus level identification

FIGURE V-I-1

PHOTOGRAPHS OF Corbicula COLLECTED AT BVPS

Methods

(Unit 1 Cooling Tower)

Collections were made (September 7) in the upper and lower reservoirs of Unit 1 cooling tower during a scheduled outage. Samples were collected using a (6" x 6") petite ponar dredge at the east side in the upper reservoir. The lower reservoir was sampled at seventeen (17) stations within the cooling tower (Figure V-I-2).

(Unit 2 Cooling Tower)

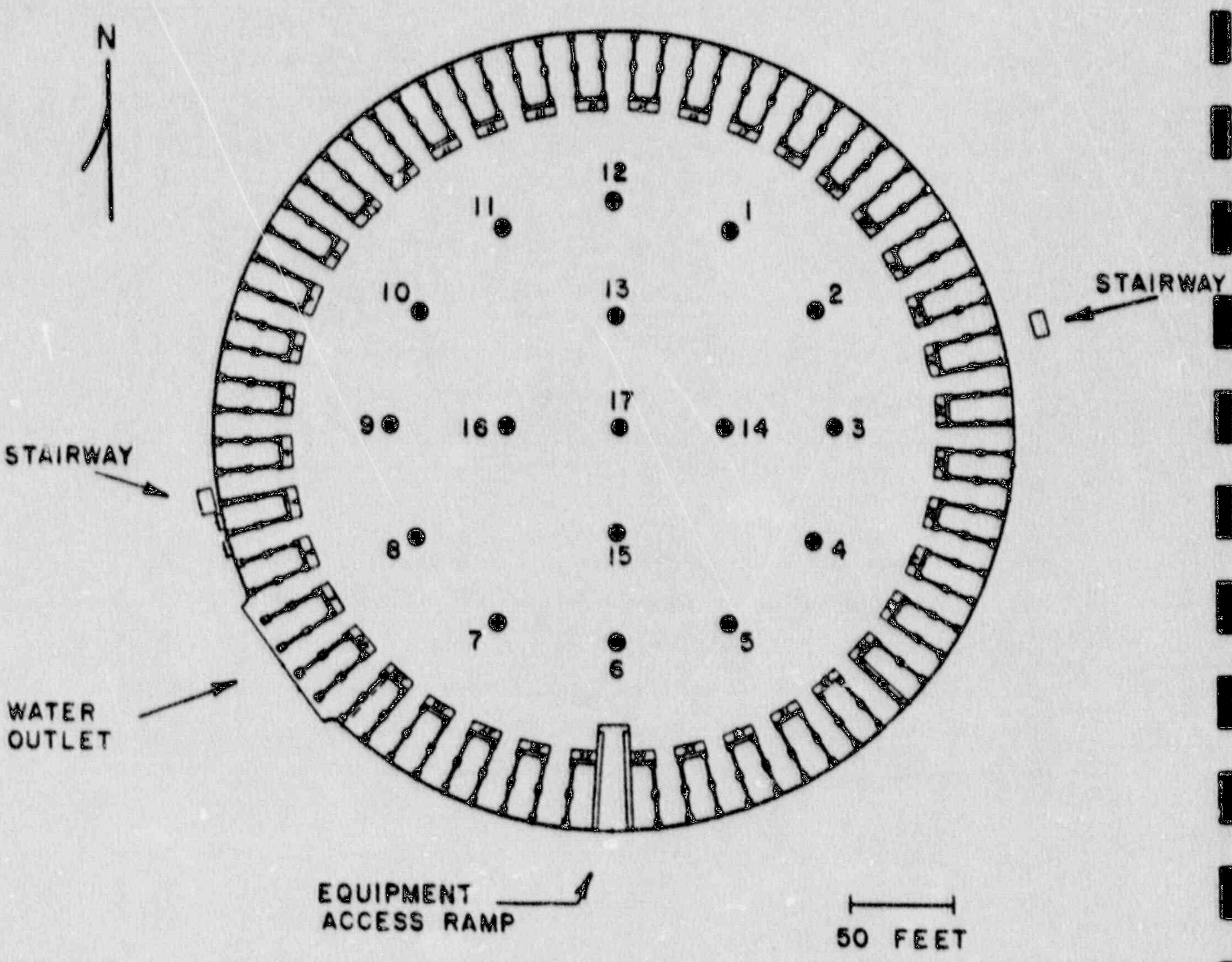
Collections were made (March 21) in the reservoir of Unit 2 cooling tower during a scheduled outage. Ten samples were collected using a (6" x 6") petite ponar dredge within the area that contained sediment. (Figure V-I-3).

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

(Intake)

Plant operations personnel have the intake surveyed semi-annually by divers for silt buildup, and if necessary, the intake bays are cleaned. Cleaning of all four bays occurred in May and November 1989, by divers using a Flygt 20 hp submersible pump. This pump has a capacity of 500 gpm (1,750 rpm) and uses a five inch propeller to push water and debris through a flexible hose (Jenkins and Logar 1985). Water and debris were sluiced through the drainage system of the intake structure, where some of the larger clam shells remained after the cleaning operations.

(TWO DIMENSIONAL: CROSS SECTIONAL HORIZONAL VIEW)



● SAMPLE LOCATION WITHIN THE LOWER WATER RESERVOIR

FIGURE V-I-2

<u>Corbicula</u> MONITORING PROGRAM SAMPLING STATIONS OF THE LOWER RESERVOIR OF UNIT 1 COOLING TOWER BVPS

(TWO DIMENSIONAL: CROSS SECTIONAL HORIZONAL VIEW)

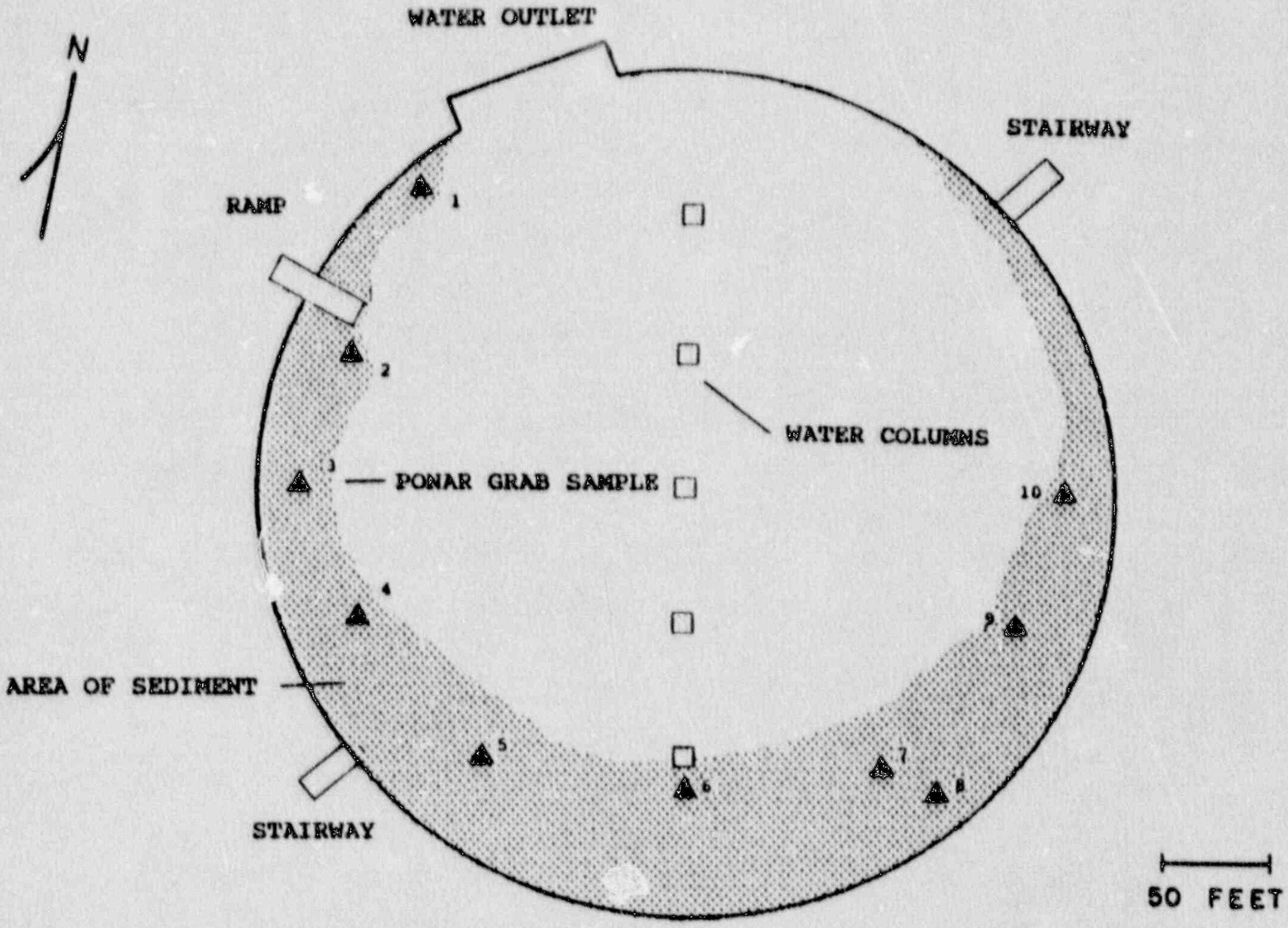


FIGURE V-I-3

Corbicula MONITORING PROGRAM SAMPLING STATIONS OF THE LOWER RESERVOIR OF UNIT 2 COOLING TOWER BVPS

(River)

Samples were collected using either a regular Ponar (9" x 9") or a petite Ponar (6" x 6") dredge along transects across the river. Ten transects were established along the Ohio River: four upstream, five downstream and one at the plant intake. A transect was also established on Raccoon Creek (Figure V-I-4).

Two transects below the BVPS were divided where samples were taken on either side of Phillis and Georgetown Islands. Each transect was based on suitable substrate (e.g., sand and/or gravel) or heated discharge (HD). Each station was identified by river navigation mile (Figure V-I-4). In May and September, samples were collected which included a single left shore, right shore, and mid-channel station.

The substrate of each sample was characterized at the time of collection. The samples were then returned to the laboratory and sorted for Corbicula. Counts were made of live and dead Corbicula for each dredge sample. Live clam counts were converted to densities (clams/m^2) for each collection based on the surface area sampled by the dredge.

Results

(Unit 1 Cooling Tower)

Results of the September 7 Corbicula survey of the Unit 1 cooling tower are presented in Table V-I-1. Densities were calculated only for live Corbicula, as densities for empty shells do not translate into potential colonizers, and such figures could be distorted by the redistribution of dead clams by currents. No live Corbicula were collected in the upper reservoir; however, the presence of shells indicates that they were transported within the circulating water system. Based on the 17 Ponar grab samples taken from the lower reservoir, the estimated number of Corbicula inhabiting this area was 300 million, of which 98% were alive (Figure V-I-5). Total length ranged from 1.0 mm to 29.0 mm for clams collected from the lower reservoir.

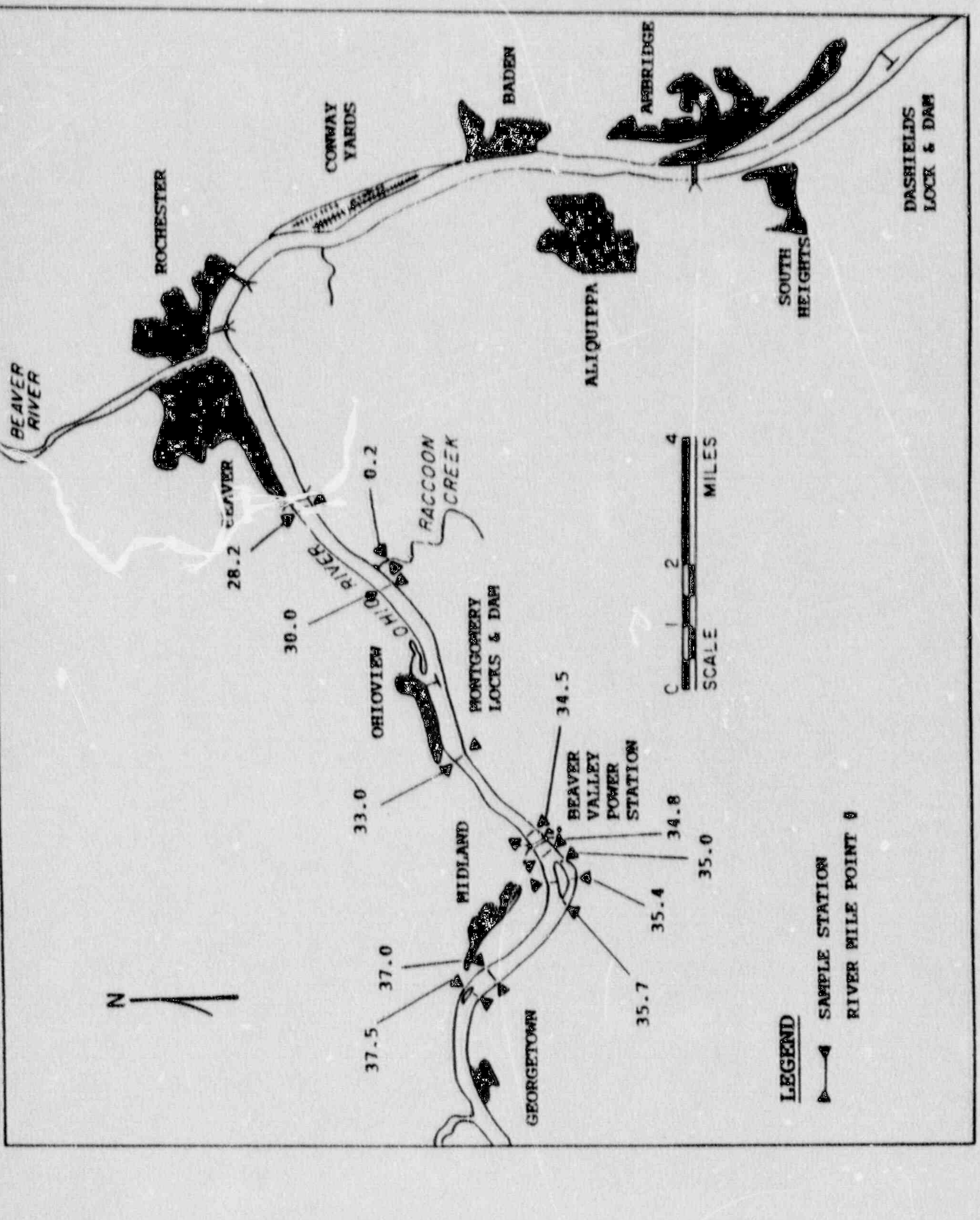


FIGURE V-I-4

Corbicula MONITORING PROGRAM SAMPLING STATIONS
OHIO RIVER SYSTEM
BVPS

TABLE V-I-1

Corbicula COLLECTED IN UNIT 1 COOLING TOWER
SEPTEMBER 7, 1989
BVPS

Sample Location	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m²
Upper Reservoir				
Qualitative Sample (East)	sil	0	195	0
Lower Reservoir				
1	sil	235	9	10,129
2	sil	214	2	9,223
3	sil	188	14	8,103
4	sil	2,695	25	116,155
5	sil	864	8	37,238
6	sil	216	2	9,310
7	sil	622	26	26,808
8	sil	92	2	3,965
9	sil	109	2	4,698
10	sil	2,072	17	89,303
11	sil	265	3	11,422
12	sil	171	12	7,370
13	sil	180	4	7,758
14	sil	104	7	4,482
15	sil	125	5	5,388
16	sil	96	3	4,138
17	sil	183	3	7,887

Substrate codes:

sil - silt

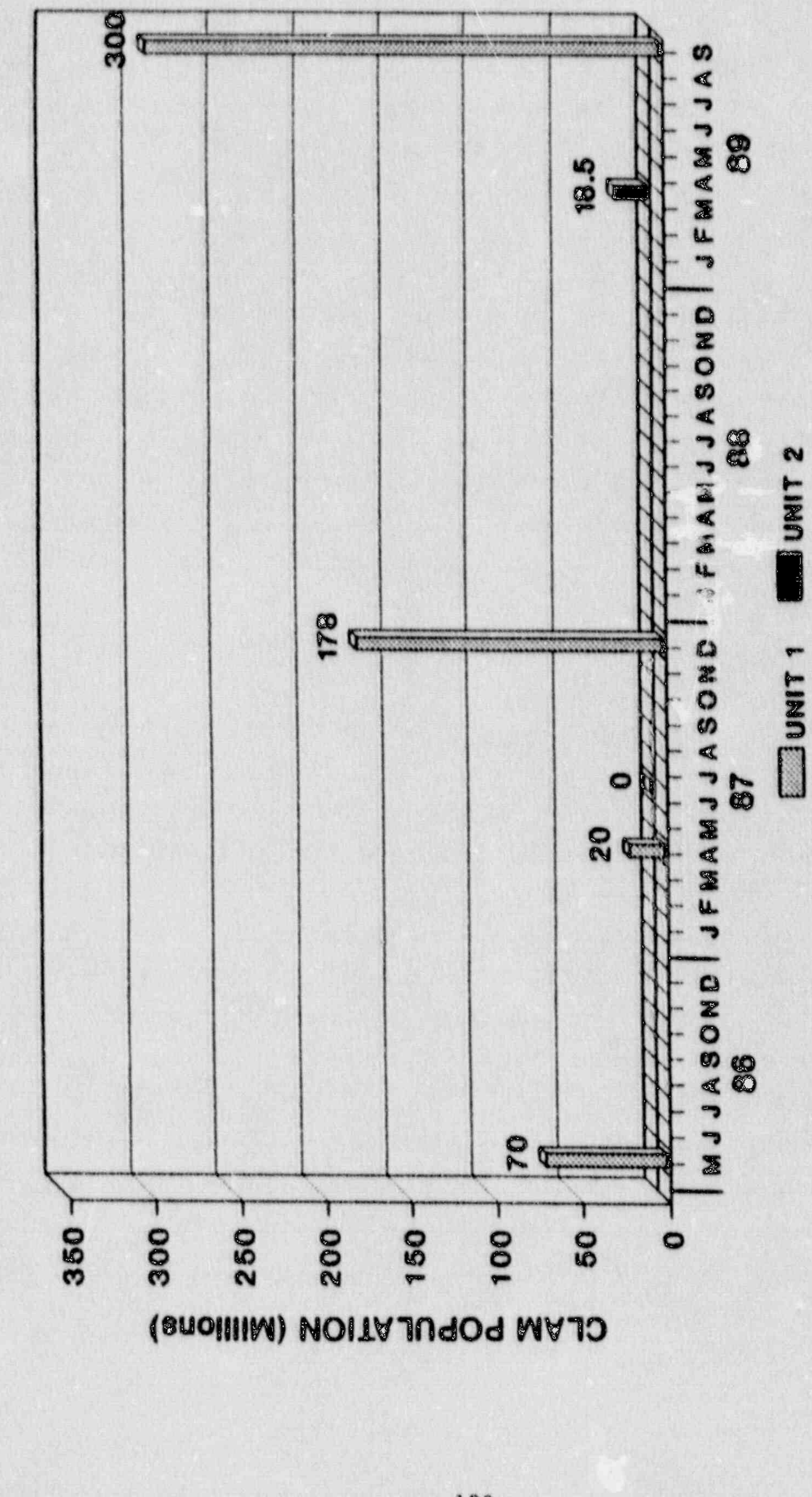


FIGURE V-I-5

APPROXIMATE POPULATIONS OF Corbicula IN UNITS 1 and 2 COOLING TOWERS DERIVED FROM SURVEYS CONDUCTED IN 1986 THROUGH 1989 BVPS

(Unit 2 Cooling Tower)

Results of the March 21 Corbicula survey of the Unit 2 cooling tower are presented in Table V-I-2. Based on the ten Ponar grab samples taken from the lower reservoir, the estimated number of clams inhabiting this area was 18.5 million, of which 42% were alive (Figure V-I-5).

(Intake)

While performing the innerbay cleaning operation (May and November 1989), the divers observed concentrations of Corbicula in each of the bays close to the intake pumps. The November cleaning operation produced more clams than what was removed in the May cleaning operation. Approximately five 55-gallon drums of clams were removed from Bay B and two 55-gallon drums removed from each of the remaining bays during the November operation. A cut-away diagram of the intake structure is provided in Figure V-I-6.

(River)

The results of the Corbicula survey in the Ohio River are given in Tables V-I-3 (May) and V-I-4 (September). Dead clams were not counted in samples of the regular benthic macroinvertebrate monitoring program. Live Corbicula were collected in substrates of silt, sand, and gravel.

Substantially fewer Corbicula were collected in May as compared to September's collection. Live density calculations surpassed $100/m^2$ eleven times, with the highest density being $862/m^2$ at mile 33.0 of the Ohio River in September.

Table V-I-5 summarizes Corbicula frequency in past macroinvertebrate collections for the BVPS (1973 through 1989). Peaks in population density are apparent in the years 1976, 1981, and 1988; no Corbicula were found during 1973, 1979 and 1980. Corbicula densities increased substantially during fall collections.

TABLE V-I-2

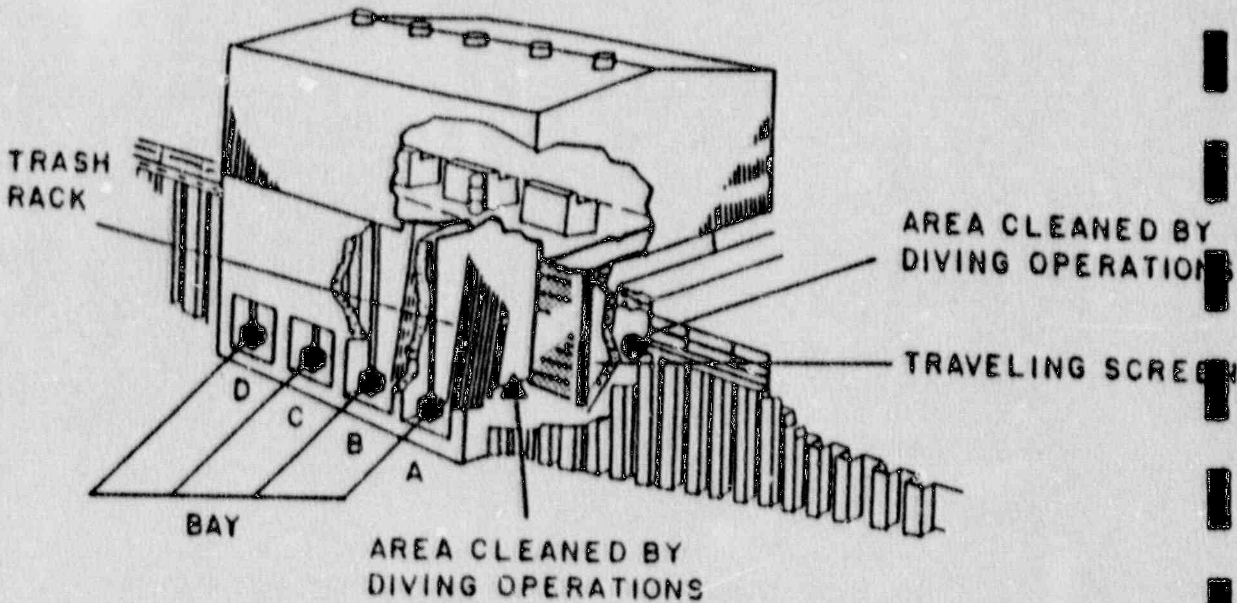
Corbicula COLLECTED IN UNIT 2 COOLING TOWER
March 21, 1989
BVPS

Sample Location	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Lower Reservoir				
1	sil	1	4	43
2	sil	0	0	0
3	sil	1	1	43
4	sil	0	0	0
5	sil	0	1	0
6	sil	0	0	0
7	sil	166	564	7,155
8	sil	44	16	1,896
9	sil	263	376	11,335
10	sil	220	9	9,482

Substrate Codes:

sil - silt

(THREE DIMENSIONAL: CUTAWAY VIEW)



BAY D

(TWO DIMENSIONAL: SIDE VIEW)

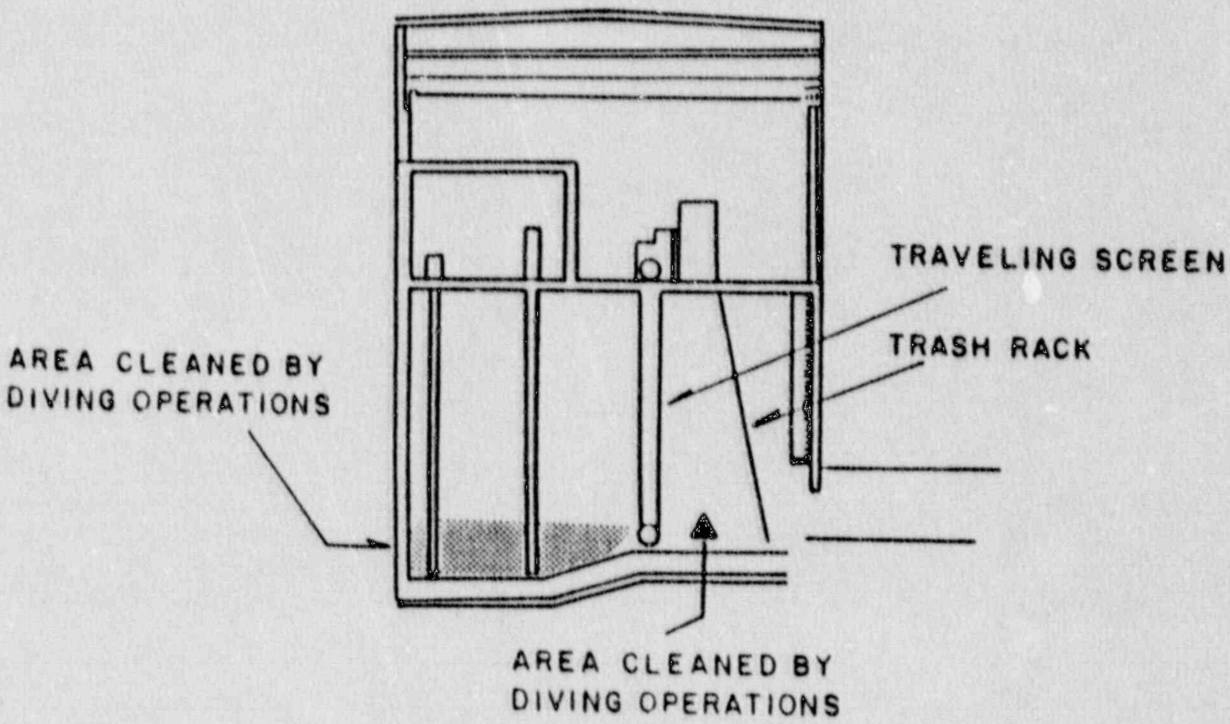


FIGURE V-I-6

<u>Corbicula</u> MONITORING PROGRAM SAMPLING STATIONS
INTAKE STRUCTURE
BVPS

TABLE V-[illegible]-3

Corbicula COLLECTED IN THE OHIO RIVER
MAY 23, 1989
BVPS

Sample Location	River Mile	River Bank	Depth (ft.)	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Raccoon Creek	0.3	R	6	sil	0	0	0
		M	5	sil/gra/cob	0	0	0
		L	2	sil	0	0	0
Ohio River	28.2	R	1	sil	0	0	0
		M	36	gra	0	1	0
		L	1	sil	1	1	43
	30.0	R	3	cla/sil	0	0	0
		M	29	gra	0	1	0
		L	3	cla/sil	0	0	0
	33.0	R	2	sil	0	1	0
		M	20	gra/cob	1	0	43
		L	1	sil	1	24	43
	34.5 (1)	R	2	sil/gra	0	4	0
		M	20	gra/cob	0	0	0
		L	2	sil	0	-	0
		L	2	sil	0	-	0
	34.8	R	2	sil	0	0	0
		M	22	gra/cob	0	0	0
		L	20	sil	0	10	0
(Back Channel)	35.0	R	2	cla/sil/san	0	1	0
		M	30	sil/san	0	1	0
		L (HD)	1	sil	0	0	0
	35.4 (2A)	R	3	gra	0	0	0
		M	19	san/gra	0	1	0
		L	2	cla/san	0	-	0
		L	2	cla/san	0	-	0
(Back Channel)	35.6 (2B)	R	2	sil/san	1	-	20
		M	11	gra/cob	5	-	99
		L	1	sil	0	-	0
(Back Channel)	35.7	R	2	sil	0	1	0
		M	14	gra/cob	0	1	0
		L	3	gra	0	1	0
	37.0 (3)	R (HD)	2	sil/san	0	2	0
		M	22	gra/cob	0	0	0
		L	1	sil	1	-	20
		L	1	sil	0	-	0
	37.5	R	3	sil/san	1	1	43
		M	22	bed	0	0	0
		L	2	san/cob	0	0	0
(Back Channel)	37.5	R	2	sil	0	0	0
		M	16	san/gra/cob	1	3	43
		L	4	san	0	1	0

Substrate Codes:

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

Footnotes:

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

TABLE V-I-4

Corbicula COLLECTED IN THE
OHIO RIVER SEPTEMBER 14, 1989
BVPS

Sample	River				Clams Collected		Station Density
Location	Mile	Bank	Depth (ft.)	Substrate	Alive	Dead	Live Clams/m^2
Raccoon Creek	0.3	R	4	sil	0	1	0
		M	6	sil/san	1	1	43
		L	2	sil	0	0	0
Ohio River	28.2	R	2	sil/det	1	0	43
		M	35	san/gra	1	0	43
		L	3	sil	0	1	0
	30.0	R	2	sil/san	1	3	43
		M	38	san/gra	0	1	0
		L	6	sil	2	2	86
	33.0	R	5	sil/san	2	3	86
		M	21	san/gra	20	3	862
		L	4	sil/san	5	9	216
	34.5(1)	R	3	sil/san	7	9	302
		M	21	gra	0	0	0
		L	3	sil/san	0	-	0
		L	2	sil/san	2	-	39
	34.8	R	4	sil	0	2	0
		M	22	san/gra	2	0	86
		L	20	sil/det	9	12	388
(Back Channel)	35.0	R	9	sil	9	9	388
		M	25	sil/san/gra	2	3	86
		L(HD)	3	sil	0	2	0
	35.4(2A)	R	2	cob	1	1	43
		M	17	san/gra	5	2	216
		L	2	cla/san	8	-	158
		L	2	cla/san	4	-	79
(Back Channel)	35.4(2B)	R	2	sil	13	-	256
		M	12	gra/cob	2	-	39
		L	3	sil	15	-	296
(Back Channel)	35.7	R	3	sil	2	4	86
		M	12	san/gra	0	0	0
		L	3	sil/det	2	9	86
	37.0(3)	R(HD)	3	sil/san	3	3	129
		M	21	cob	0	2	0
		L	1	sil	8	-	158
		L	2	sil	3	-	59
	37.5	R	3	san	2	5	86
		M	22	gra	0	0	0
		L	4	san	0	2	0
(Back Channel)	37.5	R	5	sil	1	3	43
		M	14	san	1	2	43
		L	4	sil/san/gra	2	7	86

Substrate Codes:

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

Footnotes:

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

TABLE V-I-5

Corbicula DENSITIES (Clams/m^2) SUMMARIZED
FROM BENTHIC MACROINVERTEBRATE COLLECTIONS
1973 THROUGH 1989
BVPS

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

(-) indicates area not sampled

Table V-I-6 summarizes Corbicula present in ichthyoplankton samples collected from April through August. Only the night collections (May and July, 1989) contained clams. No Corbicula were collected during the day surveys in 1989.

Monthly totals for Corbicula collected from the traveling screens during the weekly impingement surveys in 1989, are presented in Table V-I-7. The greatest number of Corbicula were collected in September and October; numbers declined through the end of December. Figure V-I-7 presents monthly totals for Corbicula collected during impingement surveys for the years 1981 through 1989. The number of live Corbicula collected from the screens of operating intake bays during September 1-15 ranged from 2,380 to 4,612, which was several fold more than the month with the next highest abundance (October). Weekly totals of live Corbicula collected during the impingement surveys from January through July numbered six or less.

Summary

The results of the 1989 Corbicula survey for the Unit 1 cooling tower indicated that no live clams were present in the upper reservoir. Since the water entering this area comes directly from the condensers, it is suspected that elevated water temperatures make this area unsuitable for the clams. The Corbicula population in the lower reservoir on September 7 was estimated at 300 million (98% alive). The estimated population of Corbicula in the Unit 2 reservoir on March 21 was 18.5 million (42% alive).

The river surveys conducted in 1989 demonstrate that Corbicula inhabiting the upper Ohio drainage provides an extremely large number of clams to the BVPS. Cleaning of the intake bays by divers resulted in removing many live clams from the innerbays; this along with the weekly impingement data show that adult clams move into the plant with the water currents.

TABLE V-I-6

Corbicula DENSITIES (Clams/100 m^3) PRESENT IN ICHTHYOPLANKTON SAMPLES COLLECTED WITH A 0.5m PLANKTON NET IN THE OHIO RIVER, 1988 and 1989
BVPS

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

[(a)]Night survey was conducted.

TABLE V-I-7

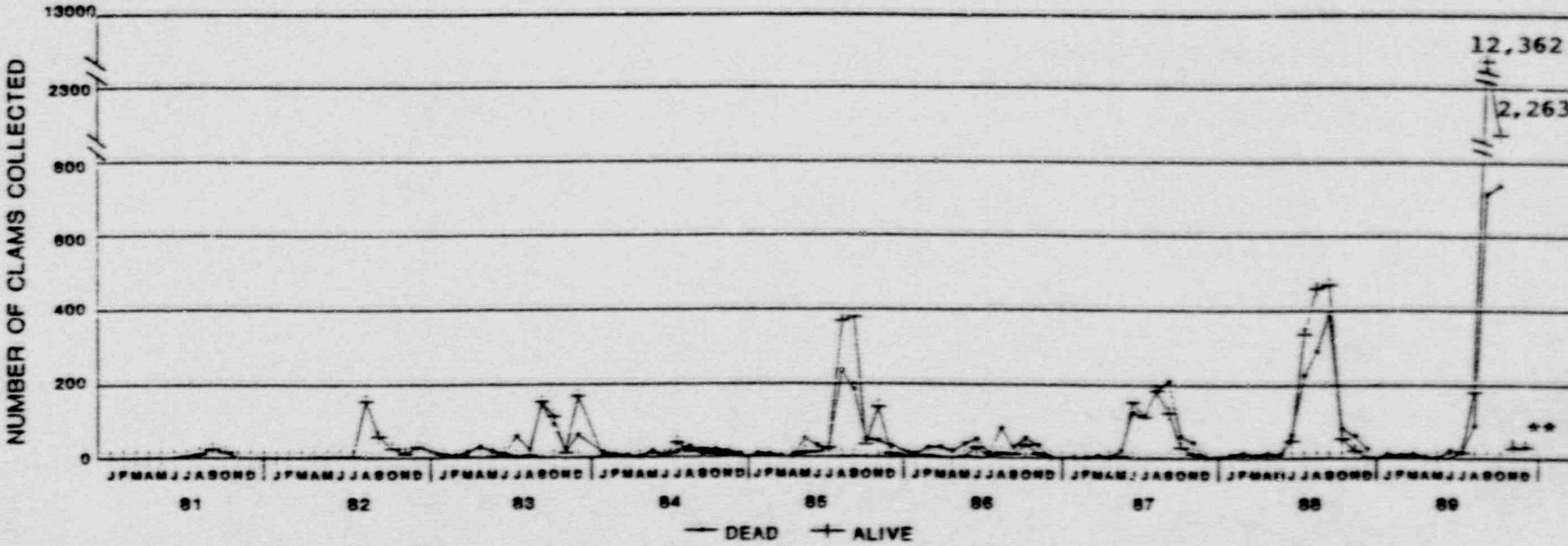
SUMMARY OF *Corbicula* COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1989
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	6	0	1	0	0
	13	1	1	0	0
	20	4	3	0	0
	27	1	5	0	1
February	3	0	5	0	0
	10	0	3	0	0
	17[(a)]	-	-	-	-
	24	-	-	-	-
	31[(a)]				
March	3	0	7	0	0
	10	0	3	2	0
	17	0	0	0	0
	24	0	2	0	0
	31[(a)]	-	-	-	-
April	7	0	0	0	0
	14	0	1	0	2
	21	0	0	0	0
	28	0	1	0	0
May	5	0	0	0	0
	12	3	0	0	0
	19[(b)]	-	-	-	-
	26[(b)]	-	-	-	-
June	2	0	1	0	7
	9	0	3	0	0
	16	1	10	0	0
	23	0	0	0	0
	30	1	0	0	0
July	7	2	1	0	0
	14	4	3	0	0
	21	6	3	0	3
	28	5	8	0	0

TABLE V-I-7
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	4	5	12	0	0
	11	12	9	0	0
	18	50	40	0	0
	25	114	29	0	0
September	1	2,380	218	0	0
	8	3,351	48	173	4
	15	4,612	135	729	24
	22	0	0	62	4
	29	933	213	122	70
October	6	868	345	544	36
	13	227	41	47	17
	20	114	26	63	15
	27	232	134	168	124
November	3 (b)	-	-	-	-
	10 (b)	-	-	-	-
	17 (b)	-	-	-	-
	24	28	31	0	0
December	1 (b)	-	-	-	-
	8 (c)	-	-	-	-
	15 (c)	-	-	-	-
	22 (c)	-	-	-	-
	29	32	31	0	1
TOTAL		12,986	1,373	1,910	308

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



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

FIGURE V-I-7

SUMMARY OF Corbicula COLLECTED FROM THE INTAKE STRUCTURE TRAVELING SCREENS DURING IMPINGEMENT SURVEYS, 1981 THROUGH 1989
BVPS

2. Growth Study

Objective

The Corbicula growth study was designed to collect data on the growth rates of clams held in the intake structure and Unit 1 cooling tower.

Methods

To calculate growth rates of clams in the Unit 1 cooling tower and the intake structure, clams of known size were housed in 1 $ft.^2$ cages, which were placed in the study areas. Each cage was constructed of 1 mm mesh fiberglass screening secured within a durable plastic frame and contained approximately ten pounds of industrial glass beads (3/8" diameter) to provide ballast and a uniform substrate for the clams. Shell length (maximum anteroposterior dimension) was measured to the nearest 0.05 mm with Vernier calipers.

Cage one was initially part of the 1988 Corbicula growth study, placed in the Unit 1 cooling tower on March 3, 1988, and maintained there until the September 1989 scheduled outage. Cage two was placed in the Unit 1 cooling tower on March 22, 1989. Another cage was placed in the intake structure on March 22, 1989. Clams used in these cages had been removed from the cooling tower and housed in laboratory aquaria prior to their placement in the intake structure and cooling tower. Initial shell length measurements were made before each cage was placed in its respective location. Clams were selected for each cage ranging in length from 14.00 mm to 14.90 mm. Growth measurements were made every 28 days until the end of the year. All clams were removed, shell length measured and recorded, and all individuals were returned to their original cage. An effort was made to keep each clam out of water for a minimum amount of time.

TABLE V-I-8

RESULTS OF *Corbicula* GROWTH STUDY
IN INTAKE STRUCTURE AND UNIT 1 COOLING TOWER, 1989
BVPS

	Intake Structure			Cooling Tower					
	Cage 1			Cage 1			Cage 2		
Sampling Date	$\bar{y}$	s	n	$\bar{y}$	s	n	$\bar{y}$	s	n
Jan 13[(a)]	-	-	-	26.11	0.598	39	-	-	-
Feb 10	-	-	-	26.24	0.603	39	-	-	-
Mar 10	-	-	-	26.51	0.624	39	-	-	-
Mar 22[(b)]	14.41	0.311	40	-	-	-	14.40	0.303	40
Apr 7	14.42	0.285	40	26.86	0.671	39	14.64	0.306	40
May 5	14.43	0.296	40	27.39	0.690	39	15.41	0.373	40
Jun 2	14.44	0.300	40	27.80	0.732	39	16.51	0.448	40
Jun 30	15.01	0.398	40	27.92	0.743	39	17.60	0.365	40
Jul 28	17.83	0.673	40	28.11	0.754	39	18.77	0.356	40
Aug 25	20.62	0.648	40	28.17	0.776	39	19.77	0.427	40
Sep 22[(c)]	21.87	0.765	40	28.11	0.759	39	19.88	0.508	40
Oct 20[(c)]	22.36	0.762	40	-	-	-	-	-	-
Nov 17[(c)]	22.36	0.751	40	-	-	-	-	-	-
Dec 15[(c)]	22.40	0.895	40	-	-	-	-	-	-

(a) Continuation of cooling tower cage 1, March 3, 1988, with an initial measurement of $\bar{y}$ = 14.47.

(b) Initial measurement for intake structure cage 1 and cooling tower cage 2.

(c) Cooling tower cages removed September 6 due to scheduled outage.

($\bar{y}$) mean shell length in millimeters.

(s) standard deviation.

(n) sample size measured for each sampling date.

Results

Table V-I-8 summarizes the growth data collected from clams in the intake structure and Unit 1 cooling tower. Temperatures were consistently higher in the cooling tower compared to the intake structure. Mean shell length for clams maintained in the intake structure cage increased 6.2 mm from March 22 to August 25 while the cooling tower (cage 2) clams showed an average increase of 5.4 mm in shell length for the same period. Growth measurement data could not be collected at Unit 1 cooling tower for the last three months of 1989 due to a scheduled outage.

Summary

The results obtained show that growth of Corbicula was initially more rapid in the cooling tower than in the intake structure, probably due to the higher water temperatures in the cooling tower compared to the intake structure for the months of March through June. Higher river water temperatures (typically 70 to 80°F) in late June through August resulted in rapid growth of the intake structure clams during this time. Mean shell length of intake structure clams on August 25 was 20.62 mm compared to 19.77 mm for the cooling tower (cage 2) clams.

3. Spawning Study

Objective

The Corbicula spawning study was designed to collect data on the reproductive activity of clams inhabiting the intake structure and Unit 1 cooling tower.

Methods

Adult clams maintained in cages that were originally placed in the intake structure and Unit 1 cooling tower in March of 1988 were initially sampled (January 13 through March 22, 1989). On March 22, 1989, six cages each containing 100 adult clams originally collected from the Unit 1 cooling tower (shell length ≥17.0 mm) were placed in both the intake structure and Unit 1 cooling tower.

Sampling was conducted approximately every fourteen days, at which time, twenty clams were removed from one of the six cages (cages sampled on a rotating basis) in both cooling tower and intake structure. Samples were transported in a dry towel to the laboratory for examination.

In the laboratory, the shell length of each clam was measured to the nearest 0.05 mm with a Vernier caliper and recorded. One of the inner gills (demibranch) from each clam was removed, dissected, and examined using a dissecting microscope for the presence of pediveliger larvae. The gravid condition of each clam was then recorded using the following criteria:

Number of larvae	Gravid Condition
0	none
1-50	few
51-100	moderate
101-500	many
>500	gorged

Results

The intake structure water temperatures showed an increase through July and declined to December (Figure V-I-8). The Unit 1 cooling tower water temperatures generally increased through July; however, data was not available for the latter months due to the scheduled outage. The Corbicula reproduction study data, expressed as the percentage of clams examined in each gravid condition, also is illustrated in Figure V-I-8 for the intake structure and Unit 1 cooling tower.

The greatest percentage of clams examined having pediveliger larvae in the inner gill in the intake structure occurred on August 11, 1989 when 100% were in a gravid condition. The greatest percentage of clams exhibiting a gorged condition in the intake structure occurred on August 25,

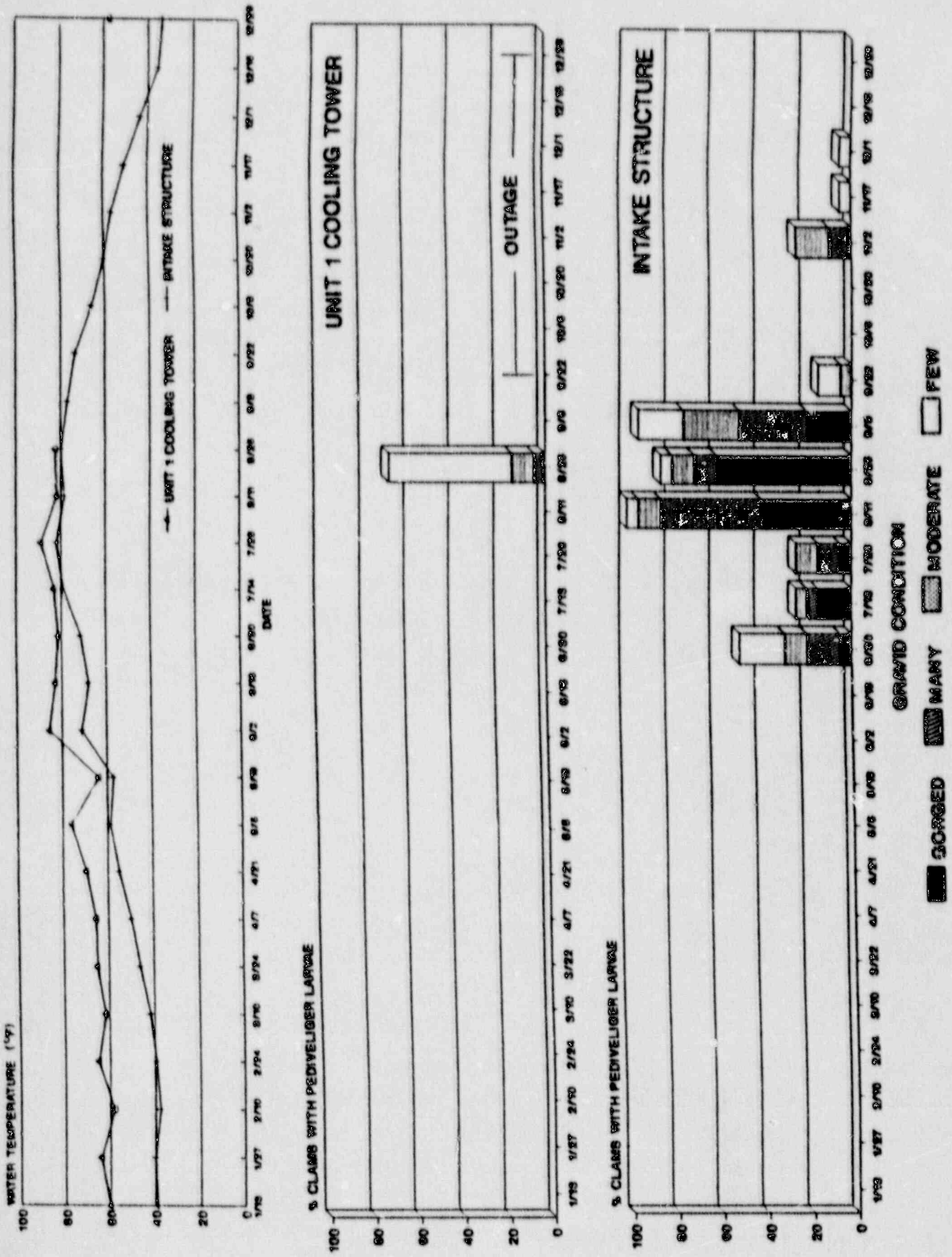


FIGURE V-I-8

RESULTS OF *Corbicula* REPRODUCTION STUDY IN THE INTAKE STRUCTURE AND UNIT 1 COOLING TOWER, 1989 BVPS

1989 when 60% of the clams examined were incubating more than 500 pediveliger larvae in the dissected gill. Overall, the advent of pediveliger larvae release was continuous from June 30 through September 8, 1989, and perhaps to the following week. The availability of larval clams through the intake structure occurred more or less continuously for 10 to 12 weeks in 1989.

In the cooling tower, the only time that clams were in a gravid condition occurred on August 25, 1989, when 70% of the clams sampled from the cooling tower cage were incubating larvae. None of the sampled clams exhibited a gorged condition in the cooling tower. From September through the end of the year reproduction data could not be collected at the cooling tower due to a scheduled outage.

Summary

The period of potential larval release from gravid adult clams occurred in late June to mid-September 1989 at the intake structure. Unit 1 cooling tower clams had a minor larval release period in the latter part of August.

4. Larvae Study

Objective

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

Methods

Empty clam cages (larval cages) were placed inside the intake structure and cooling towers. For every month of the initial five months, an empty clam cage was placed in each cooling tower and two cages were placed in the intake structure. This resulted in the placement of five clam cages in each cooling tower and ten cages in the intake structure. The clam cage mesh size (1 mm) permitted only very small clams or pediveliger

larvae to enter and colonize the cage. Removal of a clam cage for examination of live and dead clams occurred five months after initial placement. Each removed clam cage was returned to the laboratory where it was washed to obtain the clams which had colonized the cage. Corbicula obtained from each cage were rinsed through a series of stacked sieves with mesh size ranging from 16.00 mm to 600 microns. The largest and smallest live clams were measured using the Vernier calipers to establish a range for the sample. It should be noted that the size distribution data obtained using the sieves reflects clam width, rather than length. Clams retained on each sieve were counted and the number recorded.

Results

The larval sampling cages that received the most Corbicula were located in the intake structure (Table V-I-9). The greatest number of clams (alive and dead) collected from one cage was 2,491 (July 13 to December 15). The largest clam measured (20.10 mm) was obtained from the intake structure (sample period May 12 to October 13). Table V-I-10 and Figure V-I-9 present size distribution data for clams collected in the larval sampling cages. The intake structure graph presents size distribution data representing an average for the two cages which were sampled each month.

The influx of juvenile clams ($\leq$ 1.0 mm) into the intake structure cages was not observed until August 18, when ambient river water temperatures were in the 75 to 80°F range (Figure V-I-9). This delay in colonization may have resulted from high water conditions in the spring which interrupted a bimodal pattern of larval releases that was observed from the 1988 survey. June 16 showed the first time large numbers appeared in the Unit 1 cooling tower cages. The first larval study cage examined after the Unit 2 outage and recolonization period (October 13) contained numerous clams that were retained on the 3.35 mm sieve (488) and 6.3 mm sieve (89). This would suggest that spawning had occurred several months earlier during the recolonization period. The interruption in larval cage study data for Units 1 and 2 cooling towers due to scheduled outages limits the interpretation of results and comparisons between these BVPS structures and the intake structure.

TABLE V-I-9

RESULTS OF THE *Corbicula* LARVAE STUDY
IN THE INTAKE STRUCTURE AND UNITS 1 AND 2 COOLING TOWERS, 1989
BVPS

Date		Total Number Clams Collected												Clam Length Range (mm)			
		Intake Structure						Cooling Tower						Intake Structure		Cooling Tower	
		Cage A			Cage B			Unit 1			Unit 2						
Cage Placement	Cage Removal	Alive	Dead	% Mor	Alive	Dead	% Mor	Alive	Dead	% Mor	Alive	Dead	% Mor	Cage A	Cage B	Unit 1	Unit 2
Aug 17	Jan 13	526	49	8.5	504	219	30.3	7	0	0	1	0	0	<1.00-18.10	1.25-16.30	2.30-7.95	3.65
Sep 16	Feb 17	5	96	95.0	6	77	92.8	9	6	40.0	0	[illegible]	[illegible]	5.00-9.75	2.20-9.85	1.65-9.70	0
Oct 14	Mar 17[a]	0	19	100.0	3	2	40.0	6	4	40.0	3	1	25.0	0	1.15-4.00	1.70-9.30	2.00-5.10
Nov 21	Apr 14[a]	0	2	100.0	1	4	80.0	4	1	20.0	-	-	-	0	8.40	3.00-4.35	-
Dec 14	May 12[b]	0	4	100.0	14	6	30.0	13	2	13.3	-	-	-	0	2.95-7.30	1.80-3.10	-
Jan 13	Jun 16[b]	0	0	0	0	2	100.0	246	238	49.2	-	-	-	0	0	<1.00-5.10	-
Feb 17	Jul 13[b]	2	0	0	1	0	0	362	20	5.2	-	-	-	4.25-5.25	7.85	1.00-9.30	-
Mar 17	Aug 18[b]	211	90	29.9	372	98	20.9	77	10	11.5	-	-	-	<1.00-7.70	<1.00-17.20	1.65-13.40	-
Apr 14	Sep 15[b][c]	665	35	5.0	1,104	106	8.8	200	0	0	-	-	-	1.80-19.20	1.40-19.10	1.50-13.20	-
May 12	Oct 13[c]	642	7	1.1	754	16	2.1	-	-	-	1,016	22	2.1	1.00-20.10	1.55-13.30	-	1.50-11.60
Jun 16	Nov 10[c]	1,059	1	0.1	875	8	0.9	-	-	-	960	8	0.8	<1.00-14.90	1.60-14.85	-	<1.00-11.70
Jul 13	Dec 15[c]	2,287	10	0.4	2,455	36	1.4	-	-	-	791	3	0.4	<1.00-15.45	1.35-12.50	-	1.20-13.10
Aug 18	Jan 19[d]	224	18	6.9	101	56	35.7	-	-	-	239	11	4.4	<1.00-13.10	<1.00-12.00	-	1.35-12.70
Total		5,621	331		6,190	630		924	281		3,010	46					

(a) Unit 2 cooling tower cages removed March 17 due to scheduled outage.
(b) Unit 2 cooling tower cage placement for clam recolonization.
(c) Unit 1 cooling tower cages removed September 6 due to scheduled outage.
(d) Unit 1 cooling tower cage placement for clam recolonization.

TABLE V-I-10

RESULTS OF THE *Corbicula* LARVAE STUDY SIZE DISTRIBUTION
IN THE INTAKE STRUCTURE AND UNITS 1 AND 2 COOLING TOWERS, 1989
BVPS

Date	Cage Location	Live Clam Size Distribution Numbers						Total
		≤1.00 (mm)	3.35 (mm)	6.3 (mm)	9.5 (mm)	12.5 (mm)	16.0 (mm)	Live Clams/Cage
Jan 13	Int[c]	360	133	19	3	0	0	515
	1 ct	3	4	0	0	0	0	7
	2 ct	1	0	0	0	0	0	1
Feb 17	Int	2	3	1	0	0	0	6
	1 ct	7	1	1	0	0	0	9
	2 ct	0	0	0	0	0	0	0
Mar 17	Int	2	0	0	0	0	0	2
	1 ct	5	0	1	0	0	0	6
	2 ct[a]	2	1	0	0	0	0	3
Apr 14	Int	0	1	0	0	0	0	1
	1 ct	4	0	0	0	0	0	4
	2 ct[a]	-	-	-	-	-	-	-
May 12	Int	4	4	0	0	0	0	8
	1 ct	13	0	0	0	0	0	13
	2 ct[b]	-	-	-	-	-	-	-
Jun 16	Int	0	0	0	0	0	0	0
	1 ct	243	2	1	0	0	0	246
	2 ct[b]	-	-	-	-	-	-	-
Jul 13	Int	1	1	0	0	0	0	2
	1 ct	133	226	3	0	0	0	362
	2 ct[b]	-	-	-	-	-	-	-

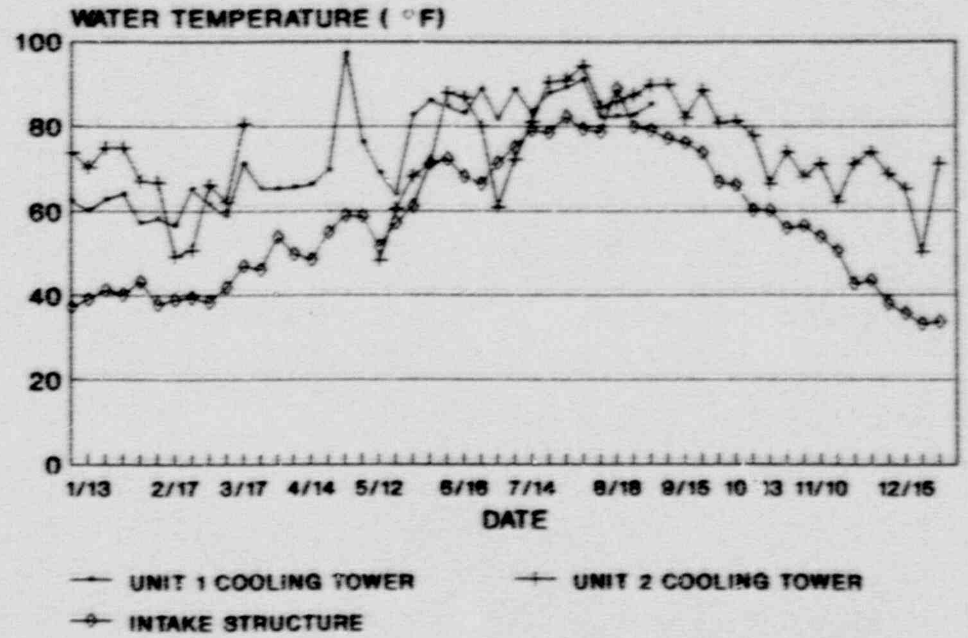
TABLE V-I-10
(Continued)

Date	Cage Location	Live Clam Size Distribution Numbers ≤1.00(mm)	3.35(mm)	6.3(mm)	9.5(mm)	12.5(mm)	16.0(mm)	Total Live Clams/Cage
Aug 18	Int	282	10	0	1	1	0	294
	1 ct	21	11	37	8	0	0	77
	2 ct[b]	-	-	-	-	-	-	-
Sep 15	Int	188	563	123	4	8	0	886
6	1 ct[a]	60	43	97	0	0	0	200
15	2 ct[b]	-	-	-	-	-	-	-
Oct 13	Int	76	369	240	12	2	0	699
	1 ct[a]	-	-	-	-	-	-	-
	2 ct	439	488	89	0	0	0	1,016
Nov 10	Int	117	397	433	21	0	0	968
	1 ct[a]	-	-	-	-	-	-	-
	2 ct	217	446	297	0	0	0	960
Dec 15	Int	514	1,459	392	6	0	0	2,371
	1 ct[a]	-	-	-	-	-	-	-
	2 ct	142	301	348	0	0	0	791
Totals		2,836	4,463	2,082	55	11	0	9,447

(a) Cooling tower cages removed due to scheduled outage.
(b) Cage placement for clam recolonization.
(c) Number of clams represent the average of two cages in the intake structure.

Symbols

Int - Intake structure
1 ct - Unit 1 cooling tower
2 ct - Unit 2 cooling tower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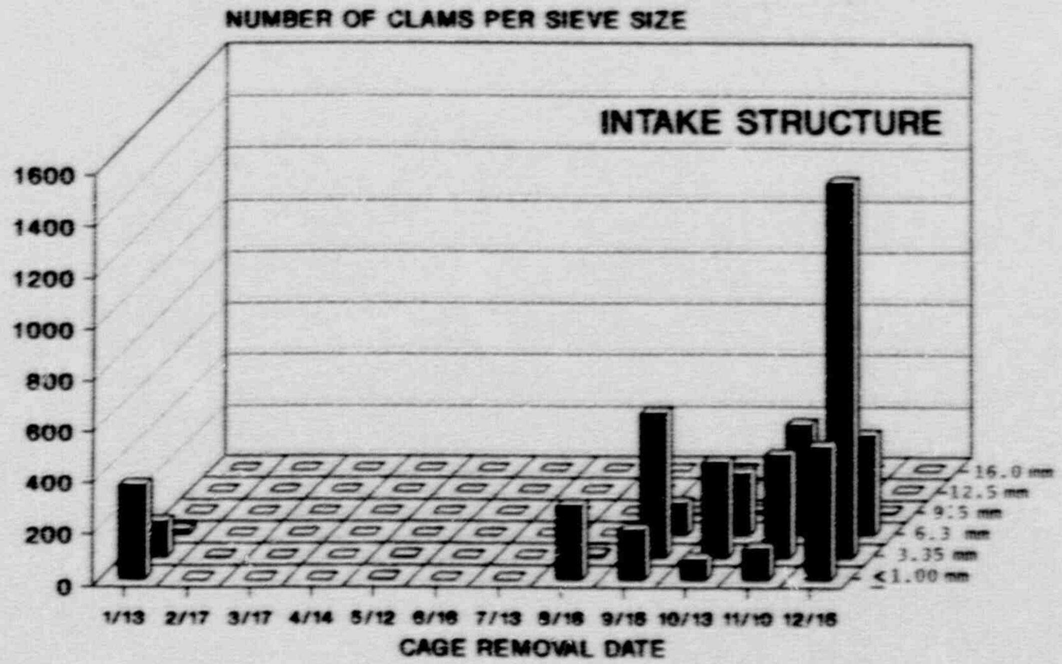
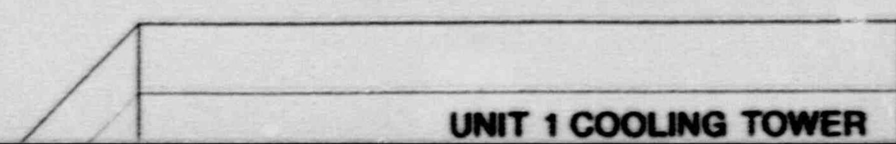
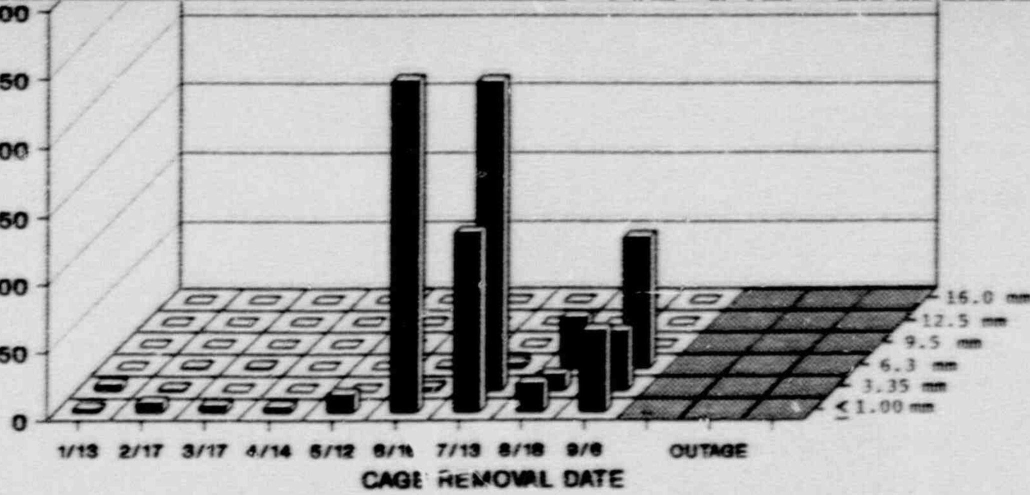
100
80
60
40
20
0
1/13
2/17
3/17
4/14
5/12
6/16
7/14
8/18
9/15
10 13
11/10
12/15
DATE
UNIT 1 COOLING TOWER
UNIT 2 COOLING TOWER
INTAKE STRUCTURE


NUMBER OF CLAMS PER SIEVE SIZE
INTAKE STRUCTURE
1600
1400
1200
1000
800
600
400
200
0
16.0 mm
12.5 mm
9.5 mm
6.3 mm
3.35 mm
≤1.00 mm
1/13
2/17
3/17
4/14
5/12
6/16
7/13
8/18
9/18
10/13
11/10
12/16
CAGE REMOVAL DATE


UNIT 1 COOLING TOWER



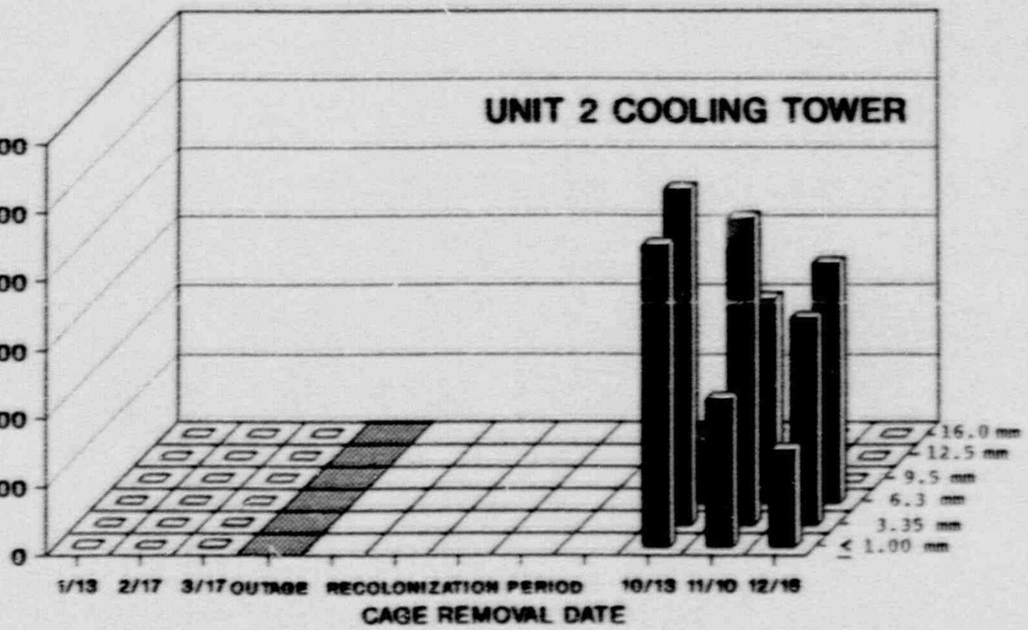


FIGURE V-I-9

RESULTS OF THE Corbicula LARVAE STUDY SIZE DISTRIBUTION IN THE INTAKE STRUCTURE AND UNITS 1 AND 2 COOLING TOWERS, 1989
BVPS

Water temperatures in both cooling towers typically fluctuated more from week to week than the intake structure (Ohio River) water temperatures (Figure V-I-9). This along with chlorination probably influences reproductive activity and larval survival of clams in the cooling towers above any other environmental factors.

Summary

Results of the larval cage study for the intake structure indicated that spawning activity in the Ohio River occurred from August through December of 1989. Chlorination of the cooling tower water may be a factor in the larvae study results.

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