1987 ANNUAL ENVIRONMENTAL REPORT
NON-RADIOLOGICAL
DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION
UNITS NO. 1 & 2

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DUQUESNE LIGHT COMPANY
1987 ANNUAL ENVIRONMENTAL REPORT

I. INTRODUCTION

This report presents a summary of the non-radiological environmental data collected by Duquesne Light Company (DLCo) during calendar year 1987, 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 DLCo'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 DLCo is continuing the Aquatic Monitoring Studies.

A. SCOPE AND OBJECTIVES OF THE PROGRAM

The objectives of the 1987 environmental program were:

(1) to assess the possible environmental impact of plant operation (including impingement and entrainment) on the plankton, 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 decommissioned Shippingport Station shares the site with BVPS.

Figure I-1 shows a view of both stations. 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) up-stream 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 tributaties. Flow generally varies from 5,000 to 100,000 cubic feet per second (cfs). The range of flows in 1987 is shown on Figure I-3 as well as Table I-1.

Ohio River water temperatures generally vary from 32° to $82^\circ F$ (0° to 28° C). Minimum and maximum temperatures generally occur in January and July/August, respectively. During 1987, minimum temperatures were observed in January and maximum temperatures in July and August (see Figures I-3 and Table I-1).

BVPS Unit 1 and 2 have a thermal rating of 2,660 megawatts (Mw). Unit 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 Ohio River. Commercial operation of BVPS Unit 1 began in 1976 and Unit 2 began in 1987.

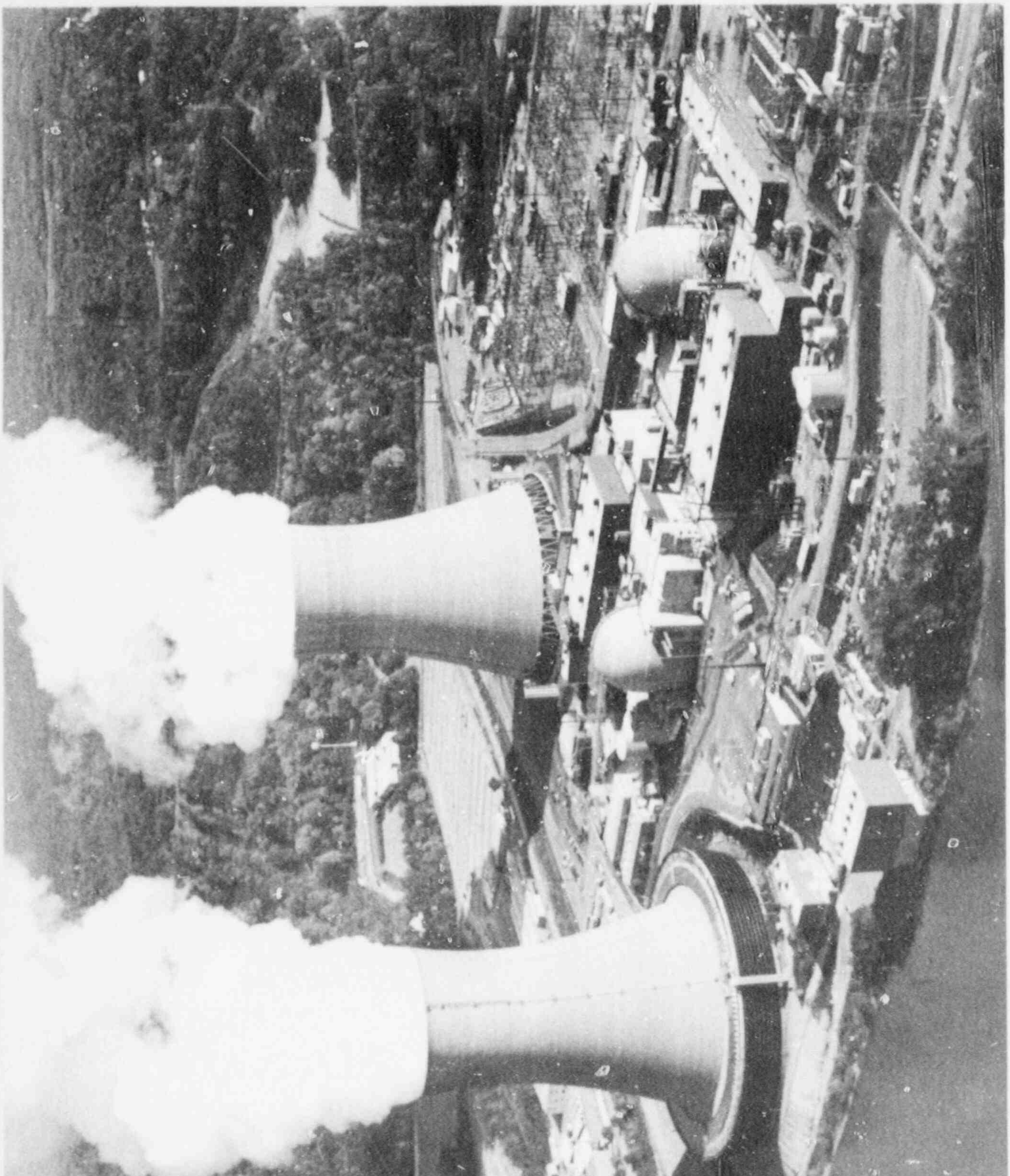

FIGURE I-1

VIEW OF THE BEAVER VALLEY POWER STATION
BVPS

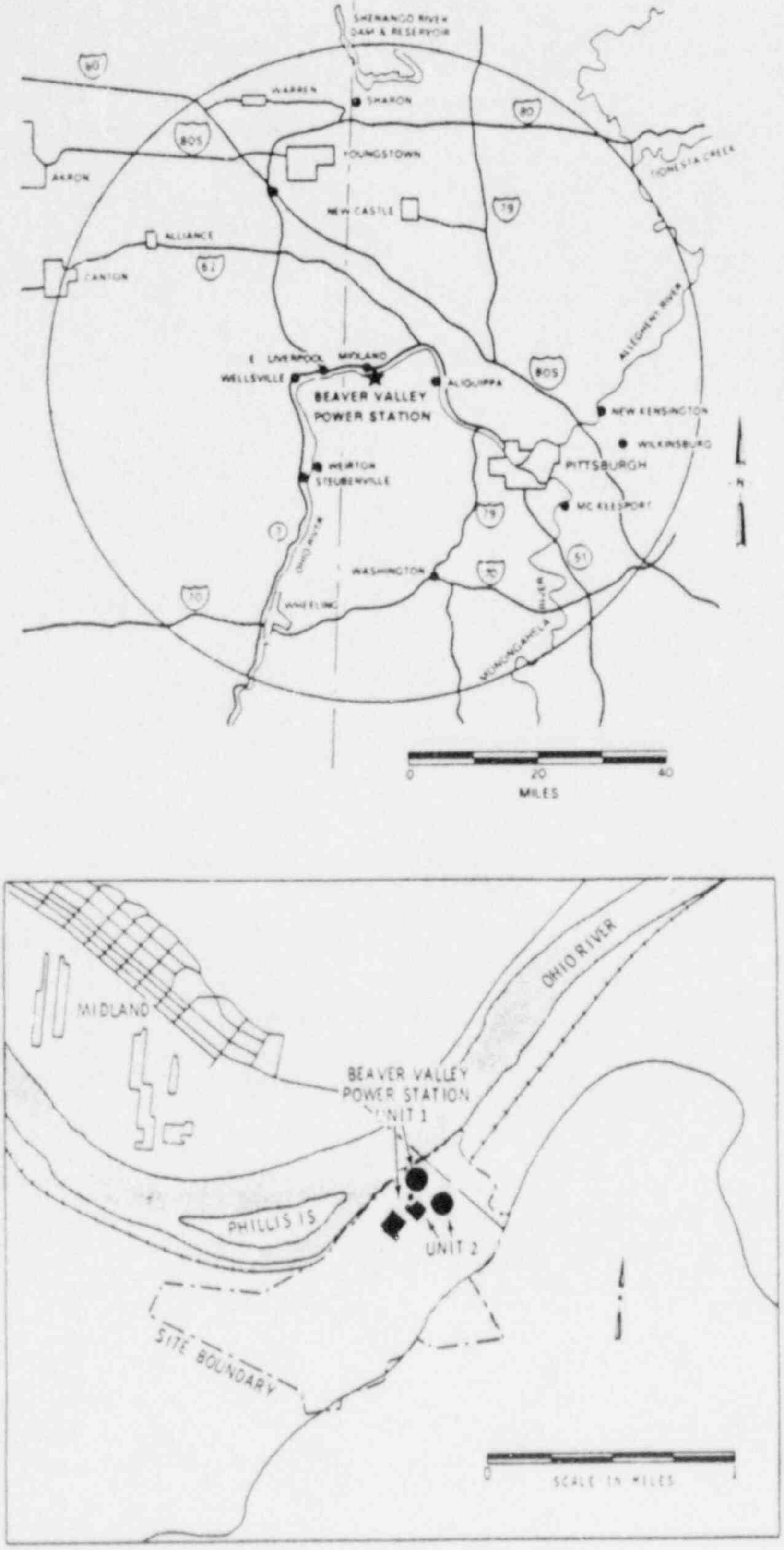

FIGURE I-2

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

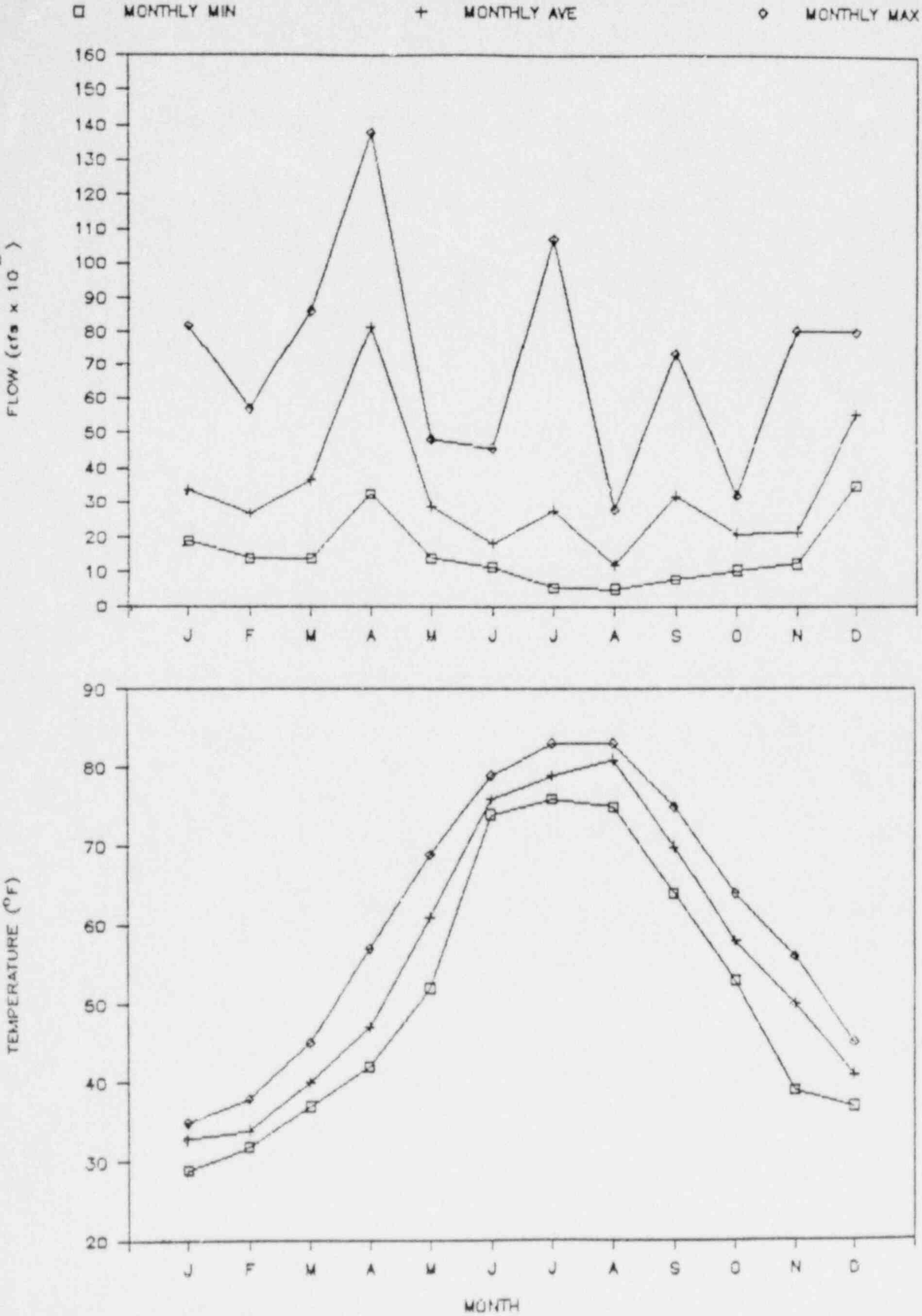

FIGURE I-3

OHIO RIVER FLOW (cfs) AND TEMPERATURE (° F)
RECORDED BY THE U.S. ARMY CORPS OF ENGINEERS
FOR THE NEW CUMBERLAND POOL, 1987
BVPS

TABLE I-1

OHIO RIVER FLOW (cfs) AND TEMPERATURE (^{o}F) RECORDED BY THE
U.S. ARMY CORPS OF ENGINEERS FOR THE
NEW CUMBERLAND POOL, 1987, BVPS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow (cfs x 10^3)												
Monthly Maximum	82.0	57.0	86.0	138.0	48.0	45.5	107.0	28.0	73.0	32.0	80.5	80.0
Monthly Average	33.7	26.7	36.5	81.4	28.8	18.2	27.7	12.2	32.0	21.0	21.6	55.1
Monthly Minimum	19.0	14.0	13.9	32.5	14.0	11.5	5.5	5.0	8.0	10.5	12.5	35.0
Temperature (^{o}F)												
Monthly Maximum	35	38	45	57	69	79	83	83	75	64	56	45
Monthly Average	33	34	40	47	61	76	79	81	70	58	50	41
Monthly Minimum	29	32	37	42	52	74	76	75	64	53	39	37

II. SUMMARY AND CONCLUSIONS

The 1987 BVPS Units 1 and 2 Non-Radiological Environmental Monitoring Program included surveillance and field sampling of Ohio River aquatic life. This is the twelfth year of operational monitoring for Unit 1 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. BVPS Unit 2 went into commercial operation on November 17, 1987.

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 1987 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 83% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 13% and 3% respectively.

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

PHYTOPLANKTON. The phytoplankton community of the Ohio River near BVPS exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. Total cell densities were within the range observed during previous years. Diversity indices of phytoplankton were similar or lower to those previously observed near BVPS.

ZOOPLANKTON. Zooplankton densities throughout 1987 were typical of the temperate zooplankton community found in large river habitats. Total densities exceeded the range of those reported in previous years. Populations developed highest densities in May and a secondary peak occurred in November. Protozoans and rotifers were always predominant. Common and abundant taxa in 1987 were similar to those reported during preoperational and other operational years. Shannon-Weiner diversity, number of species, and evenness were within the ranges of preceding years. Based on the data collected during the twelve operating years (1976 through 1987) 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 fifteen year period from 1973 to 1987. The data indicate that 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 (minnows and shiners) 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 of the family Cyprinidae have dominated the catches. Emerald shiners, gizzard shad, sand shiners, and bluntnose minnows have consistently been among the most numerous fish, although the latter two species may have declined in recent years. Carp, channel catfish, smallmouth and spotted bass, yellow perch, and walleye have all remained common species. Since 1978, sauger have become a common game species to this area.

Differences in the 1987 electrofishing and gill net catches, between the Control and Non-Control Transects were similar to previous years (both operational and pre-operational) 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 1987 indicate that fish in the vicinity of the power plant have not been adversely affected by BVPS operation.

<u>ICHTHYOPLANKTON</u>. Shiners, gizzard shad, and freshwater drum dominated the 1987 ichthyoplankton catch from the back channel of Phillis Island. Peak densities occurred in June and consisted mostly of early larval stages. No spawning was noted in April. There was a decrease in larvae density after July. No substantial differences were observed in species composition or spawning activity over previous years.

<u>FISH IMPINGEMENT</u>. The results of the 1987 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has little or no effect on the fish populations. Three hundred and forty-five (345) fishes were collected, which is the fourth highest collected since initial operation of BVPS in 1976. Gizzard shad were the most numerous fish, comprising 82.6% of the total annual catch. The

total weight of all fishes collected in 1987 was 7.27 kg (16.0 lbs). Of the 345 fishes collected, 18 (5.2%) 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 withdrawned from Unit 2 no substantial entrainment losses should have occurred in 1987 due to the operation of BVPS. Assessment of monthly phytoplankton and zooplankton data of past years indicated that under worse-case conditions of minimum low river flow (5,000 cfs), about 4.1% 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 1987 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 makes this area unsuitable for the clams. Corbicula survive in the lower reservoir with an estimated population of 20 million clams (96% alive) on 29 April and 178 million clams (98% alive) on 15 December. No live Corbicula were collected in the reservoir of Unit 2 cooling tower. From the river surveys conducted in May and September 1987, Corbicula inhabit the upper Ohio drainage, providing the opportunity for clams to enter BVPS.

The results of the growth study obtained show that growth of Corbicula was more rapid in the cooling tower than in the intake structure, especially for the small clam group (size class A). The higher year round temperatures within the cooling tower system probably sustained growth rates longer than in the river. This may also be a result of increased nutrients present in the cooling tower due to the evaporation of water in the cooling tower heat loss process concentrating river water nutrients.

In general, for both the intake structure and cooling tower clams of all sizes increased most rapidly during the first two months of analysis from July to September 1987 and tended to level off in growth thereafter.

The only period of potential larvae release from gravid adult clams occurred from July 31, 1987 through August 28, 1987 at the intake structure. Two weeks later at the intake, larval release was over. Therefore, the larval release period took at least four weeks but probably less than six.

There was inconclusive data of a major larval release period in the Unit 1 cooling tower. Possibly, the consistently warm temperature conditions maintained within the tower may have retarded or prevented a spawning season. Many cold-blooded organisms require a cold period to re-establish their reproductive cycles. The reproductive cycles of Corbicula at BVPS is still under investigation.

The large population of clams found in the cooling tower is evidently being supplemented by juvenile and adult clams circumventing the travelling screens in the intake structure. Gravid clams enter the tower then release their larvae which may remain in the cooling tower or are cycled back out into the river. Larvae, released from clams spawning in the river, may also enter the plant past the travelling screens and establish themselves in the cooling tower.

III. ANALYSIS OF SIGNIFICANT ENVIRONMENTAL CHANGE

In accordance with BVPS Unit 1 ETS, Appendix B to Operating License No. DPR-66, significant environmental change analyses were required on benthos, phytoplankton, and zooplankton data. However, on February 26, 1980, the NRC granted DLCo a request to delete all the aquatic monitoring program, with the exception of fish impingement, from the ETS (Amendment No. 25, License No. DPR-66). In 1983, the NRC deleted the requirement for additional impingement studies. However, in the interest of providing a non-disruptive data base DLCo is continuing the Aquatic Monitoring Studies.

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) 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 1987, 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 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.

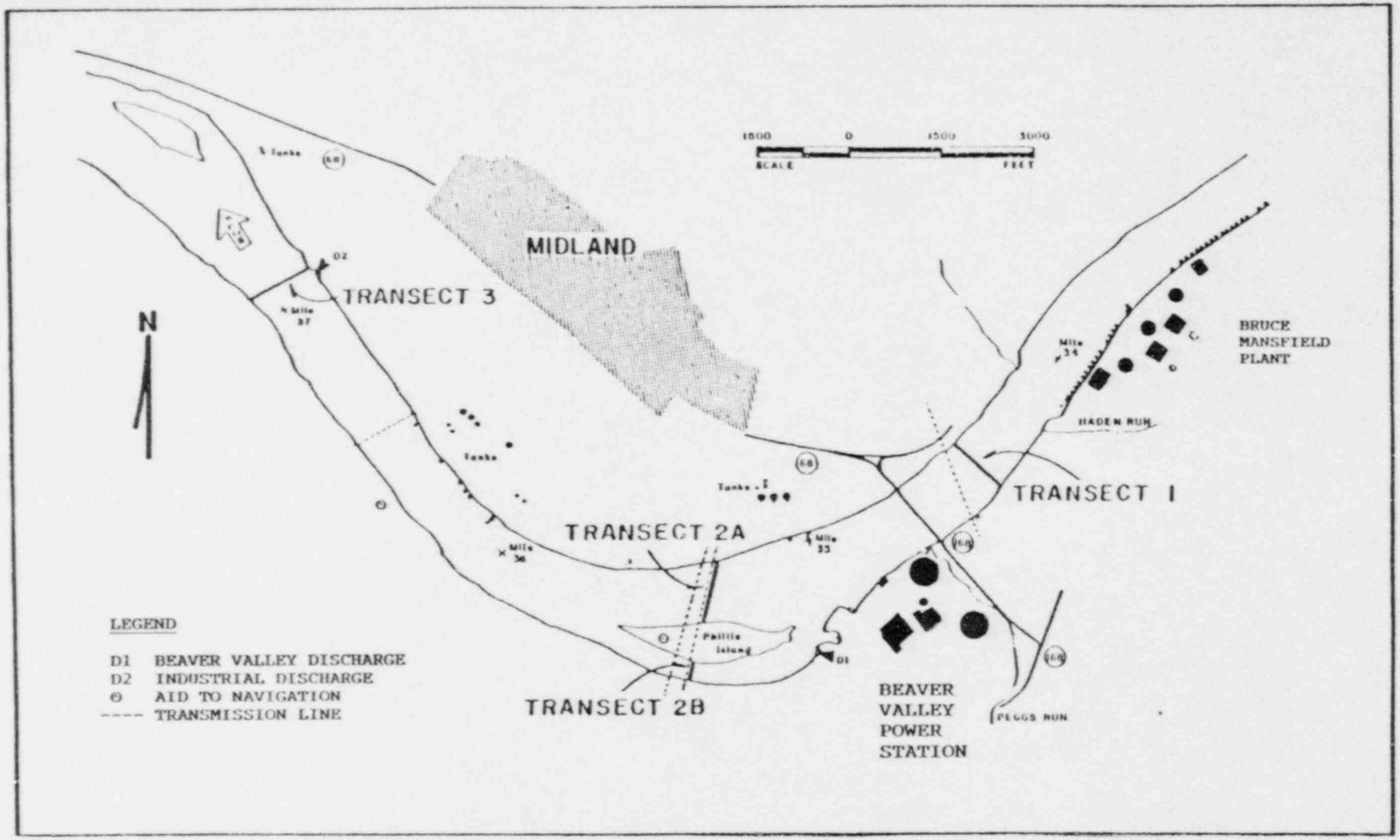

FIGURE V-A-1

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

TABLE V-A-1

AQUATIC MONITORING PROGRAM SAMPLING DATES
1987 BVPS

Month	Benthos	Corbicula Monitoring[a]	Fish	Impingement	Ichthyoplankton		Phyto- and Zooplankton
					Day	Night	
January				2, 9, 16, 23, 30			16
February				6, 13, 20, 27			13
March				6, 13, 20, 27			20
April		29		3, 10, 17, 24	21		17
May	13	13	19	1, 8, 15, 22, 29	19	20	15
June		5		5, 12, 19, 26	19		12
July			14	3, 10, 17, 24, 31	14	15	17
August				7, 14, 21, 28	10		14
September	16	16, 17	15	4, 11, 18, 25			18
October		23 thru 31[b]		2, 9, 16, 23			16
November		1 thru 15[b]	10	15, 20, 27			15
December		15		4, 11, 24			18

(a) *Corbicula* Monitoring also includes all Impingement dates.
(b) Diving operations.

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, 1987. 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.

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.

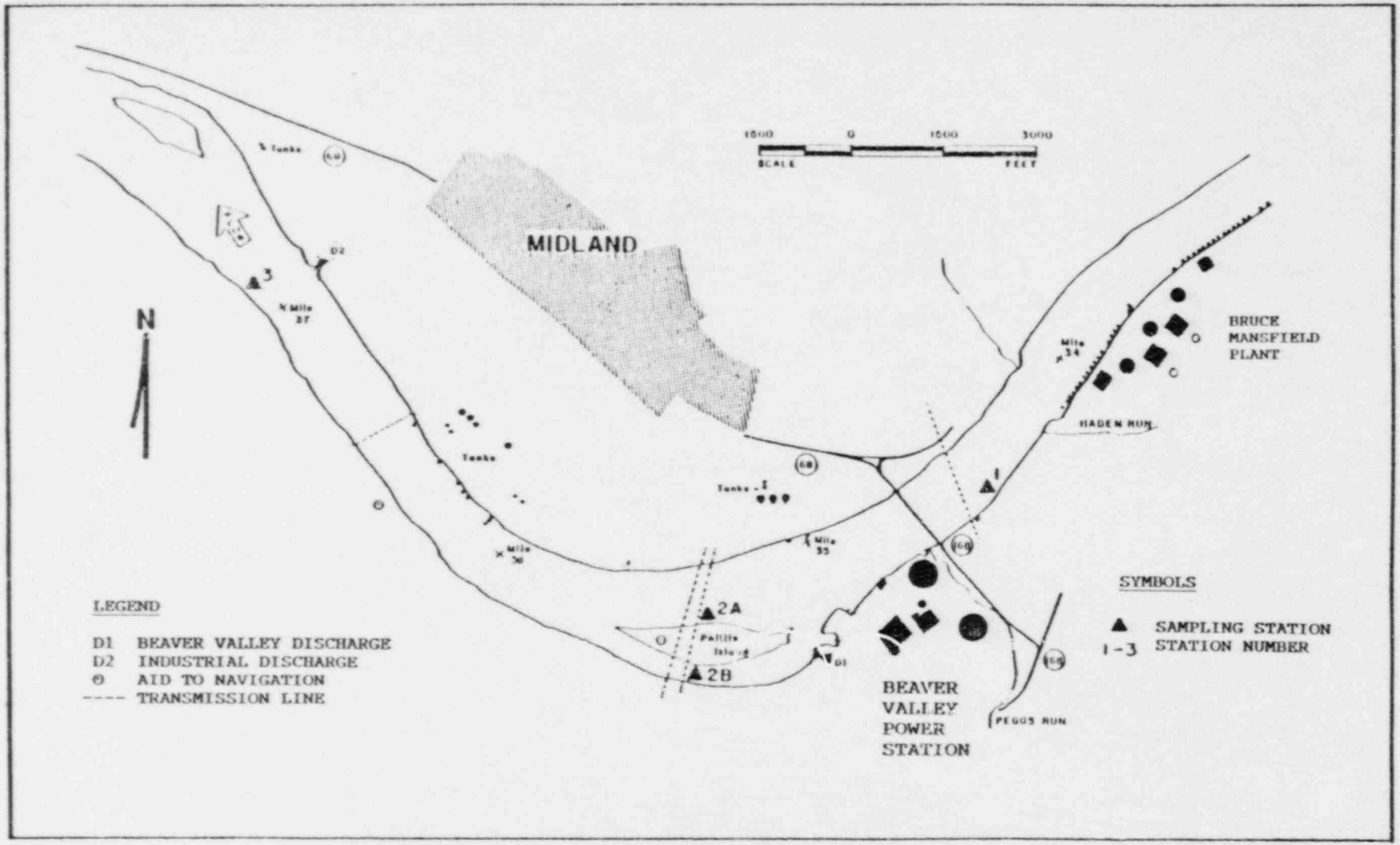

FIGURE V-B-1

BENTHOS SAMPLING STATIONS
BVPS

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
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	
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
Entoprocta															
Urnatella gracilis	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Ectoprocta															
Federicella sp.					X	X							X	X	
Paludicella articulata					X		X								
Pectinatella sp.	X														
Plumatella sp.	X														
Annelida															
Oligochaeta															
Aeolosomatidae			X	X	X			X							
Echytraeidae		X		X	X	X	X	X	X	X	X		X		
Naididae															
Amphichaeta leydigii						X									
Amphichaeta sp.							X						X		
Arcteonais lomondi					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	
Nais barbata						X						X			
N. bretscheri	X	X			X	X				X			X	X	
N. communis	X					X						X	X		X
N. elinguis						X							X	X	X

TABLE V-B-1
(Continued)

	Preoperational			Operational											
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
N. variabilis						X							X		
Nais sp.	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Ophidonais serpentina								X		X			X		X
Paranais frici	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Paranais sp.							X								
Pristina osborni				X			X					X		X	X
P. sima				X						X	X		X		X
Pristina sp.				X											X
Slavina appendiculata					X										
Stephensoniana trivandrana				X	X	X			X	X		X			
Stylaria lacustris				X						X		X	X		
Uncinais uncinata			X												
Vejdovskyella intermedia											X		X		X
Tubificidae															
Aulodrilus limnobius	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
Borthrioneurum vejdovskyanum				X	X	X	X	X		X					
Branchiura sowerbyi		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
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
L. hoffmeisteri	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
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
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
without hair chaetae	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lumbriculidae															
Hirudinea															
Glossiphoniidae															
Helobdella elongata										X	X				
Helobdella 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
Arthropoda															
Acarina				X		X		X		X	X				
Ostracoda				X	X	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
Decapoda							X								
Collembolla		X													
Ephemeroptera															
Heptageniidae	X		X												
Stenacron sp.				X							X				
Stenonema sp.								X							
Ephemeridae															
Hexagenia sp.												X		X	
Caenidae															
Caenis sp.				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		
Trichoptera															
Psychomyidae															
Polycentropus sp.						X									
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	
Coleoptera		X													
Hydrophilidae						X									
Elmidae															
Ancyronyx variegatus						X									
Dubiraphia sp.	X	X				X									
Helichus sp.	X														

TABLE V-B-1
(Continued)

	Preoperational			Operational											
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Stenelmis sp.	X				X	X									
Psephenidae															
Diptera															
Unidentified Diptera		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
Chironomus sp.		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
Dicrotendipes nervosus	X														
Dicrotendipes sp.	X	X		X							X				X
Glyptotendipes sp.						X	X				X				
Harnischia sp.		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
Rheotanytarsus sp.	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	
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
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
Thienemannimyia group	X		X		X	X	X								
Zavrelimyia sp.						X									
Orthocladiinae							X								
Orthocladiinae pupae											X				
Cricotopus bicinctus						X									
C. (s.s.) *trifascia*						X									
Cricotopus (*Isocladius*) *sylvestris* Group							X								
C. (*Isocladius*) sp.						X									

TABLE V-B-1
(Continued)

	Preoperational			Operational											
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Cricotopus (s.s.) sp.	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			
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
Dolichopodidae					X	X									
Empididae		X		X	X	X				X					
Wiedemannia sp.		X													
Ephydridae						X									
Muscidae				X	X										
Rhagionidae						X									
Tipulidae						X									
Stratiomyiidae					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
Sphaeridae							X	X	X						
Pisidium sp.	X			X										X	
Sphaerium sp.	X			X	X	X	X			X	X	X	X	X	X
Unidentified immature Sphaeriidae				X	X	X				X					
Unionidae															
Anadonta grandis						X									
Elliptio sp.						X									
Unidentified immature Unionidae	X				X	X			X	X					

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

Forty-one macroinvertebrate taxa were identified during the 1987 monitoring program (Table V-B-1). Species composition during 1987 was similar to that observed during previous preoperational (1973 through 1975) and operational (1976 through 1986) years. The macroinvertebrate assemblage during 1987 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 Procladius, Cryptochironomus, Polypedilum, Coelotanypus, and Chironomus. The Asiatic clam (Corbicula), which was collected from 1974 through 1978, has been collected in the 1981 through 1987 surveys. None were collected during 1979 or 1980 surveys.

No ecologically important additions of species were encountered during 1987 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 1987 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.

TABLE V-B-2

MEAN NUMBER OF MACROINVERTEBRATES (Number/m^2) AND PERCENT COMPOSITION
OF OLIGOCHAETA, CHIRONOMIDAE, MOLLUSCA AND OTHER ORGANISMS, 1987
BVPS

	STATION							
	1		2A		2B		3	
	#/m^2	%	#/m^2	%	#/m^2	%	#/m^2	%
May 14								
Oligochaeta	1,941	98	40	44	2,267	86	944	88
Chironomidae	10	1	20	22	329	12	99	9
Mollusca	20	1	20	22	20	1	30	3
Others	0	0	10	11	33	1	0	0
Totals	1,971	100	90	99	2,649	100	1,073	100
September 16								
Oligochaeta	2,772	95	109	38	2,089	75	1,784	69
Chironomidae	98	3	60	21	619	22	699	27
Mollusca	30	1	118	41	59	2	98	4
Others	10	<1	0	0	13	<1	10	<1
Totals	2,910	99	287	100	2,780	99	2,591	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 13, 1987
BVPS

Taxa	STATION 1	2A	2B	3
Entoprocta				
Urnatella gracilis			+	+
Annelida				
Oligochaeta eggs	+		+	+
Arcteonais lomondi	20			
Nais communis	10		13	
Nais elinguis	10		20	
Nais sp.	20	30	52	10
Ophidonais serpentina	10		7	
Paranais frici	660		446	216
Pristina sigma	88			10
Vejdovskyella intermedia			53	
Aulodrilus pluriseta			7	
Branchiura sowerbyi			13	
Limnodrilus cervix			7	
Limnodrilus claparedianus			7	
Limnodrilus hoffmeisteri	394		230	108
Limnodrilus udekemianus	30		13	10
Potamothrix vejdovskyi				30
Immatures w/o capilliform chaeta	601	10	1,261	472
Immatures w/ capilliform chaeta	98		138	88
Arthropoda				
Amphipoda				
Gammarus sp.		10	33	
Diptera				
Chironomidae adult			7	
Chironominae pupa			20	
Chironomus sp.			210	
Polypedilum sp.	10		26	
Tanypodinae pupa		10		
Coelotanypus scapularis		10		10
Procladius sp.			59	59
Ceratopogonidae			7	
Stratiomyidae				10
Unidentified Diptera				20
Mollusca				
Corbicula fluminea		10	20	30
Sphaerium sp.	20	10		
Total	1,971	90	2,649	1,073

+ 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 16, 1987
BVPS

Taxa	STATION 1	2A	2B	3
Nematoda	10		13	10
Ectoprocta				
Urnatella gracilis	+		+	+
Annelida				
Oligochaeta eggs	+		+	+
Nais communis			7	
Paranais frici				10
Pristina osborni			20	
Pristina sp.	10			
Aulodrilus pigueti	10			20
Branchiura sowerbyi			26	
Limnodrilus cervix	10			
Limnodrilus claparedianus				10
Limnodrilus hoffmeisteri	552	20	223	148
Limnodrilus udekemianus	50			10
Peloscolex m. multisetosus			7	
Potamothrix vejdovskyi				10
Immature w/o capilliform chaetae	2,120	89	1,635	1,330
Immature w/ capilliform chaetae	20		171	246
Arthropoda				
Diptera				
Chironomidae pupae		10	7	
Chironomus sp.			33	
Cryptochironomus sp.	88		33	59
Dicrotendipes sp.		40		
Harnischia sp.			13	20
Polypedilum sp.			276	98
Rheotanytarsus sp.			20	
Coelotanypus scapularis	10		184	236
Djalmabatista pulcher				10
Procladius sp.			53	276
Cricotopus sp.		10		
Mollusca				
Corbicula fluminea	30	118	59	98
Total	2,910	287	2,780	2,591

+ Indicates organisms present.

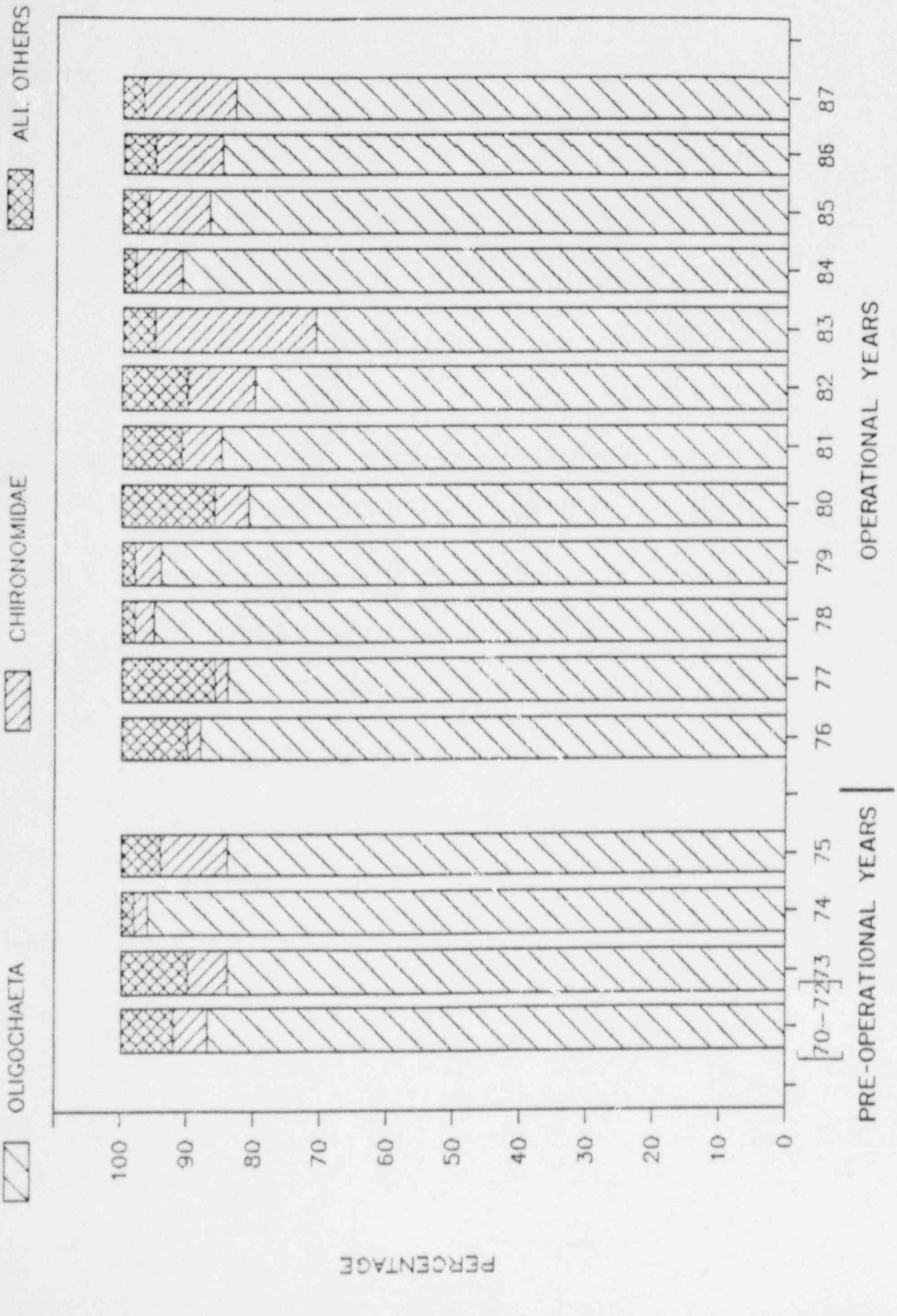

FIGURE V-B-2

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

Comparison of Control and Non-Control Stations

No adverse impact to the benthic community was observed during 1987. 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 indicates 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, the oligochaetes which were common or abundant at both stations were Limnodrilus hoffmeisteri and Paranais frici. In September, the oligochaete Limnodrilus hoffmeisteri, the midge Coelotanypus scapularis, and the clam Corbicula fluminia were the common organisms collected at both stations.

In May and September 1987, 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 83% of the individuals collected in 1987 (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, had increased in abundance from 1974 through 1976, but declined in number during 1977. Since 1981, Corbicula have been collected in the benthic surveys including 1987.

TABLE V-B-5

MEAN DIVERSITY VALUES FOR BENTHIC MACROINVERTEBRATES
COLLECTED IN THE OHIO RIVER, 1987
BVPS

	STATION			
	1	2A	2B	3
DATE: May 13				
No. of Taxa	10	4	12	9
Shannon-Weiner Index	2.23	1.76	2.30	2.34
Evenness	0.69	0.99	0.73	0.77
DATE: September 16				
No. of Taxa	8	4	10	13
Shannon-Weiner Index	1.25	1.68	1.86	2.43
Evenness	0.44	0.86	0.67	0.66

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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					
	1973		1974		1975	
	1	2B	1	2B	1	2B
January						
February	205	0	703	311		
March						
April						
May	248	508	1,116	2,197		
June	5	40	507	686		
July	653	119	421	410		
August	99	244	143	541	1,017	1,124
September			175	92		
October	256	239				
November	149	292	318	263	75	617
December						
Mean	231	206	483	643	546	871

TABLE V-3-6
(Continued)

	Operational Years											
	1976		1977		1978		1979		1980		1981	
	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
January												
February	358	200	312	1,100	1,499	2,545			1,029	1,296		
March							425	457				
April												
May	927	3,660	674	848	351	126	1,004	840	1,041	747	209	456
June												
July												
August	851	785	591	3,474	601	1,896	1,185	588				
September									1,523	448	2,185	912
October												
November	388	1,295	108	931	386	1,543	812	806				
December												
Mean	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	
	1	2B	1	2B	1	2B	1	2B	1	2B	1	2B
January												
February												
March												
April												
May	3,450	3,026	3,590	1,314	2,741	621	2,256	867	601	969	1,971	2,649
June												
July												
August												
September	2,956	3,364	4,172	4,213	1,341	828	1,024	913	849	943	2,910	2,780
October												
November												
December												
Mean	3,223	3,195	3,881	2,764	2,041	725	1,640	890	725	956	2,440	2,714

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 1987, 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 pre-operational 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 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 83% of the macrobenthos collected, whereas Chironomidae and Mollusca each accounted for about 13% and [illegible]% 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 and to assess possible environmental impact to the phytoplankton resulting from the operation of 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 known aliquot of well-mixed sample was concentrated by settling. A measured aliquot of the concentrate was placed in an inverted microscope chamber and examined at 400X magnification. A minimum of 200 cells were identified and counted in each sample. For each collection date, volume of the final concentrate was adjusted depending on cell density. A Hyrax diatom slide was also prepared monthly from each sample. This slide was examined at 1000X magnification in order to make positive indentification of the diatoms.

Densities (cells/ml), Shannon-Weiner 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 (Annual Environmental Reports 1976-1986). Species composition has also been similar in entrainment samples and those from the Ohio River (DLCo 1980). Therefore, samples collected from the intake bays should provide an adequate characterization of the phytoplankton community in the Ohio River.

During 1987, the January through April samples had phytoplankton densities of 2,222 to 5,695 cells/ml (Table V-C-1 and Figure V-C-1). Total mean densities increased in May. Densities were high in July, August, and September when the annual maximum of 29,799 cells/ml was observed. Densities decreased in October, November, and December (Table V-C-1) to 2,731 cells/ml (Figure V-C-1).

Diatoms (Chrysophta), green algae (Chlorophyta) and blue-green algae (Cyanophyta) were generally the most abundant groups of phytoplankton during 1987 (Table V-C-1 and Figure V-C-2). The relative abundance for the group microflagellates was highest in February, when it composed 63% of the total numbers observed. Relative densities of blue-green algae (Cyanophyta) were highest during August (32%) (Table V-C-1).

Diversity indices for the phytoplankton during 1987 are presented in Table V-C-2. Shannon-Weiner indices ranged from 1.89 to 3.76, evenness values from 0.37 to 0.69, and richness values from 3.11 to 5.57. High diversity values occurred in 11 of the 12 months. The lowest value for Shannon-Weiner Index occurred in April; however, the lowest number of species occurred in March when microflagellates and small centric diatoms (Chrysophyta) were predominant. Highest number of taxa (50) occurred in July.

Phytoplankton communities were generally dominated by different taxa each season. The most abundant taxa during winter (January through March) were microflagellates, Chlorophyta I (unidentifiable cells), and small centric-diatoms (Table V-C-3). In April and May, small centric diatoms (Chrysophyta) were most abundant. Small centric diatoms, which were present in all phytoplankton samples, were most abundant in September. They included several small (4 to 12, µm dia.) species. Positive species identification was not possible during quantitative analysis at 400X magnification. Burn mount analysis at 1000X magnification revealed the group "small centrics" included primarily Cyclotella atomus, C. pseudostelligera, C. meneghiniana, Stephanodiscus hantzschii, and S. astraea. Microcystis incerta (Cyanophyta) and Chlorophyta I were the most abundant species in July and August respectively. Small centrics

TABLE V-C-1

MONTHLY PHYTOPLANKTON GROUP DENSITIES (Number/ml) AND PERCENT COMPOSITION
FROM ENTRAINMENT SAMPLES, 1987
BVPS

Group	Jan		Feb		Mar		Apr		May		Jun	
	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%
Chlorophyta	568	23	273	12	599	11	786	14	3,735	27	7,950	57
Chrysophyta	739	30	431	19	2,837	50	1,303	23	6,075	44	3,842	28
Cyanophyta	417	17	77	3	0	0	4	<1	2,185	16	0	0
Cryptophyta	50	2	48	2	8	<1	53	1	474	3	295	2
Microflagellates	729	29	1,392	63	2,251	40	3,403	61	1,390	10	1,768	13
Other Groups	0	0	1	<1	0	0	0	0	9	<1	27	<1
Total	2,503	101	2,222	99	5,695	101	5,549	99	13,868	100	13,882	100

Group	Jul		Aug		Sep		Oct		Nov		Dec	
	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%	#/ml	%
Chlorophyta	5,989	22	6,730	28	2,330	8	903	12	704	9	152	6
Chrysophyta	8,810	32	6,430	27	20,526	69	2,525	34	4,888	63	869	32
Cyanophyta	8,188	30	7,598	32	1,900	6	241	3	0	0	0	0
Cryptophyta	292	1	311	1	132	<1	193	3	53	1	71	3
Microflagellates	3,975	15	2,782	12	4,902	16	3,542	48	2,077	27	1,635	60
Other Groups	36	<1	27	<1	9	<1	4	<1	4	<1	4	<1
Total	27,290	100	23,878	100	29,799	99	7,408	100	7,726	100	2,731	101

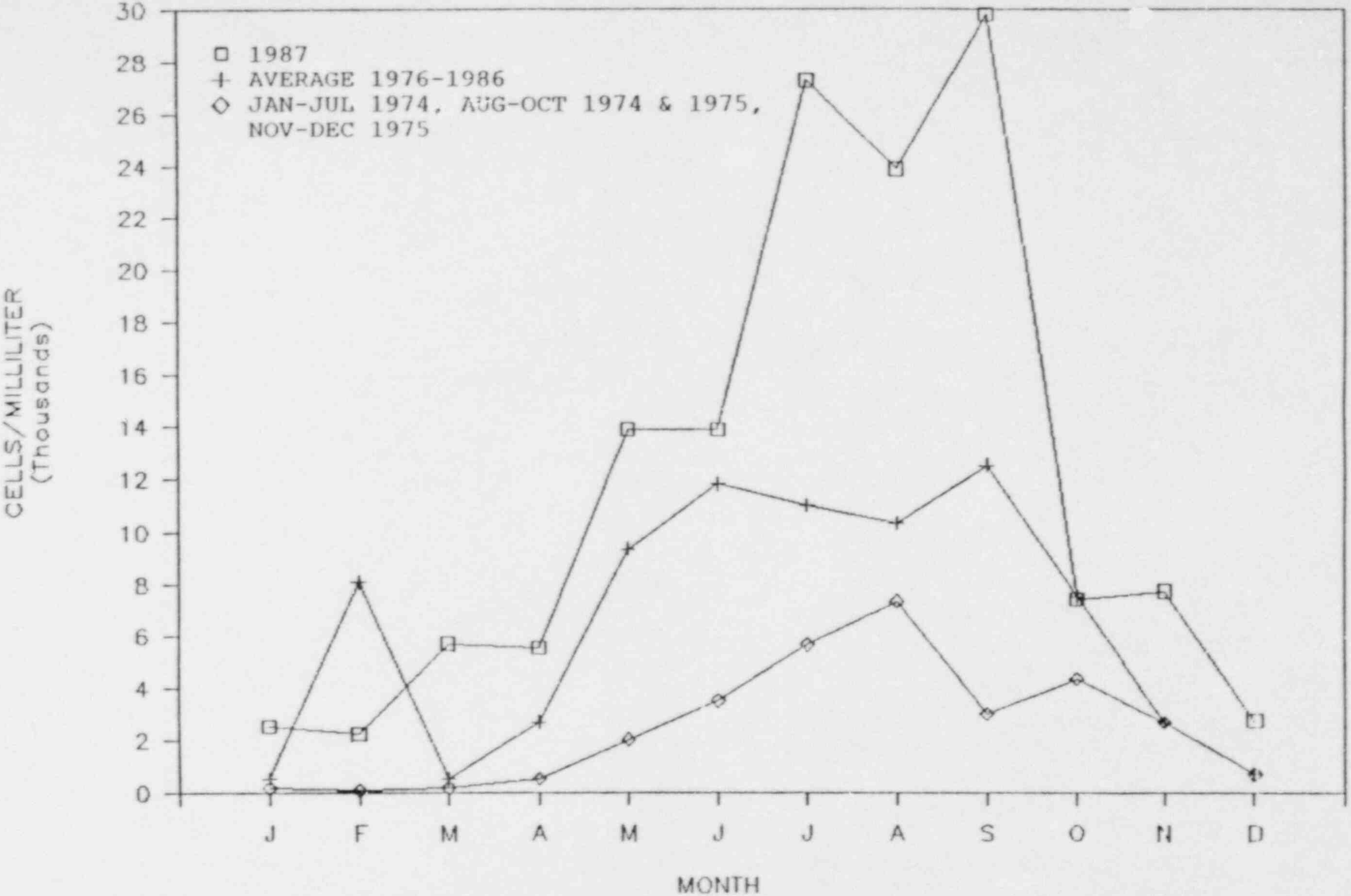

FIGURE V-C-1

MONTHLY PHYTOPLANKTON DENSITIES IN THE OHIO RIVER
DURING PREOPERATIONAL (1974-1975) AND
OPERATIONAL (1976-1987) YEARS
BVPS

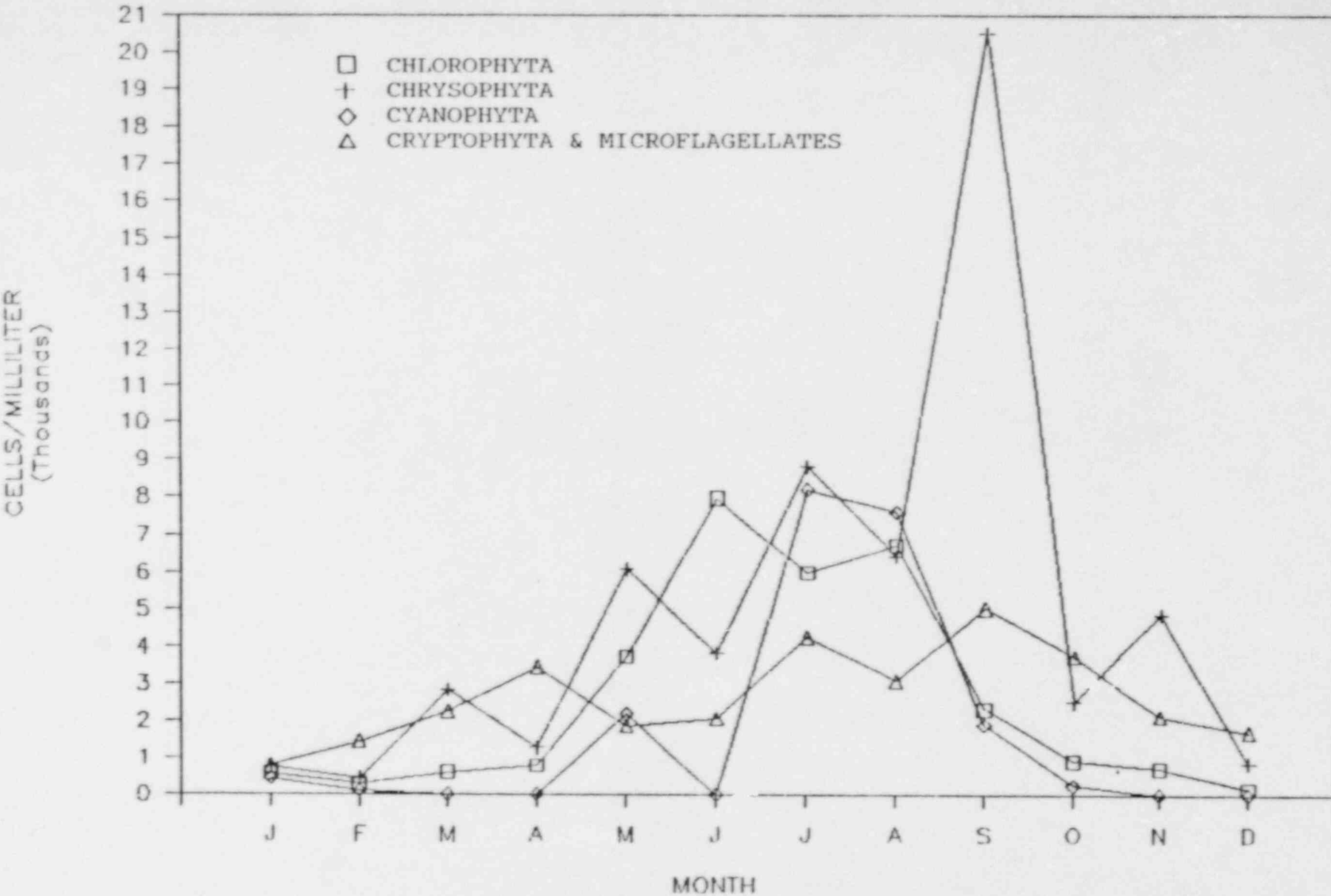

FIGURE V-C-2

PHYTOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1987
BVPS

TABLE V-C-2

PHYTOPLANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1987
BVPS

Date	Jan	Feb	Mar	Apr	May	Jun
No. of Species	42	44	29	33	33	36
Shannon-Weiner Index	2.99	2.28	2.51	1.89	3.38	3.56
Evenness	0.55	0.41	0.52	0.37	0.67	0.69
Richness	5.24	5.58	3.24	3.71	3.36	3.67

	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
No. of Species	50	39	33	36	35	31	37
Shannon-Weiner Index	3.76	3.44	2.12	2.52	2.54	2.41	2.78
Evenness	0.67	0.65	0.42	0.48	0.50	0.48	0.53
Richness	4.80	3.77	3.11	3.93	3.80	3.79	4.00

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 1987
BVPS

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CYANOPHYTA												
Aphanizomenon flos-aquae							446	173	100			
Merismopedia tenuissima							1,165	983	146			
Microcystis incerta							5,565	6,360	1,590			
Oscillatoria tenera							530					
Schizothrix calcicola	18	11		2			291	82	64			
Coccoid cyanophyta	398	66			2,185					232		
CHLOROPHYTA												
Actinastrum hantzschii					73					54		
Ankistrodesmus convolutus	44	10	14	7	892	682	273	400	127	36	162	12
Ankistrodesmus falcatus	19	15		9	27	64	100	127	27	18	40	7
Chlamydomonas spp.	15	2	22	9	391	46	109	9	36	40	18	2
Chlorophyta I	398	177	563	575	463	1,768	2,385	3,312	1,458	430	221	66
Coelastrum microporum						146		218				
Crucigenia crucifera						328		36				
Dictyosphaerium pulchellum	4				146	36	510	36			18	
Elakatothrix gelatinosa						354						
Lagerheimia quadriseta		22										
Micractinium pusillum										45	18	
Pediastrum duplex								291				
Pediastrum tetras							109		73			
Scenedesmus bicellularis	44	44			530	265	1,458	530			88	44
Scenedesmus dimorphus					155							
Scenedesmus opolensis	4			9	410	355	109	528	155	90	81	
Scenedesmus quadricauda					228	246	118	200	264	36	54	12
Selenastrum minutum	22					177				66		
Selenastrum westii				177	265	3,138	265	662		33		
Tetrastrum hetercanthum						146	36	73				

TABLE V-C-3
(Continued)

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CHRYSOPHYTA												
Achnanthes minutissima			99	7						33		66
Asterionella formosa	68	31	112	16	155	36				4	22	104
Cymbella ventricosa	2	1	9	12							4	30
Diatoma tenue		13	14	5								2
Diatoma vulgare	1		50	9				9			18	16
Dinobryon sertularia	4	12	4	2	127		46					
Fragilaria crotonensis							655		55		81	
Fragilaria vaucheriae		1	68									
Gomphonema olivaceum	1	4	194								9	12
Gomphonema parvulum	3	4		14			18	9	27	9		2
Melosira ambigua		3								112	198	
Melosira distans	9	6		9	109	36	109		410	234	162	18
Melosira granulata	11	16	54	21	127	1,219	346	1,793	792	72	76	34
Melosira varians	2	2	54			100	127	55		9	32	87
Navicula cryptocephala	3	3	40	39	9	18	18	18	18	9	9	32
Navicula viridula	6	11	162	46	27				27		18	44
Nitzschia agnita	3	3		12	9	9	9	73				
Nitzschia frustulum			18	12			18					
Nitzschia palea	6	11	58	9	18	18	46	55	36	4	27	23
Skeletonema potamos	44						3,445	398	928		442	
Synedra tenera	8	11	4		300		73			4	14	
Tabellaria fenestrata										9	68	
Small centrics	553	265	1,854	1,061	5,031	2,343	3,710	3,975	18,152	1,986	3,669	376
CRYPTOPHYTA												
Cryptomonas erosa	6	4	4	9	209	118	27	46		27	9	5
Rhodomonas minuta	44	44	4	44	265	177	265	265	132	166	44	66
MICROFLAGELLATES	729	1,392	2,251	3,403	1,390	1,768	3,975	2,782	4,902	3,542	2,077	1,635
Total Phytoplankton	2,503	2,222	5,695	5,549	13,868	13,882	27,290	23,878	29,799	7,408	7,726	2,731
Total of Most Abundant Taxa	2,469	2,184	5,652	5,518	13,541	13,593	26,356	23,498	29,519	7,300	7,679	2,695
Percent Composition of Most Abundant Phytoplankton	99	98	99	99	98	98	97	98	99	98	99	99

and microflagellates were the most abundant algae collected in November and December.

Comparison of Control and Non-Control Transects

Plankton samples were not collected at any river stations after April 1, 1980, due to a reduction in the scope of the aquatic sampling program, therefore, comparison of data was not possible in 1987.

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 (DLCo 1980). Total phytoplankton densities also displayed a bimodal pattern in 1987, when peaks occurred in July and September (Figure V-C-1).

In general, the phytoplankton community in 1987 was similar to those of preoperational and operational years. No major change in species composition or community structure was observed during 1987. The small differences in the phytoplankton community between 1987 and the previous years are due to natural fluctuations and were not a result of BVPS operations.

Shannon-Weiner, evenness, and richness diversity values were unusually low in April when the phytoplankton was strongly dominated by small centric diatoms. Centric diatoms frequently develop high densities in large rivers during the spring. Yearly mean Shannon-Weiner diversity indices from 1973 through 1987 were similar (except during 1973 when the value was much lower) ranging from a low of 1.50 in 1986 to a maximum of 4.48 in 1986 (Table V-C-4). Evenness values were also similar, except during 1973, 1974 and April 1986 when values were lower. From 1975 through 1987, evenness ranged from 0.29 to 0.90. The maximum evenness diversity

TABLE V-C-4

PHYTOPLANKTON DIVERSITY INDICES (MEAN OF ALL SAMPLES 1973 TO 1987)
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		13	24	27	28	30		24	17	16	19
Shannon Index[a]	1.55	0.54	No	0.63	1.64	2.28	3.55	3.72	No	3.37	3.25	3.27	2.38
Evenness	0.33	0.15	Sample	0.11	0.25	0.35	0.55	0.52	Sample	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	No Sample		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				No Sample				4.53	4.22	4.37	4.22	4.48	4.36
Evenness								0.80	0.83	0.81	0.87	0.85	0.83
Richness								5.57	3.96	4.98	3.92	6.19	4.91
1976													
Number of Species	31	35	31	38	47	49	46	43	38	33	35	38	39
Shannon Index	3.98	4.36	3.90	4.25	4.14	4.27	4.28	4.30	3.93	4.16	4.24	4.45	4.19
Evenness	0.80	0.85	0.78	0.81	0.75	0.76	0.78	0.80	0.75	0.83	0.83	0.85	0.80
Richness	5.15	5.89	4.92	4.70	4.68	4.79	4.72	4.34	3.85	4.17	4.95	5.79	4.83
1977													
Number of Species	20	28	31	24	36	30	44	39	37	32	33	27	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	2.98	3.46	2.72	3.26	3.52	3.57	5.19	3.54
1980 (c)													
Number of Species	28	18	24	25	21	18	30	16	32	24	33	37	24
Shannon Index	3.88	2.64	3.78	3.82	3.28	3.26	3.61	3.45	4.10	3.54	3.73	4.56	3.57
Evenness	0.81	0.64	0.83	0.82	0.75	0.78	0.74	0.86	0.82	0.77	0.74	0.87	0.78
Richness	4.07	2.65	3.49	4.02	2.50	2.38	2.90	1.94	3.33	2.59	4.01	5.40	3.15

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

(a) Shannon-Weiner Index

(b) No data

(c) Data for period April 1980 [illegible]ember 1987 represents single entrainment samples collected monthly.

value is 1.0 and would occur 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. The highest number of taxa (68) ever observed in phytoplankton studies at BVPS occurred during November of operational year 1986.

Summary and Conclusions

The phytoplankton community of the Ohio River near BVPS exhibited a seasonal pattern similar to that observed in previous years. This pattern is common to temperate, lotic environments. Total cell densities were within the range observed during previous years. Diversity indices of phytoplankton were similar or lower to those previously observed near BVPS.

D. ZOOPLANKTON

Objectives

Plankton sampling was conducted to determine the condition of the zooplankton community of the Ohio River in the vicinity of the BVPS and to assess possible environmental impact to the zooplankton due to the operation of BVPS.

Methods

The zooplankton analysis was performed on one liter aliquots taken from the preserved one-gallon samples obtained from the intake bay. (see Phytoplankton methods, in Part C). One liter from each sample was filtered through a 35 micron (.035 mm) mesh screen. The portion retained was washed into a graduated cylinder and allowed to settle for a minimum of 24 hours. The supernatant was withdrawn until 10 ml of concentrate remained. 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 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 (DLCo 1980). Samples collected from intake bays are usually representative of the zooplankton populations of the Ohio River.

During 1987, protozoans and rotifers accounted for 97% or more of all zooplankton on all sample dates (Table V-D-1). Total organism densities

TABLE V-D-1

MONTHLY ZOOPLANKTON GROUP DENSITIES (Number/liter) AND PERCENT COMPOSITION
FROM ENTRAINMENT SAMPLES, 1987
BVPS

Group	Jan #/L	Jan %	Feb #/L	Feb %	Mar #/L	Mar %	Apr #/L	Apr %	May #/L	May %	Jun #/L	Jun %
Protozoa	500	91	1,260	95	1,725	93	480	80	36,000	100	9,360	66
Rotifera	40	7	70	5	125	7	120	20	0	0	4,720	34
Crustacea	10	2	0	0	0	0	0	0	0	0	0	0
Total	550	100	1,330	100	1,850	100	600	100	36,000	100	14,080	100

Group	Jul #/L	Jul %	Aug #/L	Aug %	Sep #/L	Sep %	Oct #/L	Oct %	Nov #/L	Nov %	Dec #/L	Dec %
Protozoa	10,080	87	6,750	87	3,520	90	1,030	74	4,320	93	725	81
Rotifera	1,400	12	950	12	280	7	370	26	320	7	175	19
Crustacea	70	1	100	1	120	3	0	0	0	0	0	0
Total	11,550	100	7,800	100	3,920	100	1,400	100	4,640	100	900	100

during the winter and early spring (January through April) were less than 1,850/liter (Figure V-D-1, Table V-D-1). Total organism densities peaked in May (36,000/liter) and November. Zooplankton populations in the Ohio River usually exhibit a bimodal pattern. The maximum zooplankton density in the Ohio River near BVPS frequently occurs in the spring, although it is sometimes delayed until summer or early fall (Table V-D-2, Figure V-D-1). Low precipitation and warm weather in the spring provided optimum conditions for zooplankton populations to develop in May. 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 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 April of 1987 were between 480 and 1,725/liter (Table V-D-1). Protozoans peaked in May, and progressively decreased until November when a small increase occurred. Protozoans progressively decreased in December to densities of 725/liter. Vorticella sp. and Strombidium spp. and Tintinnidium fluviatile were the common protozoans throughout the year. Vorticella sp. or Strombidium spp. dominated the protozoan assemblage during ten months (Table V-D-3). The most abundant protozoan in the other months was Tintinnidium fluviatile (June and September). These taxa have been a main part of the protozoan assemblage of the Ohio River near BVPS since the studies were initiated in 1972.

The rotifer assemblage in 1987 (Fig[illegible]-D-2) displayed a typical p[illegible] of rotifer populations in tempe[illegible] waters (Hutchinson [illegible] Rotifer densities increased from [illegible]/liter in January to a

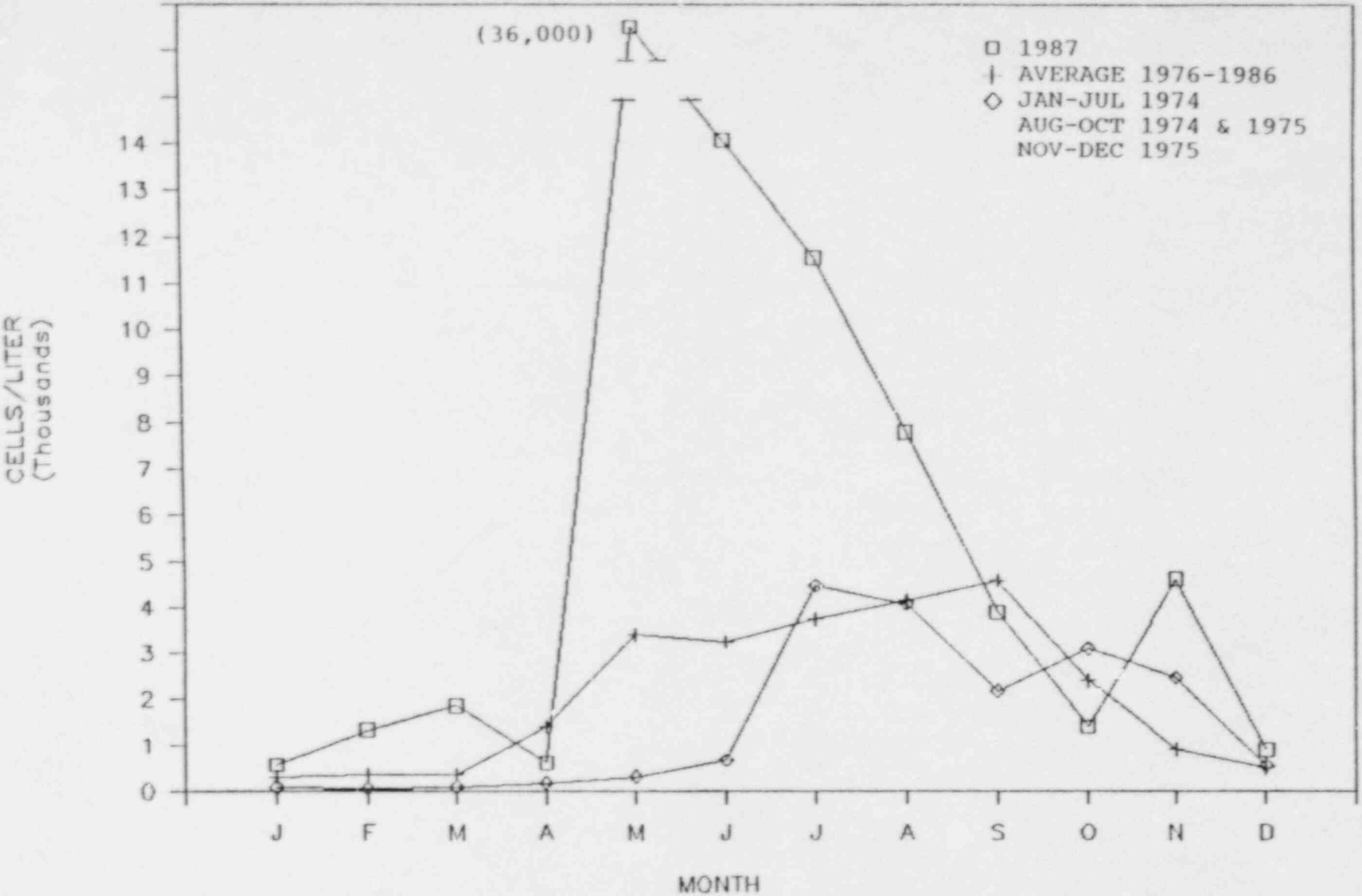

FIGURE V-D-1

MONTHLY ZOOPLANKTON DENSITIES IN THE OHIO RIVER
DURING PREOPERATIONAL (1974-1975) AND
OPERATIONAL (1976-1987) YEARS
BVPS

TABLE V-D-2

MEAN ZOOPLANKTON DENSITIES (Number/liter) BY MONTH FROM 1973 THROUGH 1987, 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	3,62[illegible]	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	[illegible],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
Protozoa												
1973	-	45	-	63	82	188	56	331	-	346	135	58
1974	50	42	72	91	138	409	1,690	716	1,006	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
Rotifera												
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	10[illegible]	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

TABLE V-D-2
(Continued)

Rotifera (Cont'd)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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
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

(a) No sample collected.

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, 1987
BVPS

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PROTOZOA												
Anarma sp.						1,200						
Arcella sp.			50	20					520	40	160	50
Codonella cratera			250	40			280		160	50		50
Cyclidium sp.	60	50	275	40			350		80		120	
Cyphoderia ampulla												
Difflugia acuminata				20				1,550	120			
Difflugia limnetica	30			20								25
Difflugia sp.			200									
Euglypha ciliata		30										
Holophyrid ciliate		40	150	40	800	400	630	300			200	25
Lionotus sp.	60	80										
Nuclearia simplex							560	200				
Phascalodon vorticella											280	
Scuticociliates								250	80		160	25
Strobilidium gyrans							700			50		
Strobilidium sp.												[illegible]
Strombidium sp.	20		125	40	31,000	4,000	4,130	1,800	920	460	2,880	[illegible]
Tintinnidium fluvitale				120		1,520	1,750	1,500	960	90	200	25
Tintinnopsis cylindrica										70		
Turaniella sp.						480			80			
Urotricha						320						
Vampyrella sp.								300				
Vorticella sp.	270	970	400	100	2,600		350	200	440	170		275
Ciliate unidentified	30		125	40			350			40	120	
ROTIFERA												
Cephalodella sp.	20											50
Kellicottia bostoniensis												25
Keratella cochlearis						560	350	250	80	50		
Keratella cochlearis f. tecta						320						
Notommata sp.		30		40								
Monostyla bulla												25
Monostyla sp.				20								
Polyarthra dolichoptera				20		3,680	280	300	120	30		25
Synchaeta sp.										190	200	25
Trichocerca pusilla							280			30		
Rotifer unidentified		30	100	40						50		25

TABLE V-D-3
(Continued)

Taxa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TOTAL ZOOPLANKTON	550	1,330	1,850	600	36,000	14,080	11,550	7,800	3,920	1,400	4,640	900
TOTAL of Most Abundant Taxa	490	1,230	1,675	600	34,400	12,480	10,010	6,650	3,560	1,320	4,320	900
Percentage Composition of Most Abundant Zooplankton	89	92	91	100	96	89	87	85	91	94	93	100

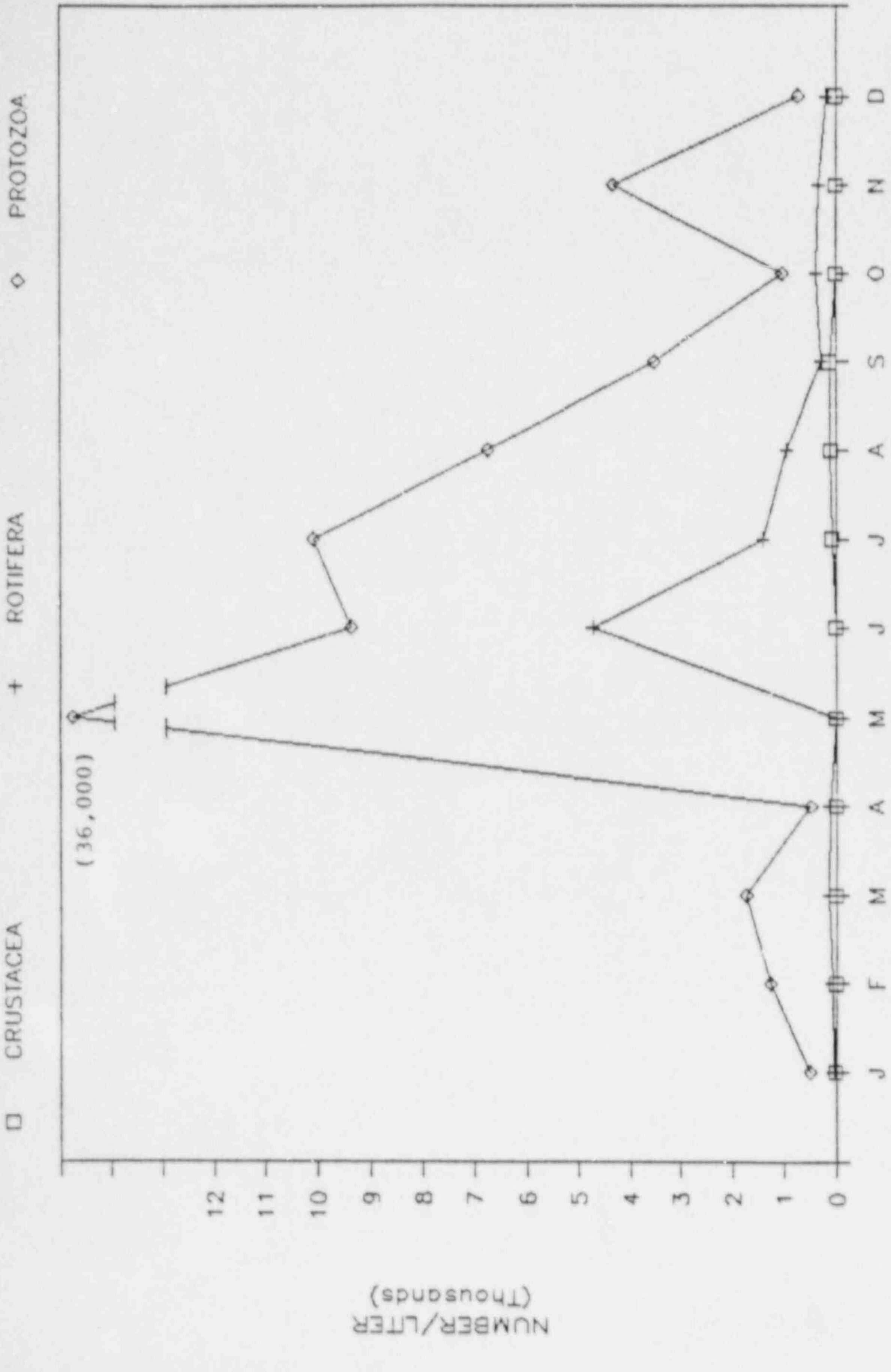

FIGURE V-D-2

ZOOPLANKTON GROUP DENSITIES
FOR ENTRAINMENT SAMPLES, 1987
BVPS

maximum of 4,720/liter in June; a small secondary peak occurred in October (Table V-D-2). Rotifer populations generally decreased after October to densities of 175/liter in December. Rotifers were the second most abundant group during 1987. Keratella cochlearis and Polyarthra dolichoptera were the most abundant rotifers during most of the year (Table V-D-3).

Crustacean densities were low (0 to 120/liter) through 1987 (Table V-D-1). Most crustaceans were collected during summer (Figure V-D-2). Crustacean densities never exceeded protozoan or rotifer densities and constituted from 0 to 3% of the total zooplankton density each month (Table V-D-1). Copepod nauplii were the most numerous crustaceans collected during 1987. Crustacean populations did not develop high densities due to unfavorable flow and turbidity conditions in the river during most of 1987. 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 3.54 occurred in April while the maximum number of species (28) occurred in September (Table V-D-4). Evenness ranged from 0.28 in May to 0.93 in April. Richness varied from a low of 0.76 in May to a high of 2.89 in July. The number of species ranged from 9 in May to 28 in July. Low diversity indices during May reflect the dominance of Strombidium spp.

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

TABLE V-D-4

ZOOPLANKTON DIVERSITY INDICES BY MONTH FOR ENTRAINMENT SAMPLES, 1987
BVPS

Date	Jan	Feb	Mar	Apr	May	Jun
No. of Species	13	14	16	14	9	20
Shannon-Weiner Index	2.64	1.76	3.40	3.54	0.89	3.15
Evenness	0.71	0.46	0.85	0.93	0.28	0.73
Richness	1.90	1.81	1.99	2.03	0.76	1.99

	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$
No. of Species	28	25	20	20	16	16	18
Shannon-Weiner Index	3.53	3.50	3.29	3.37	2.32	3.48	2.91
Evenness	0.73	0.75	0.76	0.78	0.58	0.87	0.70
Richness	2.89	2.68	2.30	2.62	1.78	2.20	2.08

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 1987 exceeded the range established during the preoperational years (1973 through 1975) and operational years (1976 through 1986) (Figure V-D-1). In 1987, the data indicate that the peak zooplankton densities occurred in May and November.

The species composition of zooplankton in the Ohio River near BVPS has remained stable during preoperational and operational years. The common or abundant protozoans during the past 14 years have been Vorticella, Codonella, Difflugia, Strobilidium, Strombidium, Cyclotrichium, Arcella and Centropyxis. The most numerous and frequently occurring rotifers have been Keratella, Polyarthra, Synchaeta, Branchionus and Trichocerca. Copepod nauplii have been the only crustacean taxa found consistently.

Community structure, as compared by diversity indices, has been similar during the past 14 years (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. The low diversity indices in May reflect the high numbers of the protozoan Strombidium spp.

In 1987, 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 1987 ranged from 0.89 to 3.54 and were similar to the range of 1.80 to 3.28 that occurred during preoperational years from 1973 to 1975. The variation in evenness during 1987 (0.28 to 0.87) was usually at the upper portion of the range reported from 1973 to 1986 (0.21 to 0.93).

TABLE V-D-5

MEAN ZOOPLANKTON DIVERSITY INDICES BY MONTH FROM 1973 THROUGH 1987 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.[illegible]2	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	0.80	0.85
1984												
Number of Species	17.00	10.00	7.00	10.00	13.00	18.00	12.00	18.00	23.00	19.00	14.00	11.00
Shannon Index	3.29	2.64	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

(a) Blanks represent periods when no collections were made.
(b) Shannon-Weiner Index
(c) Data for period April 1980-December 1987 represents single entrainment samples collected monthly.

Summary and Conclusions

Zooplankton densities throughout 1987 were typical of the temperate zooplankton community found in large river habitats. Total densities exceeded the range of those reported in previous years. Populations developed highest densities in May and a secondary peak occurred in November. Protozoans and rotifers were always predominant. Common and abundant taxa in 1987 were similar to those reported during preoperational and other operational years. Shannon-Weiner diversity, number of species, and evenness were within the ranges of preceding years. Based on the data collected during the twelve operating years (1976 through 1987) 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 fifteen year period from 1973 to 1987. The data indicate that 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.

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 1987. 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 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.

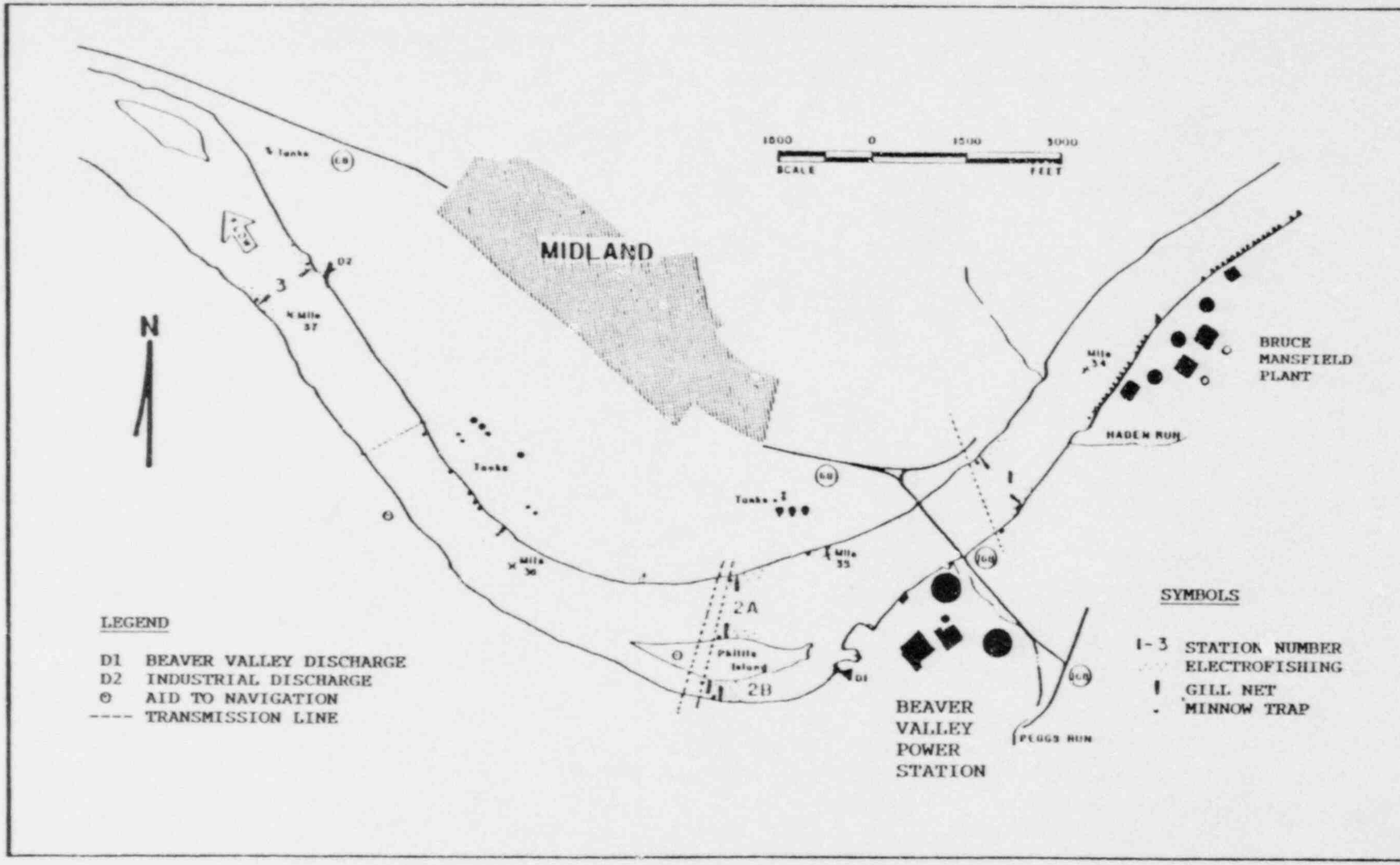

FIGURE V-E-1

FISH SAMPLING STATIONS
BVPS

Results

Fish population studies have been conducted in the Ohio River near BVPS from 1970 through 1987. These surveys have collected 63 fish species and two hybrids (Table V-E-1). In 1987, 28 fish species were collected. A combined total of 1364 individuals were collected in 1987 by gill netting, electrofishing and minnow traps (Table V-E-2).

A total of 1,158 fishes, representing 19 species were collected by electrofishing (Table V-E-3). Collectively, the minnows and shiners accounted for 68.8% of the total electrofishing catch in 1987. Gizzard shad, also a forage species, represented 24.4% of the catch. Carp and spotted bass both accounted for 1.7% of the catch. Smallmouth bass accounted for 1.0%. Each of the other taxa accounted for less than 1% of the total. Most of the fish sampled by electrofishing were collected in September (77.6%). The fewest fish were collected in November (1.6%).

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

The gill net results varied by month with the highest catch in the month of May and September (26 fish). July was the next highest month with 22 fish. November catch resulted in 6 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 126 fish were captured using minnow traps in 1987 (Table V-E-2). September had the highest catch with 64 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, electro-

TABLE V-E-1

(SCIENTIFIC AND COMMON NAME)[1]
FAMILIES AND SPECIES OF FISH COLLECTED IN THE NEW CUMBERLAND
POOL OF THE OHIC RIVER, 1970-1987
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
Cryprinidae (minnows and carps)	
Campostoma anomalum	Central stoneroller
Carassius auratus	Goldfish
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

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

TABLE V-E-2

NUMBER OF FISH COLLECTED AT VARIOUS TRANSECTS BY GILL NET (G), ELECTROFISHING (E) AND MINNOW TRAP (M) IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1987

BVPS

Taxa	1			2A			2B			3			Grand Total			Annual	Percent Annual
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M	Total	Total
Longnose gar				1									1			1	0.1
Gizzard shad	1	51		1	110	7		75		2	47		4	283	7	294	21.6
Common carp	3	10		1	4		1	3		7	3		12	20		32	2.3
River chub					1									1		1	0.1
Emerald shiner		39	9		7	16		16	5		39	43		101	73	174	12.8
Spottail shiner		1						3	1		4	17		8	18	26	1.9
Spotfin shiner						8		1	6					1	14	15	1.1
Sand shiner		6	2		2			1				3		9	5	14	1.0
Mimic shiner		1			1									2		2	0.1
Bluntnose minnow											1			1		1	0.1
Shiner sp.		76			62	1		13			524			675	1	676	49.6
River carpsucker										2			2			2	0.1
Northern hog sucker		1												1		1	0.1
Black redhorse	1												1			1	0.1
Golden redhorse	1			1				1		4			6	1		7	0.5
Shorthead redhorse		2		1				1					1	3		4	0.3
Channel catfish	3	1			1		2	1		12			17	3		20	1.5
Flathead catfish	1												1			1	0.1
White bass										2			2			2	0.1
Rock bass			1	1			2	1		1			4	1	1	6	0.4
Bluegill					1						2			3		3	0.2
Smallmouth bass		4			7	1		1		1			1	12	1	14	1.0
Spotted bass	1	5	1	2	4		4	8	2	10	3	2	17	20	5	42	3.1
White crappie										2			2			2	0.1
Black crappie										2			2			2	0.1
Bass sp.		3			1						1			5		5	0.4
Yellow perch	1		1										1		1	2	0.1
Sauger		1			1			2		5			5	4		9	0.7
Walleye	1												1			1	0.1
Freshwater drum		2			2									4		4	0.3
Total	13	203	14	8	204	33	9	127	14	50	624	65	80	1,158	126	1,364	

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, 1987
BVPS

Taxa	May			Jul			Sep			Nov			Grand Total			Annual Total	Percent Annual Total
	G	E	M	G	E	M	G	E	M	G	E	M	G	E	M		
Longnose gar										1			1			1	0.1
Gizzard shad		124		2	47		2	107	7		5		4	283	7	294	21.6
Common carp	7	6		1	2		3	5		1	7		12	20		32	2.3
River chub											1			1		1	0.1
Emerald shiner		4	4		21	2		76	36			31		101	73	174	12.8
Spottail shiner								8	13			5		8	18	26	1.9
Spotfin shiner						14		1						1	14	15	1.1
Sand shiner					2			6	3		1	2		9	5	14	1.0
Mimic shiner					1			1						2		2	0.1
Bluntnose minnow								1						1		1	0.1
Shiner sp.					14			660			1	1		675	1	676	49.6
River carpsucker				2									2			2	0.1
Northern hog sucker					1									1		1	0.1
Black redhorse	1												1			1	0.1
Golden redhorse	4			1	1					1			6	1		7	0.5
Shorthead redhorse		2					1	1					1	3		4	0.3
Channel catfish	10			7				3					17	3		20	1.5
Flathead catfish	1												1			1	0.1
White bass				1			1						2			2	0.1
Rock bass				1	1		3		1				4	1	1	6	0.4
Bluegill		1						2						3		3	0.2
Smallmouth bass		1			5			5	1	1	1		1	12	1	14	1.0
Spotted bass	2	2		5	1	2	10	17	3				17	20	5	42	3.1
White crappie				2									2			2	0.1
Black crappie							2						2			2	0.1
Bass sp.					1			3			1			5		5	0.4
Yellow perch			1				1						1		1	2	0.1
Sauger	1						2	2		2	2		5	4		9	0.7
Walleye							1						1			1	0.1
Freshwater drum		2			1			1						4		4	0.3
TOTAL	26	142	5	22	98	18	26	899	64	6	19	39	80	1,158	126	1,364	

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, 1987
BVPS

	Transect					
Gill Net	1	2A	2B	3	Total	Average
May	6	0	1	19	26	6.5
July	3	3	4	12	22	5.5
September	3	3	4	16	26	6.5
November	1	2	0	3	6	1.5
Total	13	8	9	50	80	
Average	3.3	2.0	2.3	12.5		
Electrofishing						
May	22	77	29	14	142	35.5
July	22	32	26	18	98	24.5
September	154	87	69	589	899	244.8
November	5	8	3	3	19	4.8
Total	203	204	127	624	1,158	
Average	50.8	51.0	31.8	156.0		
Minnow Trap						
May	2	0	1	2	5	1.3
July	0	9	9	0	18	4.5
September	5	22	2	35	64	16.0
November	7	2	2	28	39	9.8
Total	14	33	14	65	126	
Average	3.5	8.3	3.5	16.3		

fishing and minnow traps included the following: gizzard shad, common carp, emerald shiner, spottail shiner, spotfin shiner, channel catfish, spotted bass, and shiners spp. The remaining 22 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 V-E-6), little change is noticed either between Control and Non-Control Transects or between pre-operational and operational years. The 1987 gill net catch-per-unit-effort (fish/24 hours) averaged middle to upper end of the range established by previous collections with 1.5 and 2.8-3.1 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 1987 are presented in Tables V-E-5 and V-E-6. These fourteen years represent two preoperational years (1974 and 1975) and twelve operational years (1976 through 1987). Fish data for Transect

TABLE V-E-5

ELECTROFISHING CATCH (FISH/HOUR) MEANS ($\bar{X}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL OF THE OHIO RIVER, 1974-1987
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]
Longnose gar	–	–	–	–	–	–	–	–	–	1.5	–	–	–	–
Gizzard shad	–	2.1	1.2	2.0	–	–	3.1	3.0	0.8	69.0	31.5	27.0	36.0	76.5
Tiger muskellunge	–	–	–	–	–	–	0.8	–	–	–	–	–	–	–
Muskellunge	–	–	–	–	–	0.5	–	–	–	–	–	–	–	–
Northern pike	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pike sp.	–	–	–	–	–	–	–	–	–	–	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
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
Striped shiner	–	–	–	–	–	–	–	–	–	1.5	–	–	–	–
Spottail shiner	–	–	–	–	–	–	–	–	–	–	–	–	–	1.5
Spotfin shiner	0.9	–	4.8	7.0	0.5	–	–	–	3.0	4.5	1.5	–	–	–
Sand shiner	57.6	129.1	52.5	95.9	8.8	93.6	32.3	23.2	19.5	6.0	3.0	–	4.5	9.0
Mimic shiner	–	–	3.5	7.0	0.5	1.6	6.2	3.0	6.0	–	–	–	19.5	1.5
Bluntnose minnow	33.[illegible]	72.3	53.2	57.8	12.8	89.4	15.4	18.0	21.8	9.0	4.5	1.5	4.5	–
Creek chub	0.9	–	0.5	0.5	–	–	–	–	–	–	–	–	–	–
Stoneroller	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Blacknose dace	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shiner sp.	–	–	–	–	–	–	–	–	–	–	78.0	3.0	528.0	114.0
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.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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	–	–
Shorthead redhorse	–	–	–	–	–	–	–	0.8	0.0	–	1.5	–	–	3.0
Yellow bullhead	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brown bullhead	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Channel catfish	–	–	–	–	0.3	–	–	0.8	–	–	–	–	–	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)

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]
Brook silverside	-	-	-	-	-	-	-	-	-	-	-	-	-	-
White bass	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-
Rock bass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sunfish (Lepomis) hybrid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green sunfish	-	-	-	-	0.3	0.5	-	-	-	-	-	-	-	-
Pumpkinseed	-	-	-	-	0.3	0.5	-	-	-	1.5	-	-	-	-
Bluegill	6.6	-	1.5	-	3.0	0.5	-	1.5	0.8	1.5	1.5	-	1.5	-
Sunfish sp.	-	-	-	-	-	-	-	-	-	-	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
Spotted bass	0.9	-	-	2.7	-	2.6	4.6	1.5	-	4.5	9.0	1.5	3.0	7.5
Largemouth bass	1.1	-	-	1.0	1.0	-	0.8	-	0.8	-	-	-	3.0	-
Bass sp.	-	-	-	-	-	-	-	-	-	-	4.5	3.0	3.0	4.5
White crappie	-	-	-	-	-	-	1.5	-	-	-	-	-	1.5	-
Black crappie	-	-	-	-	-	-	-	-	-	1.5	-	1.5	-	-
Johnny darter	-	-	-	-		0.5	-	-	-	-	-	-	-	-
Yellow perch	-	-	-	-	0.3	0.5	-	0.8	-	-	3.0	-	-	-
Logperch	-	-	-	-	0.3	0.5	-	-	-	-	-		1.5	-
Sauger	-	-	-	-	-	-	-	-	-	-	-	1.5	1.5	1.5
Walleye	-	-	0.5	-	-	-	-	-	-	-	3.0	-	-	-
Freshwater drum	-	-	-	-	-	-	-	-	-	-	-	-	3.0	3.0
Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	150.8	645.2	139.4	235.9	65.6	250.6	146.9	225.2	176.0	418.5	241.5	67.5	670.5	304.5

[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	1974[a]	1975[b]	1976[c]	1977[c]	1978[c]	1979[c]	1930[d]	1981[d]	1982[d]	1983[d]	1984[d]	1985[e]	1986[d]	1987[d]
	Transect 2A, 2B, 3													
Longnose gar	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gizzard shad	0.9	1.0	1.4	0.7	0.3	2.1	2.5	21.5	19.2	19.5	76.5	[illegible].0	57.5	116.0
Tiger muskellunge	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muskellunge	-	-	-	-	-	-	0.3	-	-	-	0.5	-	-	-
Northern pike	-	-	-	-	0.3	-	-	0.2	-	-	-	-	-	-
Pike sp.	-	-	-	-	-	-	-	-	-	-	1.0	1.0	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
River chub	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
Golden shiner	-	-	-	-	-	-	-	-	0.2	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	22.5	21.5	36.5	31.0
Striped shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spottail shiner	-	-	-	-	-	-	-	-	-	-	-	-	0.5	3.5
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
Sand shiner	17.4	81.0	52.6	26.2	13.3	45.2	25.8	10.2	22.8	26.0	-	-	0.5	1.5
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
Creek chub	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stoneroller	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-
Blacknose dace	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
Shiner sp.	-	-	-	-	-	-	-	-	-	-	40.0	42.5	566.5	299.5
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	-
Silver redhorse	-	-	-	-	0.3	-	-	0.2	0.2	-	1.0	-	-	-
Black redhorse	-	-	-	0.3	0.3	-	-	-	-	-	-	2.0	-	-
Golden redhorse	-	-	-	-	-	-	0.8	0.2	1.5	1.5	-	1.0	2.0	0.5
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	-	-	-	-	-	-	-
Rock bass	-	-	0.4	-	0.1	-	-	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]
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	–	–	–
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
Sunfish sp.	–	–	–	–	–	–	–	–	–	–	0.5	0.5	–	–
Smallmouth bass	0.8	–	0.6	1.6	0.3	0.9	2.8	6.5	5.8	4.0	6.0	2.0	3.5	4.0
Spotted bass	0.4	–	–	2.7	–	2.1	1.5	0.5	0.8	2.5	9.5	1.0	2.5	7.5
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
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	–	–	–	–	–	–	–	–
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	–
Sauger	–	–	–	–	–	–	0.5	0.2	–	–	–	1.0	0.5	1.5
Walleye	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Freshwater drum	–	–	–	–	–	–	0.2	–	–	–	–	3.0	–	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

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

TABLE V-E-6

GILL NET CATCH (FISH/24) HOUR MEANS ($\bar{X}$) AT TRANSECTS IN THE NEW CUMBERLAND POOL
THE OHIO RIVER, 1974-1987
BVPS

Species	Transect 1													
	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]
Longnose gar	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–
Gizzard shad	–	–	–	–	–	–	0.1	–	0.4	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	–	–
Goldfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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
Goldfish x Carp hybrid	–	–	–	–	–	–	–	–	–	–	–	–	–	–
River carpsucker	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Quillback	–	–	0.1	0.2	–	–	–	–	–	0.1	–	–	0.1	–
White sucker	–	0.3	–	0.2	0.2	–	–	0.1	0.1	–	–	–	–	–
Black redhorse	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Silver redhorse	–	–	–	–	–	< 0.1	–	–	–	–	–	–	–	0.1
Golden redhorse	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–
Shorthead redhorse	–	–	–	–	–	–	–	–	–	–	–	0.1	0.1	0.1
Redhorse sp.	–	–	–	–	–	–	–	–	–	–	0.1	–	–	–
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
Flathead catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1
White bass	–	–	–	–	–	–	–	–	–	–	–	0.2	–	–
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	–	–	–	–	–	–	–	–
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
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
Sauger	–	–	–	–	0.2	–	0.1	–	0.2	0.1	–	–	0.3	–
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

[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

TABLE V-E-5
(Continued)

Species	Transect 2A, 2B, 3													
	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]
Longnose gar	–	–	–	–	–	–	–	–	<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
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	–
Tiger muskellunge	–	–	–	–	<0.1	–	<0.1	–	–	<0.1	–	<0.1	–	–
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
Goldfish x Carp hybrid	–	0.1	–	0.1	–	–	–	–	–	–	–	–	–	–
River carpsucker	–	–	–	–	–	–	–	–	–	–	–	<0.1	0.1	0.1
Quillback	–	–	<0.1	0.2	0.1	<0.1	<0.1	–	<0.1	0.2	–	0.1	–	–
White sucker	0.1	–	–	<0.1	–	<0.1	<0.1	–	–	0.1	<0.1	–	<0.1	–
Black redhorse	–	–	–	<0.1	0.1	<0.1	–	–	–	–	–	–	–	–
Silver redhorse	–	–	–	–	–	<0.1	–	–	<0.1	–	0.2	0.1	–	–
Golden redhorse	–	–	–	–	–	–	–	–	<0.1	–	<0.1	0.2	0.1	0.2
Shorthead redhorse	–	–	–	–	–	–	–	–	<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
Flathead catfish	–	–	–	–	–	–	–	–	<0.1	<0.1	<0.1	<0.1	0.1	–
White bass	–	–	–	–	–	–	–	–	–	0.1	–	–	<0.1	0.1
Rock bass	–	0.1	–	<0.1	<0.1	<0.1	–	–	<0.1	0.1	<0.1	0.2	<0.1	0.2
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
Largemouth bass	0.2	0.1	0.1	<0.1	<0.1	–	–	–	<0.1	<0.1	–	–	–	–
Spotted bass	–	–	0.2	0.1	<0.1	<0.1	0.1	<0.1	0.3	1.8	0.2	0.5	0.1	0.7
White crappie	–	–	<0.1	<0.1	–	0.1	0.1	–	<0.1	0.2	–	0.2	–	0.1
Black crappie	–	–	<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	–
Sauger	–	0.1	–	<0.1	0.2	0.3	<0.1	0.2	0.3	0.5	0.4	0.2	0.3	0.2
Freshwater drum	–	–	–	–	–	–	–	0.1	0.3	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	[illegible]	3.3-4.0	3.8-4.8	2.8-3.1

[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

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 (minnows and shiners) 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 of the family Cyprinidae have dominated the catches. Emerald shiners, gizzard shad, sand shiners and bluntnose minnows have consistently been among the most numerous fish, although the latter two species may have declined in recent years. Carp, channel catfish, smallmouth and spotted bass, yellow perch, and walleye have all remained common species. Since 1978, sauger have become a common game species to this area.

Differences in the 1987 electrofishing and gill net catches, between the Control and Non-Control Transects were similar to previous years (both operational and pre-operational) 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 1987 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 1987 program had five day surveys (21 April, 19 May, 19 June, 14 July and 10 August) and two night surveys (20 May, and 15 July) conducted during the spring and summer, which is the primary spawning season for most resident fish species. One surface and one bottom collection were taken at Transect 2B (back channel of Phillis Island) during each survey (Figure V-F-1). Tows were made in a zig-zag fashion across the channel utilizing a conical 505 micron mesh plankton net with a 0.5 m mouth diameter. A General Oceanics Model 2030 digital flowmeter, mounted centrically in the net mouth, was used to determine the volume of water filtered. Samples were preserved in the field using 5% buffered formalin containing rose bengal dye.

In the laboratory, ichthyoplankton was sorted from the sample and enumerated. Each specimen was identified as to its stage of development (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 38 eggs, 255 larvae, and 9 adults were collected in 1987 from 1,907.2 m^3 of water sampled (Table V-F-1). Ten taxa representing six families were identified. Shiners (Notropis spp.) accounted for 34.3% of the total catch. Gizzard shad (Dorosoma cepedianum) accounted for 25.4%. Freshwater drum eggs (Aplodinotus grunniens) represented 84.2% of the eggs collected in 1987. All adult fish (emerald shiners) were collected at night from the surface and bottom. For 1987, the night collections produced a total density of 20.36 individuals per 100 m^3 compared to those from day collections which were 14.27 individuals per

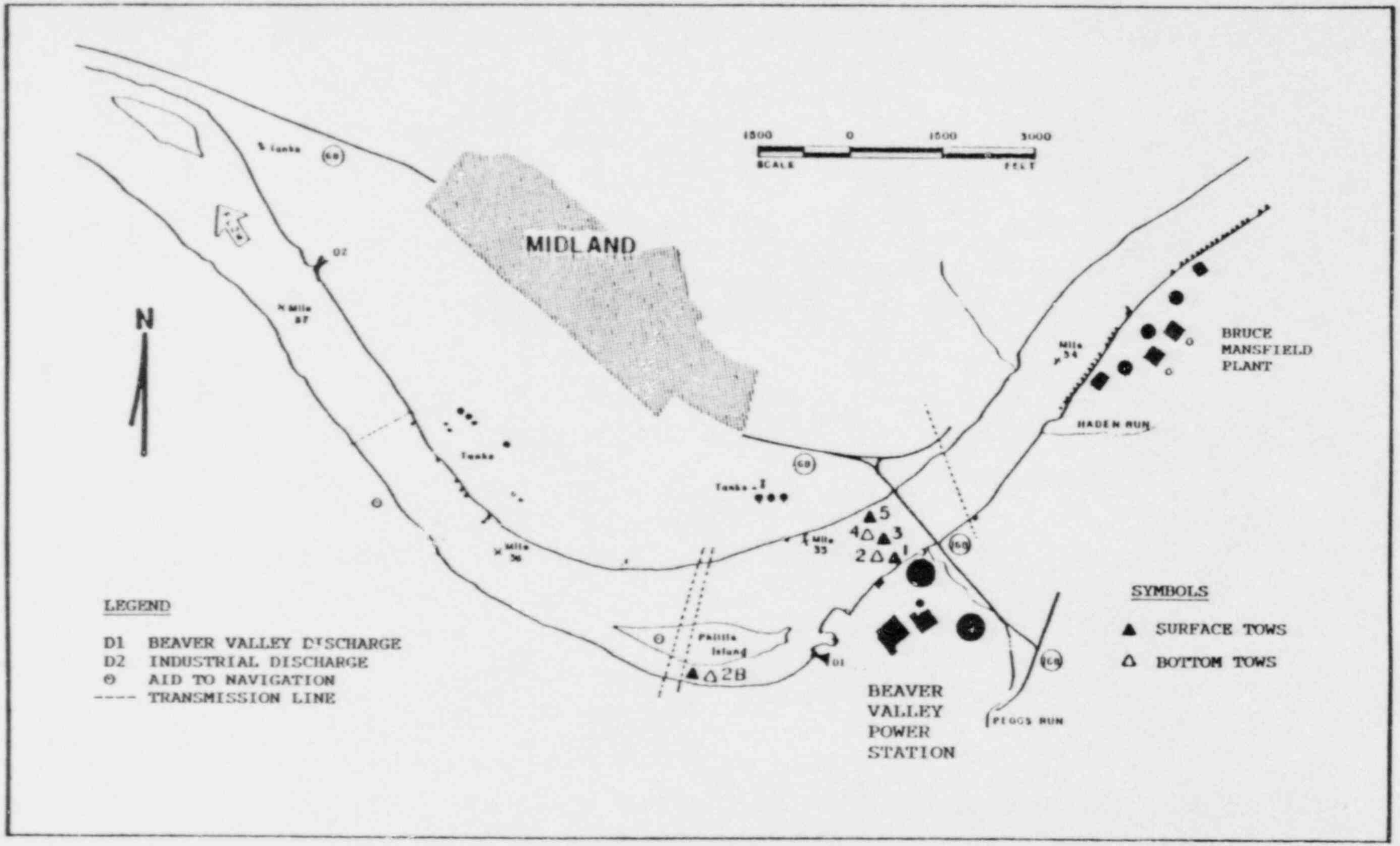


FIGURE V-F-1

ICHTHYOPLANKTON SAMPLING STATIONS
BVPS

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, 1987

Date	Depth of Collection				Total Collection and
	Surface		Bottom		
April 21	Day	Night	Day	Night	Taxa Density
Vol. water filtered (m^3)	174.7		121.4		296.1
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)					
Eggs	0		0		0
Larvae	0		0		0
Total Density (number collected)	0		0		0
May 19/20					
Vol. water filtered (m^3)	121.6	126.6	157.2	87.9	493.3
Number eggs collected	1	6	0	11	18
Number larvae collected	6	46	8	2	62
Number juveniles collected	0	0	0	0	0
Number adults collected	0	0	0	0	0
Density (number collected)					
Eggs					
Aplodinotus grunniens	0	4.74(6)	0	7.96(7)	2.64(13)
Unidentified Egg	0.82(1)	0	0	4.55(4)	1.01(5)
Larvae					
Dorosoma cepedianum (YL)	3.29(4)	20.54(26)	1.27(2)	1.14(1)	6.69(33)
Cyprinus carpio (YL)		3.16(4)			0.81(4)
Cyprinus carpio (EL)		7.11(9)	2.54(4)		2.64(13)
Notropis spp. (EL)		1.58(2)			0.41(2)
Morone chrysops (EL)	1.64(2)	3.16(4)		1.14(1)	1.42(7)
Etheostoma spp. (EL)			0.64(1)		0.20(1)
Stizostedion spp. (EL)			0.64(1)		0.20(1)
Aplodinotus grunniens (YL)		0.79(1)			0.20(1)
Total Density (number collected)	5.76(7)	41.07(52)	5.09(8)	14.79(13)	16.22(80)

TABLE V-F-1
(Continued)

Date	Depth of Collection				Total Collection and
	Surface		Bottom		
June 19	Day	Night	Day	Night	Taxa Density
Vol. water filtered (m^3)	122.7		109.7		232.4
Number eggs collected	0		13		13
Number larvae collected	50		30		80
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Density (number collected)					
Eggs					
Aplodinotus grunniens	0		10.94(12)		5.16(12)
Unidentified eggs	0		0.91(1)		0.43(1)
Larvae					
Dorosoma cepedianum (YL)	1.63(2)				0.86(2)
Dorosoma cepedianum (EL)	25.26(31)		2.73(3)		14.63(34)
Cyprinus carpio (EL)			4.56(5)		2.15(5)
Pimephales spp. (EL)	10.59(13)		2.73(3)		6.88(16)
Pimephales notatus (LL)			1.82(2)		0.86(2)
Pomoxis spp. (EL)	3.26(4)		0.91(1)		2.15(5)
Aplodinotus grunniens (YL)			7.29(8)		3.44(8)
Aplodinotus grunniens (EL)			7.29(8)		3.44(8)
Total Density (number collected)	40.75(50)	0	39.20(43)	0	40.02(93)
July 14/15					
Vol. water filtered (m^3)	125.9	148.2	112.1	143.3	529.5
Number eggs collected	0	3	1	3	7
Number larvae collected	45	14	18	8	85
Number juveniles collected	0	0	0	0	0
Number adults collected	0	3	0	7	10
Density (number collected)					
Eggs					
Aplodinotus grunniens	0	2.02(3)	0.89(1)	2.09(3)	1.32(7)
Larvae					
Notropis spp. (YL)		0.67(1)			0.19(1)
Notropis spp. (EL)	35.74(45)	7.42(11)	15.17(17)	5.58(8)	15.30(81)
Pimephales spp. (EL)		0.67(1)			0.19(1)
Aplodinotus grunniens (YL)		0.67(1)	0.89(1)		0.38(2)

TABLE V-F-1
(Continued)

Date	Depth of Collection: Surface		Bottom		Total Collection and
July 14/15	Day	Night	Day	Night	Taxa Density
Adults					
Notropis atherinoides		2.02(3)		4.88(7)	1.89(10)
Total Density (number collected)	35.74(45)	13.50(20)	16.95(19)	12.56(18)	19.26(102)
August 10					
Vol. water filtered (m^3)	174.4		181.5		355.9
Number eggs collected	0		0		0
Number larvae collected	28		0		0
Number juveniles collected	0		0		0
Number adults collected	0		0		0
Densities (number collected)					
Eggs	0		0		0
Larvae					
Dorosoma cepedianum (EL)	4.59(8)		0		2.25(8)
Notropis spp. (EL)	11.47(20)		0		5.62(20)
Total Density (number collected)	16.06(28)		0		7.87(28)
Yearly Totals					
Vol. water filtered (m^3)	719.3	274.8	681.9	231.2	1,907.2
Number eggs collected	1	9	14	14	38
Number larvae collected	129	60	56	10	255
Number juveniles collected	0	0	0	0	0
Number adults collected	0	3	0	7	10
Densities (number collected)					
Eggs					
Aplodinotus grunniens	0	3.28(9)	1.91(13)	4.33(10)	1.68(32)
Unidentified egg	0.14(1)	0	0.15(1)	1.73(4)	0.31(6)
Larvae					
Dorosoma cepedianum (YL)	0.83(6)	9.46(26)	0.29(2)	0.43(1)	1.84(35)
Dorosoma cepedianum (EL)	5.42(39)	0	0.44(3)	0	2.20(42)
Cyprinus carpio (YL)	0	1.46(4)	0	0	0.21(4)
Cyprinus carpio (EL)	0	3.28(9)	1.32(9)	0	0.94(18)
Notropis spp. (YL)	0	0.36(1)	0	0	0.05(1)

TABLE V-F-1
(Continued)

Date	Depth of Collection				Total Collection and Taxa Density
	Surface		Bottom		
	Day	Night	Day	Night	
Notropis spp. (EL)	9.04(65)	4.73(13)	2.49(17)	3.46(8)	5.40(103)
Pimephales spp. (EL)	1.81(13)	0.36(1)	0.44(3)	0	0.89(17)
Pimephales notatus (LL)	0	0	0.29(2)	0	0.10(2)
Morone chrysops (EL)	0.28(2)	1.46(4)	0	0.43(1)	0.37(7)
Pomoxis spp. (EL)	0.56(4)	0	0.15(1)	0	0.26(5)
Etheostoma spp. (EL)	0	0	0.15(1)	0	0.05(1)
Stizostedion spp.	0	0	0.15(1)	0	0.05(1)
Aplodinotus grunniens (YL)	0	0.73(2)	1.32(9)	0	0.58(11)
Aplodinotus grunniens (EL)	0	0	1.17(8)	0	0.42(8)
Adults					
Notropis atherinoides	0	1.09(3)	0	3.03(7)	0.52(10)
Total Density (number collected)	18.07(130)	26.20(72)	10.27(70)	13.41(31)	15.89(303)

[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.

100 m^3. Of the day collections' densities, 19 June were most abundant with a total density of 40.02 individuals per 100 m^3 (mostly gizzard shad larvae). The most abundant densities for the night collections were on 20 May with a total density of 30.30 individuals per 100 m^3 (freshwater drum eggs and gizzard shad larvae). No ichthyoplankton were collected in April (Table V-F-1).

Comparison of Preoperational and Operational Data

Species abundance and composition were similar to that found in previous years. Shiners, 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, 1976-1987, are presented in Table V-F-2.

Summary and Conclusions

Shiners, gizzard shad, and freshwater drum dominated the 1987 ichthyoplankton catch from the back channel of Phillis Island. Peak densities occurred in June and consisted mostly of early larval stages. No spawning was noted in April. There was a decrease in larvae density after July. No substantial differences were observed in species composition or spawning activity over previous years.

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, 1976-1987

Date	Density	Date	Density	Date	Density
1973		1974		1976	
12 Apr	0	16 Apr	0	26 Apr	0.70
17 May	0	24 May	0	19 May	0
20 Jun	16.10	13 Jun	6.98	18 Jun	5.99
26 Jul	3.25	26 Jun	9.25	2 Jul	6.63
		16 Jul	59.59	15 Jul	3.69
		1 Aug	6.85	29 Jul	4.05
1977		1978		1979	
14 Apr	0	22 Apr	0	19 Apr	0
11 May	0.90	5 May	0	1 May	0
9 Jun	24.22	20 May	0.98	17 May	0.81
22 Jun	3.44	2 Jun	4.01	7 Jun	0.39
7 Jul	3.31	16 Jun	12.15	20 Jun	11.69
20 Jul	28.37	2 Jul	13.32	5 Jul	14.82
1980		1981		1982	
23 Apr	0.42	20 Apr	1.10	19 Apr	0
21 May	0.53	12 May	0	18 May	3.77
19 Jun	9.68	17 Jun	26.40	21 Jun	7.54
22 Jul	107.04	22 Jul	17.14	20 Jul	31.66
1983		1984		1985	
13 Apr	0	16 Apr	0	18 Apr	0
11 May	0.66	10 May	0	14 May	1.81
14 Jun	4.46	8 Jun	15.46	10 Jun	13.36
12 Jul	44.05	12 Jul	44.23	11 Jul	117.59
1986		1987			
18 Apr	0.63	21 Apr	0		
13 May[a]	5.93	19 May[a]	16.22		
19 Jun	34.52	19 Jun	40.02		
15 Jul[a]	26.15	14 Jul[a]	19.26		
12 Aug	9.89	10 Aug	7.87		

[a] Day and night survey was conducted.

G. FISH IMPINGEMENT

Objective

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

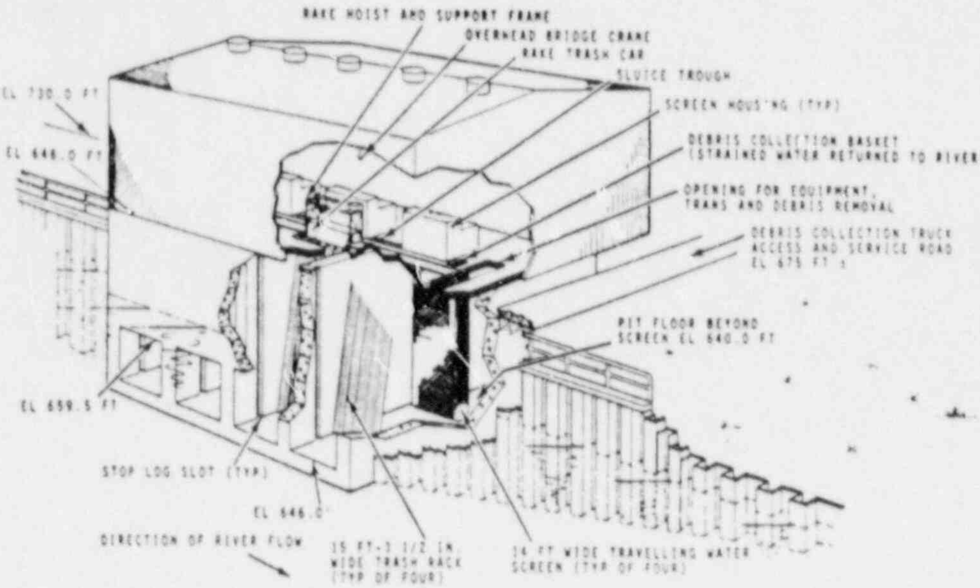
Methods

The surveys were conducted weekly throughout 1987 for a total of 49 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.

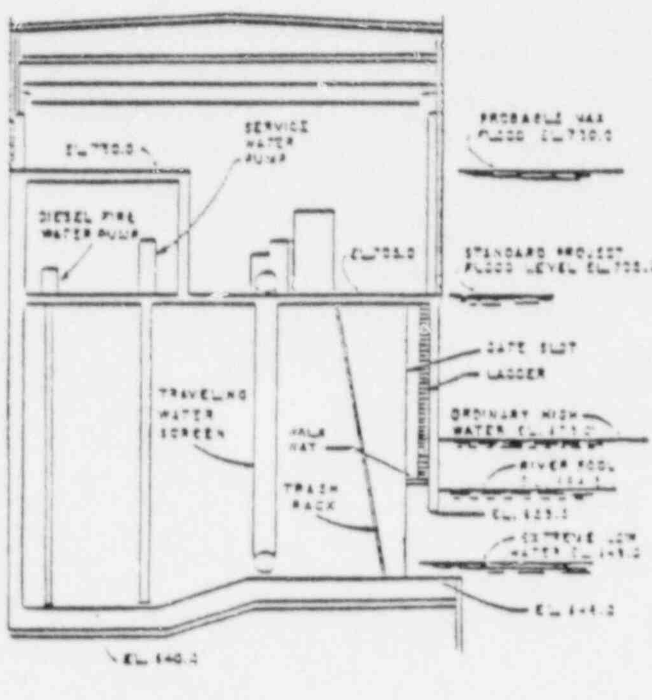
Results

The BVPS impingement surveys of 1976 through 1987 have resulted in the collection of 36 species of fish representing nine families (Table V-G-1). A total of 345 fish, representing 13 species were collected in 1987 (Table V-G-2). Gizzard shad were the most numerous fish, comprising 82.6% of the total annual catch, followed by channel catfish (5.2%), bluegill (3.8%), with all other species represented by less than 8 specimens. All fishes ranged in size from 25 mm to 352 mm, with the majority under 100 mm. The total weight of all fishes collected in 1987 was 7.27 kg (16.0 lbs). Approximately 90.3% of the total weight of fish collected (both alive and dead) was comprised of gizzard shad collected in January. No endangered or threatened species were collected (Commonwealth of Pennsylvania, 1985).

The temporal distribution of the 1987 impingement catch closely follows the pattern of catches of previous years (1976 to 1986) (Tables V-G-3 and



(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, 1976-1987
BVPS

Family and Scientific Name[1]	Common Name
Clupeidae (herrings)	
Dorosoma cepedianum	Gizzard shad
Cyprinidae (minnows and carps)	
Cyprinus carpio	Common carp
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald 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
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-G-1
(Continued)

Family and scientific Name[1]	Common Name
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 1987
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	285	37	82.6	1	21	279	6,495			5	53	61-260
Common carp	2	4	0.6	2	542							42-352
Emerald shiner	6	6	1.7			5	5			1	1	27-52
Sand shiner	1	2	0.3			1	1					63
Brown bullhead	3	4	0.9	1	1	2	2					30-38
Channel catfish	18	27	5.2	6	13	12	15					32-75
Flathead catfish	1	2	0.3	1	10							101
Rock bass	1	2	0.3					1	3			62
Green sunfish	2	4	0.6			1	9	1	8			74-79
Bluegill	13	16	3.8	4	4	9	11					25-66
Sunfish sp.	1	2	0.3			1	1					28
Spotted bass	1	2	0.3					1	36			147
Darter sp.	1	2	0.3			1	1					79
Freshwater drum	7	6	2.0			6	22			1	1	32-95
Unidentifiable	3	4	0.9			2	10			1	8	32-180
Total	345			15	591	319	6,572	3	47	8	63	

[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.

TABLE V-G-3

SUMMARY OF IMPINGEMENT SURVEY DATA FOR 1987
BVPS

Date		Number of Fish	Percent	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water	River Elevation Above Mean
Month	Day	Collected	Annual Total	Alive	Dead	Alive	Dead	A	B	C	D	Temp °F	Sea Level (ft.)
January	2	0	0.0					X	X			38.8	666.7
	9	4	1.2	1	3			X			X	37.2	666.2
	16	3	0.9		3			X		X		38.3	666.9
	23	6	1.7	2	4			X			X	36.3	667.5
	30	229	66.4	1	228			X	X	X	X	33.0	666.2
February	6	5	1.4		5			X			X	36.2	667.2
	13	1	0.3		1			X			X	36.1	666.1
	20	19	5.5		18		1	X			X	36.0	665.7
	27	3	0.9		3			X	X	X		39.7	666.2
March	6	3	0.9		3			X	X	X	X	38.9	666.6
	13	3	0.9		1		2		X		X	41.9	666.7
	20	2	0.6		1		1		X	X	X	42.8	665.5
	27	1	0.3				1		X	X	X	49.5	666.1
April	3	1	0.3	1					X	X	X	45.4	669.3
	10	1	0.3		1			X		X	X	46.5	672.1
	17	0	0.0					X	X		X	50.3	667.8
	24	3	0.9		2		1		X	X	X	60.5	667.4
May	1	0	0.0							X	X	57.2	666.3
	8	1	0.3		1				X	X	X	58.0	666.1
	15	0	0.0					X		X	X	66.0	665.6
	22	1	0.3		1			X	X	X	X	71.3	665.4
	29	1	0.3	1				X	X	X	X	74.4	665.6
June	5	1	0.3		1			X	X	X	X	76.5	665.5
	12	0	0.0					X	X	X	X	75.8	665.4
	19	0	0.0					X		X	X	80.3	665.4
	26	1	0.3				1	X	X		X	80.4	665.3

TABLE V-G-3
(Continued)

Date		Number of Fish	Percent	Operating Intake Bays[1]		Non-Operating Intake Bays[2]		Intake Bays Operating				Intake Water	River Elevation Above Mean
Month	Day	Collected	Annual Total	Alive	Dead	Alive	Dead	A	B	C	D	Temp °F	Sea Level (ft.)
July	3	5	1.4	1	3		1	X	X		X	75.0	670.5
	10	1	0.3	1				X	X	X	X	75.5	666.0
	17	3	0.9		3			X	X		X	76.0	665.6
	24	1	0.3		1			X	X		X	82.5	665.4
	31	2	0.6	1	1			X	X	X	X	81.5	665.0
August	7	2	0.6		1	1		X		X	X	81.0	665.3
	14	2	0.6		2			X	X	X	X	79.2	665.5
	21	2	0.6	1	1			X	X	X	X	80.8	665.5
	28	6	1.7	1	5			X		X	X	75.0	665.4
September	4	1	0.3		1			X	X	X	X	71.5	665.4
	11	1	0.3	1				X	X	X	X	71.0	665.7
	18	3	0.9		3			X	X	X	X	71.4	666.2
	25	5	1.4	1	4			X	X	X	X	65.0	665.9
October	2	0	0.0					X		X	X	63.1	665.7
	9	1	0.3			1		X		X	X	51.9	666.1
	16	0	0.0					X		X	X	54.0	665.5
	23	0	0.0					X	X		X	54.0	665.7
	30[3]	–	–					–	–	–	–	51.3	665.7
November	6[3]	–	–					–	–	–	–	53.5	665.2
	13[3]	–	–					–	–	–	–	50.0	665.4
	15	1	0.3			1			X	X	X	49.9	665.5
	20	0	0.0					X		X	X	49.2	665.9
	27	0	0.0					X	X	X	X	47.8	665.7
December	4	15	4.3	2	13			X		X	X	45.0	667.0
	11	2	0.6		2			X		X	X	43.8	667.5
	18[4]	–	–					–	–	–	–	40.8	666.5
	24	3	0.9		3					X	X	40.5	666.8
Total		345		15	319	3	8						

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 diving operations in screenhouse.
4 Impingement could not be conducted due to outage activities.

TABLE V-G-4

SUMMARY OF FISH COLLECTED IN IMPINGEMENT SURVEYS, 1976-1987 BVPS

Number of Fish Collected

Month	1976 Operating Intake Bays[1]	1976 Non-operating Intake Bays[2]	1976 Total	1977 Operating Intake Bays	1977 Non-operating Intake Bays	1977 Total	1978 Operating Intake Bays	1978 Non-operating Intake Bays	1978 Total	1979 Operating Intake Bays	1979 Non-operating Intake Bays	1979 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

Month	1980 Operating Intake Bays[1]	1980 Non-operating Intake Bays[2]	1980 Total	1981 Operating Intake Bays	1981 Non-operating Intake Bays	1981 Total	1982 Operating Intake Bays	1982 Non-operating Intake Bays	1982 Total	1983 Operating Intake Bays	1983 Non-operating Intake Bays	1983 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

Month	1984 Operating Intake Bays[1]	1984 Non-operating Intake Bays[2]	1984 Total	1985 Operating Intake Bays	1985 Non-operating Intake Bays	1985 Total	1986 Operating Intake Bays	1986 Non-operating Intake Bays	1986 Total	1987 Operating Intake Bays	1987 Non-operating Intake Bays	1987 Total
January	34	5	39	4	2	6	90	4	94	242	0	242
February	19	11	30	2	0	2	20	2	22	27	1	28
March	23	7	30	3	4	7	6	3	9	5	4	9
April	15	4	19	0	0	0	1	0	1	4	1	5
May	4	1	5	2	0	2	0	1	1	3	0	3
June	7	2	9	1	1	2	0	3	3	1	1	2
July	27	2	29	4	0	4	6	1	7	11	1	12
August	7	1	8	4	3	7	3	3	6	11	1	12
September	0	4	4	8	4	12	3	4	7	10	0	10
October	0	0	0	8	9	17	18	4	22	0	1	1
November	1	1	2	70	10	80	26	1	27	0	1	1
December	0	2	2	24	1	25	14	0	14	20	0	20
Total	137	40	177	130	34	164	187	26	213	334	11	345

[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.

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 244 crayfish, 237 native clams, and 128 dragonflies (Tables V-G-6 and V-G-8). In addition, 1,396 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 30 species collected, 10 were observed in both locations, 2 species were collected only in the impingement surveys, while 18 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. Three species of suckers (river carpsucker, shorthead redhorse, golden redhorse) and six species of game fish (yellow perch, white and black crappie, smallmouth bass, 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 and bluegill) were smaller than individuals of those species collected by river sampling.

Comparison of Operating and Non-Operating Intake Bay Collections

Of the 345 fish collected during the 1987 impingement studies, 334 (96.8%) were collected from operating intake bays and 11 (3.2%) from non-operating intake bays (Table V-G-2). However, due to differences between the number of operating (143) and non-operating (36) screens washed in 1987, the impingement data were computed with catch expressed as fish per 1,000 m^2 of screen surface area washed. These results showed 13.1 and 1.7 fish for operating and non-operating screens, respectively. As in previous years, the numbers of fish collected in non-operating bays indicates that fish entrapment, rather than impingement, accounts for

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, 1987
BVPS

Species[a]	Total Number of Fish Collected		Percent of Annual Total	
	Impingement	River	Impingement	River
Longnose gar		1		0.1
Gizzard shad	285	294	83.8	43.0
Common carp	2	32	0.6	4.7
River chub		1		0.1
Emerald shiner	6	174	1.8	25.5
Spottail shiner		26		3.8
Spotfin shiner		15		2.2
Sand shiner	1	14	0.3	2.0
Mimic shiner		2		0.3
Bluntnose minnow		1		0.1
River carpsucker		2		0.3
Northern hog sucker		1		0.1
Black redhorse		1		0.1
Golden redhorse		7		1.0
Shorthead redhorse		4		0.6
Brown bullhead	3		0.9	
Channel catfish	18	20	5.3	2.9
Flathead catfish	1	1	0.3	0.1
White bass		2		0.3
Rock bass	1	6	0.3	0.9
Green sunfish	2		0.6	
Bluegill	13	3	3.8	0.4
Smallmouth bass		14		2.0
Spotted bass	1	42	0.3	6.1
White crappie		2		0.3
Black crappie		2		0.3
Yellow perch		2		0.3
Sauger		9		1.3
Walleye		1		0.1
Freshwater drum	7	4	2.1	0.6
Total	340	683		

(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, 1987
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	2	7	2	0	0
	9	0	0	0	0
	16	1	1	0	0
	23	2	5	0	2
	30	3	0	0	0
February	6	0	2	0	3
	13	1	1	0	0
	20	2	0	1	0
	27	1	1	0	1
March	6	12	1	0	0
	13	0	1	0	0
	20	2	0	0	0
	27	2	0	0	0
April	3	0	1	1	0
	10	6	0	0	1
	17	2	3	0	0
	24	0	0	0	0
May	1	0	1	0	0
	8	0	1	0	1
	15	0	0	0	0
	22	0	3	0	0
	29	0	4	0	0
June	5	5	3	0	0
	12	3	2	0	0
	19	5	4	3	2
	26	4	6	1	2
July	3	14	5	1	3
	10	6	12	0	0
	17	2	1	0	0
	24	2	4	0	0
	31	0	1	0	0

TABLE V-G-6
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	7	6	4	1	0
	14	7	1	0	0
	21	2	3	0	0
	28	1	1	1	0
September	4	2	3	0	0
	11	3	1	0	0
	18	2	6	0	0
	25	1	5	0	0
October	2	2	3	0	1
	9	1	2	1	0
	16	2	0	0	0
	23	0	0	0	0
	30(a)	-	-	-	-
November	6(a)	-	-	-	-
	13(a)	-	-	-	-
	15	0	0	0	1
	20	0	1	0	0
	27	1	0	0	0
December	4	1	0	0	0
	11	4	0	0	0
	18(b)	-	-	-	-
	24	1	0	4	0
Total		118	95	14	17

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

TABLE V-G-7

SUMMARY OF *Corbicula* COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1987
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	2	0	1	0	0
	9	0	0	0	1
	16	0	0	0	0
	23	0	0	0	0
	30	0	0	0	0
February	6	0	0	0	0
	13	0	0	0	0
	20	0	1	0	0
	27	0	1	0	0
March	6	0	1	0	0
	13	0	0	0	1
	20	0	0	1	2
	27	0	1	0	1
April	3	0	0	0	1
	10	0	1	0	0
	17	1	0	0	0
	24	0	0	0	0
May	1	0	2	0	1
	8	0	3	0	1
	15	0	1	0	0
	22	3	11	0	0
	29	3	2	0	0
June	5	25	21	0	0
	12	27	20	0	0
	19	33	33	8	7
	26	53	38	8	5
July	3	13	16	7	5
	10	32	27	0	0
	17	8	12	5	6
	24	7	10	9	1
	31	32	37	0	0

TABLE V-G-7
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	7	45	43	10	15
	14	27	23	0	0
	21	51	36	0	0
	28	45	46	7	21
September	4	48	77	0	0
	11	38	52	0	0
	18	12	52	0	0
	25	26	29	0	0
October	2	10	30	0	3
	9	12	19	0	1
	16	6	2	0	0
	23	2	5	0	0
	30(a)	-	-	-	-
November	7(a)	-	-	-	-
	13(a)	-	-	-	-
	15	5	16	4	16
	20	3	4	0	2
	27	0	4	0	0
December	4	0	0	1	0
	11	0	1	0	0
	18(b)	-	-	-	-
	24	0	1	0	0
TOTAL		567	679	60	90

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

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TABLE V-G-8

SUMMARY OF MOLLUSKS (OTHER THAN *Corbicula*) AND DRAGONFLIES COLLECTED IN IMPINGEMENT SURVEYS CONDUCTED FOR ONE 24-HOUR PERIOD PER WEEK, 1987
BVPS

Date		Number of Organisms in all Bays	
Month	Day	Mollusks(c)	Dragonflies
January	2	0	0
	9	0	0
	16	0	0
	23	0	1
	30	0	0
February	6	0	0
	13	0	0
	20	0	0
	27	0	0
March	6	0	0
	13	0	0
	20	0	0
	27	0	0
April	3	0	0
	10	1	0
	17	0	1
	24	2	1
May	1	5	4
	8	2	1
	15	1	0
	22	7	2
	29	10	6
June	5	15	7
	12	9	4
	19	9	3
	26	11	9
July	3	3	17
	10	15	15
	17	15	7
	24	22	2
	31	1	4

TABLE V-G-8
(Continued)

Date		Number of Organisms in all Bays	
Month	Day	Mollusks[c]	Dragonflies
August	7	2	6
	14	1	5
	21	2	2
	28	4	2
September	4	4	4
	11	12	7
	18	9	2
	25	26	5
October	2	10	4
	9	18	3
	16	3	0
	23	4	0
	30(a)	-	-
November	6(a)	-	-
	13(a)	-	-
	15	2	1
	20	6	0
	27	0	1
December	4	5	2
	11	0	0
	18(b)	-	-
	24	1	0
Total		237	128

(a) Impingement could not be conducted due to diving operations in screenhouse.
(b) Impingement could not be conducted due to outage activities.
(c) Other than <u>Corbicula</u>.

some of the catch. Entrapment occurred when fish were lifted out of the water on the frame plates as the traveling screen rotates. Alternatively, impingement occurred when fish were forced against the screen due to velocities created by the circulating water pumps.

Of the 244 crayfish collected in the 1987 impingement studies, 213 (87.3%) were collected from operating bays and 31 (12.7%) 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 8.4 and 4.8 crayfish for operating and non-operating screens, respectively.

Corbicula collected in the 1987 studies included 1,246 (89.3%) in the operating bays and 150 (10.7%) 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 48.9 and 23.4 Corbicula for operating and non-operating screens, respectively.

Summary and Conclusions

The results of the 1987 impingement surveys indicate that withdrawal of river water at the BVPS intake for cooling purposes has little or no effect on the fish populations. Three hundred and forty-five (345) fishes were collected, which is the fourth highest collected since initial operation of BVPS in 1976. Gizzard shad were the most numerous fish, comprising 82.6% of the total annual catch. The total weight of all fishes collected in 1987 was 7.27 kg (16.0 lbs). Of the 345 fishes collected, 18 (5.2%) 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 (DLCo 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. A night collection was 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 184 eggs, 1,511 larvae, 8 juveniles, and 6 adults representing seventeen taxa and eight familes were collected from 4192.8 m^3 of water filtered during sampling along the river entrainment transects (Table V-H-1). Shiners, freshwater drum, gizzard shad, and carp were the most common taxa, representing 55.4%, 13.5%, 11.5%, and 10.4% of the total

TABLE V-H-1

NUMBER AND DENSITY OF FISH EGGS, LARVAE, JUVENILES, AND ADULTS
(Number/100 m^3) COLLECTED WITH A 0.5 m PLANKTON NET
AT THE ENTRAINMENT RIVER TRANSECT IN THE OHIO RIVER NEAR BVPS, 1987

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	
21 April											
Vol. water filtered (m^3)	83.0		121.4		172.1		127.9		111.6		616.0
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	0		0		0		0		0		0
Density (number collected)											
Eggs	0		0		0		0		0		0
Larvae	0		0		0		0		0		0
Total Station Density (number collected)	0		0		0		0		0		0
19/20 May											
Vol. water filtered (m^3)	92.6	81.7	125.2	104.0	122.4	115.7	143.5	153.5	109.1	111.5	1,159.2
Number eggs collected	0	8	1	6	7	14	1	17	3	6	63
Number larvae collected	10	44	31	7	34	32	30	16	3	129	336
Number juveniles collected	0	0	0	0	0	0	0	0	0	0	0
Number adults collected	0	0	0	0	0	0	0	3	0	0	3
Density (number collected)											
Eggs											
Cyprinus carpio	0	0	0.80(1)	0	0	0	0	1.30(2)	0	0	0.26(3)
Aplodinotus grunniens	0	8.57(7)	0	4.81(5)	5.72(7)	6.91(8)	0.70(1)	2.61(4)	0	4.48(5)	3.19(37)
Unidentified	0	1.22(1)	0	0.96(1)	0	5.19(6)	0	7.17(11)	2.75(3)	0.90(1)	1.98(23)
Larvae											
Dorosoma cepedianum (YL)[a]	4.32(4)	6.12(5)	15.18(19)	0.96(1)	24.50(30)	8.64(10)	8.36(12)	1.30(2)	0	8.07(9)	7.94(92)
Cyprinus carpio (YL)	0	1.22(1)	0.80(1)	2.88(3)	0.82(1)	5.19(6)	6.97(10)	5.21(8)	0	10.76(12)	3.62(42)
Cyprinus carpio (EL)	1.08(1)	24.48(20)	7.19(9)	0	0	10.37(12)	3.48(5)	0	0	56.50(63)	9.49(110)
Notemigonus crysoleucas (EL)	0	0	0	0.96(1)	0.82(1)	0	0	0.65(1)	0	1.79(2)	0.43(5)
Notropis spp. (YL)	0	0	0	0	0	1.73(2)	0	1.30(2)	0	2.69(3)	0.60(7)
Notropis spp. (EL)	0	3.67(3)	0.80(1)	0	0	0	0	0	0	8.97(10)	1.21(14)
Catostomidae (YL)	0	0	0	0	0	0	0	0	0	0.90(1)	0.09(1)
Morone chrysops (YL)	0	0	0	0	0	0	0	0	0	0.90(1)	0.09(1)
Morone chrysops (EL)	3.24(3)	6.12(5)	0	0.96(1)	0	0	0	0	0.92(1)	17.04(19)	2.50(29)
Pomoxis spp. (EL)	0	0	0	0	0	0	0.70(1)	0	0	3.59(4)	0.43(5)
Percidae (YL)	0	0	0	0	0	0	0	1.95(3)	0	3.59(4)	0.60(7)
Percidae (EL)	0	0	0	0	0	0	0	0	0	0.90(1)	0.09(1)
Etheostoma spp. (YL)	0	0	0	0	0	0	0.70(1)	0	0.92(1)	0	0.17(2)
Etheostoma spp. (EL)	1.08(1)	0	0	0	1.63(2)	0	0	0	0.92(1)	0	0.34(4)
Perca flavescens (EL)	0	12.24(10)	0	0	0	1.73(2)	0	0	0	0	1.04(12)
Stizostedion spp. (YL)	0	0	0.80(1)	0	0	0	0	0	0	0	0.09(1)
Aplodinotus grunniens (YL)	0	0	0	0.96(1)	0	0	0.70(1)	0	0	0	0.17(2)
Unidentifiable (*L)	1.08(1)	0	0	0	0	0	0	0	0	0	0.09(1)

TABLE V-H-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
Adults											
Notropis atherinoides	0	0	0	0	0	0	0	0.65(1)	0	0	0.09(1)
Notropis stramineus	0	0	0	0	0	0	0	0.65(1)	0	0	0.09(1)
Etheostoma nigrum	0	0	0	0	0	0	0	0.65(1)	0	0	0.09(1)
Total Station Density (number collected)	10.80 (10)	63.65 (52)	25.56 (32)	12.50 (13)	33.50 (41)	39.76 (46)	21.60 (31)	23.45 (36)	5.50 (6)	121.08 (135)	34.68 (402)
19 June											
Vol. water filtered (m^3)	87.9		84.3		112.4		126.0		102.8		513.4
Number eggs collected	4		0		0		1		1		6
Number larvae collected	73		27		69		31		80		280
Number juveniles collected	0		0		0		0		0		0
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs											
Aplodinotus grunniens	3.41(3)		0		0		0.79(1)		0.97(1)		0.97(5)
Unidentified	1.14(1)		0		0		0		0		0.19(1)
Larvae											
Dorosoma cepedianum (EL)	15.93(14)		1.19(1)		40.92(46)		0		14.59(15)		14.80(76)
Cyprinus carpio (YL)	0		0		0		1.59(2)		0		0.39(2)
Cyprinus carpio (EL)	0		2.37(2)		0		7.14(9)		0		2.14(11)
Notropis spp. (EL)	67.12(59)		10.68(9)		20.46(23)		2.38(3)		63.23(65)		30.97(159)
Etheostoma spp. (LL)	0		0		0		0.79(1)		0		0.19(1)
Aplodinotus grunniens (YL)	0		13.05(11)		0		6.35(8)		0		3.70(19)
Aplodinotus grunniens (EL)	0		4.74(4)		0		6.35(8)		0		2.34(12)
Total Station Density (number collected)	87.60(77)		32.03(27)		61.39(69)		25.40(32)		78.79(81)		55.71(286)
14/15 July											
Vol water filtered (m^3)	110.0	96.2	156.6	94.4	133.1	163.8	150.6	143.1	120.3	114.5	1,282.6
Number eggs collected	2	12	4	19	2	40	0	32	0	4	115
Number larvae collected	167	58	55	5	19	12	39	19	428	32	834
Number juveniles collected	0	0	0	1	0	1	0	1	0	0	3
Number adults collected	0	3	0	0	0	0	0	0	0	0	3
Density (number collected)											
Eggs											
Aplodinotus grunniens	1.82(2)	12.47(12)	0.64(1)	13.77(13)	1.50(2)	23.81(39)	0	19.57(28)	0	3.49(4)	7.87(101)
Unidentified	0	0	1.92(3)	6.36(6)	0	0.61(1)	0	2.80(4)	0	0	1.09(14)
Larvae											
Dorosoma cepedianum (EL)	0.91(1)	1.04(1)	0	0	0.75(1)	0	0	0.70(1)	11.64(14)	0	1.40(18)
Cyprinus carpio (EL)	0	1.04(1)	0.64(1)	0	0	0.61(1)	0	0	0	4.37(5)	0.62(8)
Notropis spp. (YL)	0	0	8.30(13)	0	0	0	4.65(7)	4.89(7)	0	0	2.11(27)

TABLE V-H-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
Notropis s, . (EL)	150.91 (166)	54.05 (52)	5.11 (8)	1.06 (1)	12.02 (16)	3.66 (6)	3.98 (6)	0	339.15 (408)	20.96 (24)	53.56 (687)
Pimephales spp. (EL)	0	0	0	0	0	1.22(2)	0	0	0	0	0.16(2)
Lepomis spp. (EL)	0	0	0	0	0	0	0	0	1.66(2)	0	0.16(2)
Pomoxis spp. (EL)	0	1.04(1)	0	2.12(2)	0.75(1)	1.22(2)	0	0	0	1.75(2)	0.62(8)
Etheostoma spp. (EL)	0	1.04(1)	0	0	0	0	0	0	0	0	0.08(1)
Aplodinotus grunniens (YL)	0	1.04(1)	16.60(26)	2.12(2)	0.75(1)	0	9.96(15)	4.89(7)	0	0.87(1)	4.13(53)
Unidentifiable (*L)	0	1.04(1)	4.47(7)	0	0	0.61(1)	7.30(11)	2.80(4)	3.32(4)	0	2.18(28)
Juveniles											
Dorosoma cepedianum (JJ)	0	0	0	1.06(1)	0	0	0	0	0	0	0.08(1)
Moxostoma spp. (JJ)	0	0	0	0	0	0	0	0.70(1)	0	0	0.08(1)
Lepomis spp. (JJ)	0	0	0	0	0	0.61(1)	0	0	0	0	0.08(1)
Adult											
Notropis atherinoides	0	3.12(3)	0	0	0	0	0	0	0	0	0.23(3)
Total Station Density (number collected)	153.64 (169)	75.88 (73)	37.68 (59)	26.48 (25)	15.78 (21)	32.36 (53)	25.90 (39)	36.34 (52)	355.78 (428)	31.44 (36)	74.46 (955)
10 August											
Vol. water filtered (m^3)	133.7		148.6		146.8		87.3		105.2		621.6
Number eggs collected	0		0		0		0		0		0
Number larvae collected	37		1		9		4		10		61
Number juveniles collected	3		0		0		2		0		5
Number adults collected	0		0		0		0		0		0
Density (number collected)											
Eggs	0		0		0		0		0		0
Larvae											
Dorosoma cepedianum (EL)	5.98(8)		0		0.68(1)		0		0.95(1)		1.61(10)
Cyprinus carpio (EL)	0.75(1)		0		0		1.15(1)		0		0.32(2)
Notropis spp. (EL)	19.45(26)		0		4.77(7)		2.29(2)		8.56(9)		7.08(44)
Pomoxis spp. (EL)	0.75(1)		0		0.68(1)		0		0		0.32(2)
Aplodinotus grunniens (EL)	0		0		0		1.15(1)		0		0.16(1)
Aplodinotus grunniens (LL)	0		0.67(1)		0		0		0		0.16(1)
Unidentifiable (*L)	0.75(1)		0		0		0		0		0.16(1)
Juveniles											
Notropis atherinoides (JJ)	2.24(3)		0		0		0		0		0.48(3)
Ictalurus punctatus (JJ)	0		0		0		2.29(2)		0		0.32(2)
Total Station Density (number collected)	29.92(40)		0.67(1)		6.13(9)		6.87(6)		9.51(10)		10.62(66)

TABLE V-H-1
(Continued)

Date	Station 1		Station 2		Station 3		Station 4		Station 5		Total Collected and Taxa Density
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	
Yearly Total											
Vol. water filtered (m^3)	507.2	177.9	636.1	198.4	686.8	279.5	635.3	296.6	549.0	226.0	4,192.8
Number eggs collected	6	20	5	25	9	54	2	49	4	10	184
Number larvae collected	287	102	114	12	131	44	104	35	521	161	1,511
Number juveniles collected	3	0	0	1	0	1	2	1	0	0	8
Number adults collected	0	3	0	0	0	0	0	3	0	0	6
Density (number collected)											
Eggs											
Cyprinus carpio	0	0	0.16(1)	0	0	0	0	0.67(2)	0	0	0.07(3)
Aplodinotus grunniens	0.99(5)	10.68(19)	0.16(1)	9.07(18)	1.31(9)	16.82(47)	0.32(2)	10.79(32)	0.18(1)	3.98(9)	3.41(143)
Unidentified	0.20(1)	0.56(1)	0.47(3)	3.53(7)	0	2.50(7)	0	5.06(15)	0.55(3)	0.44(1)	0.91(38)
Larvae											
Dorosoma cepedianum (YL)	0.79(4)	2.81(5)	2.99(19)	0.50(1)	4.37(30)	3.58(10)	1.89(12)	0.67(2)	0	3.98(9)	2.19(92)
Dorosoma cepedianum (EL)	4.53(23)	0.56(1)	0.16(1)	0	6.99(48)	0	0	0.34(1)	5.46(30)	0	2.48(104)
Cyprinus carpio (YL)	0	0.56(1)	0.16(1)	1.51(3)	0.15(1)	2.15(6)	1.89(12)	2.70(8)	0	5.31(12)	1.05(44)
Cyprinus carpio (EL)	0.39(2)	11.80(21)	1.89(12)	0	0	4.65(13)	2.36(15)	0	0	30.09(68)	3.12(131)
Notemigonus crysoleucas (EL)	0	0		0.50(1)	0.15(1)	0	0	0.34(1)	0	0.88(2)	0.12(5)
Notropis spp. (YL)	0	0	2.04(13)	0	0	0.72(2)	1.10(7)	3.03(9)	0	1.33(3)	0.81(34)
Notropis spp. (EL)	49.49(251)	30.92(55)	2.83(18)	0.50(1)	6.70(46)	2.15(6)	1.73(11)	0	87.80(482)	15.04(34)	21.56(904)
Pimephales spp. (EL)	0	0	0	0	0	0.72(2)	0	0	0	0	0.05(2)
Catostomidae (YL)	0	0	0	0	0	0	0	0	0	0.44(1)	0.02(1)
Morone chrysops (YL)	0	0	0	0	0	0	0	0	0	0.44(1)	0.02(1)
Morone chrysops (EL)	0.59(3)	2.81(5)	0	0.50(1)	0	0	0	0	0.18(1)	8.41(19)	0.69(29)
Lepomis spp. (EL)	0	0	0	0	0	0	0	0	0.36(2)	0	0.05(2)
Pomoxis spp. (EL)	0.20(1)	0.56(1)	0	1.01(2)	0.29(2)	0.72(2)	0.16(1)	0	0	2.65(6)	0.36(15)
Percidae (YL)	0	0	0	0	0	0	0	1.01(3)	0	1.77(4)	0.17(7)
Percidae (EL)	0	0	0	0	0	0	0	0	0	0.44(1)	0.02(1)
Etheostoma (YL)	0	0	0	0	0	0	0.16(1)	0	0.18(1)	0	0.05(2)
Etheostoma (EL)	0.20(1)	0.56(1)	0	0	0.29(2)	0	0	0	0.18(1)	0	0.12(5)
Etheostoma (LL)	0	0	0	0	0	0	0.16(1)	0	0	0	0.02(1)
Perca flavescens (EL)	0	5.62(10)	0	0	0	0.72(2)	0	0	0	0	0.29(12)
Stizostedion spp. (YL)	0	0	0.16(1)	0	0	0	0	0	0	0	0.02(1)
Aplodinotus grunniens (YL)	0	0.56(1)	5.82(37)	1.51(3)	0.15(1)	0	3.78(24)	2.36(7)	0	0.44(1)	1.76(74)
Aplodinotus grunniens (EL)	0	0	0.63(4)	0	0	0	1.42(9)	0	0	0	0.31(13)
Aplodinotus grunniens (LL)	0	0	0.16(1)	0	0	0	0	0	0	0	0.02(1)
Unidentifiable (*L)	0.39(2)	0.56(1)	1.10(7)	0	0	0.36(1)	1.73(11)	1.35(4)	0.73(4)	0	0.72(30)

TABLE V-H-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
Juveniles											
Dorsoma cepedianum (JJ)	0	0	0	0.50(1)	0	0	0	0	0	0	0.02(1)
Notropis atherinoides (JJ)	0.59(3)	0	0	0	0	0	0	0	0	0	0.07(3)
Ictalurus punctatus (JJ)	0	0	0	0	0	0	0.32(2)	0	0	0	0.05(2)
Moxostoma spp. (JJ)	0	0	0	0	0	0	0	0.34(1)	0	0	0.02(1)
Lepomis spp. (JJ)	0	0	0	0	0	0.36(1)	0	0	0	0	0.02(1)
Adults											
Notropis atherinoides	0	1.69(3)	0	0	0	0	0	0.34(1)	0	0	0.10(4)
Notropis stramineus	0	0	0	0	0	0	0	0.34(1)	0	0	0.02(1)
Etheostoma nigrum	0	0	0	0	0	0	0	0.34(1)	0	0	0.02(1)
Total Station Density (number collected)	58.36 (296)	70.26 (125)	18.71 (119)	19.15 (38)	19.80 (140)	35.42 (99)	17.00 (108)	29.67 (88)	95.63 (525)	75.66 (171)	40.76 (1709)

[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 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.

catch. Shiners comprised 62.1% of the larvae, and 37.5% of juveniles collected. Gizzard shad comprised 13.0% of the larvae. Eggs (184) made up 10.8% of the total ichthyoplankton catch. Freshwater drum made up 77.7% of the total egg catch.

Seasonal Distribution

No eggs were collected during the first survey (21 April) and the last survey (10 August) (Table V-H-1). The two night collections (20 May and 15 July) resulted in a sample density average of 49.79/100 m^3 and 39.05/100 m^3. The 19 June collection yielded a sample density average of 55.71/100 m^3 of which shiners and gizzard shad larvae made up 55.6% and 26.6% of the catch, respectively. The 10 August (day) collection showed a decreased sample density average of 10.62/100 m^3 (Table V-H-1).

Greatest density (355.79/100 m^3) was obtained on 14 July (day) at station (5). This was due to a large catch of shiners (Notropis spp. larvae) (Table V-H-1).

Spatial Distribution

Larvae were dominant at all stations; however, highest densities were at Stations 1 and 5. Most of the larvae collected at Stations 1 and 5 were shiners. Stations 1, 2, 3, 4, and 5 yielded 389, 126, 175, 139 and 682 larvae respectively.

Summary and Conclusions

The similarity of species composition and relative abundance of ichthyoplankton taken in 1987 along the river transect to those of 1979-1986, combined with the close correlation between river sampling in front of the intake and actual entrainment sampling established in previous years (DLCo 1976, 1977, 1978 and 1979) suggests little change in ichthyoplankton entrainment impact by BVPS in 1987.

2. Phytoplankton

Objectives

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

Methods

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

In the laboratory, phytoplankton analyses were performed in accordance with procedures described above 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 sampling program, therefore, comparison of entrainment and river samples was not possible for the 1987 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 (DLCo 1980). However, the species composition of phytoplankton in the river and in the entrainment samples were similar (DLCo 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 (DLCo 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 (5,000 cfs), about 4.1% 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 zooplankters were counted. For the zooplankton analyses, a well-mixed sample was taken and processed using the same procedures described in Section D, ZOOPLANKTON. After April 1, 1980, plankton sampling was reduced to one entrainment sample collected monthly. Each sample was 1 gal taken from below the skimmer wall from one operating intake bay.

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

Comparison of Entrainment and River Samples

Plankton samples were not collected at any river stations after April 1, 1980 due to a reduction of the aquatic sampling program, therefore, comparison of entrainment and river samples was not possible for the 1987 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 (DLCo 1980). Protozoans and rotifers were predominant, whereas crustaceans were sparse. Densities of the four most abundant taxa for each month (DLCo, 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 (5,000 cfs), about 4.1% 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 body. 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 may pass easily through the water passages of a power plant. Once the veliger settles and attaches itself to the substrate, growth of the clam occurs very quickly. 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).

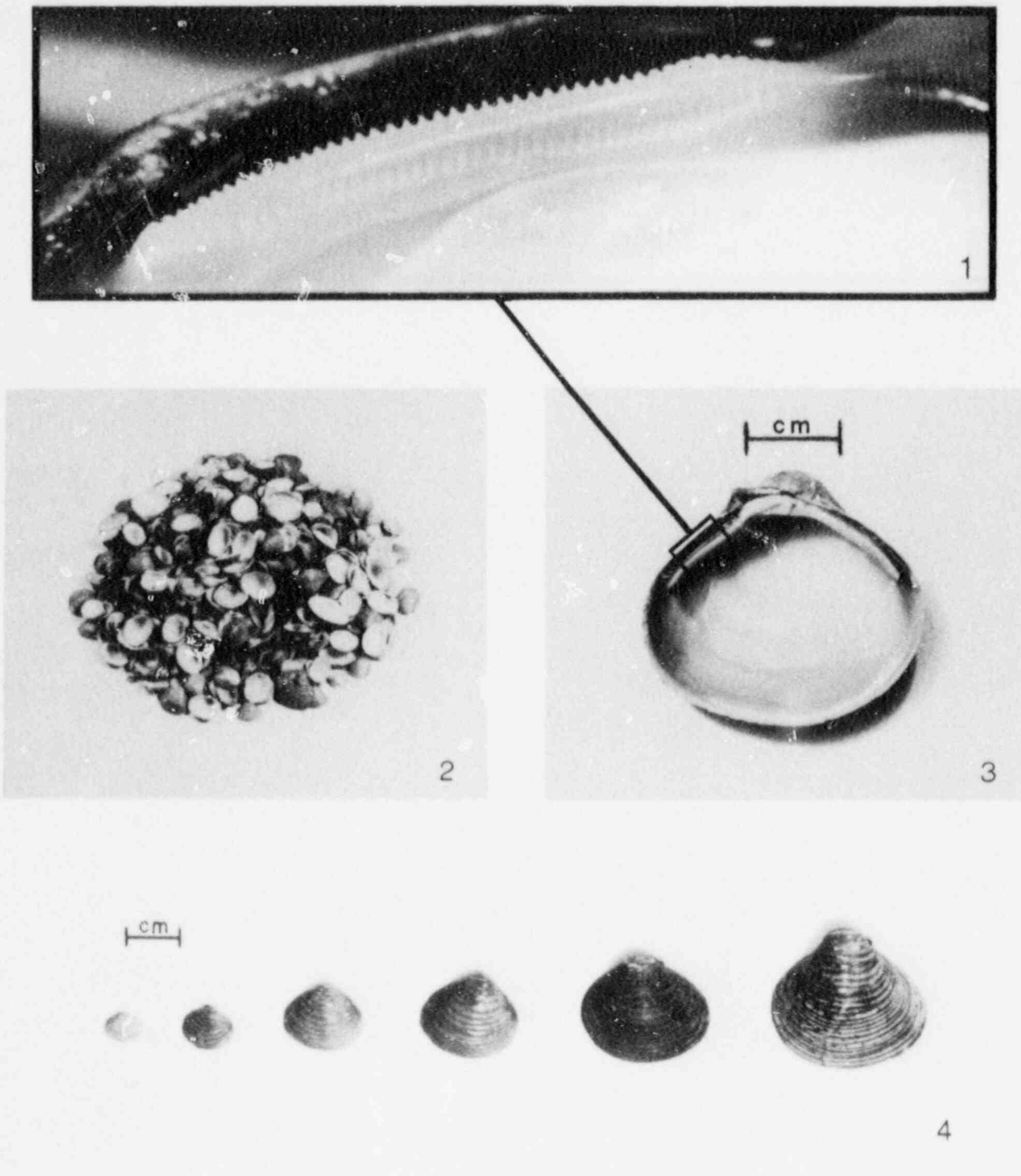
These clams are extremely hardy; they can live out of water for more than a week. Poisons and other water-borne control methods have generally proved to be inadequate because the clams can survive prolonged periods closed in their shells.

The Corbicula Monitoring Program includes the Ohio River and the circulating cooling water system of the BVPS (intake structure and cooling tower). This report describes this Monitoring Program and the results obtained during field and plant surveys conducted through 1987.

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



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

Corbicula in the Ohio River in order to evaluate the potential for infestation of the BVPS.

Methods

(Unit 1 Cooling Tower)

Collections were made (29 April and 15 December) in the upper and lower reservoirs of Unit 1 cooling tower during shutdown periods. Samples were collected using a (6x6") petite Ponar dredge. Samples were taken at the east side in the upper reservoir. The lower reservoir was sampled at seventeen (17) stations within the cooling tower using a 14' boat (29 April) and walked after draining on 15 December (Figure V-I-2).

(Unit 2 Cooling Tower)

Collections were made (5 June) in the reservoir of Unit 2 cooling tower prior to the initial fueling and startup of Unit 2. Samples were collected using a (6 x 6") petite ponar dredge. The lower reservoir was sampled at twenty-two (22) stations within the cooling tower using a 14' boat.

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 October and November 1987 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

(TWO DIMENSIONAL: CROSS SECTIONAL HORIZONAL VIEW)

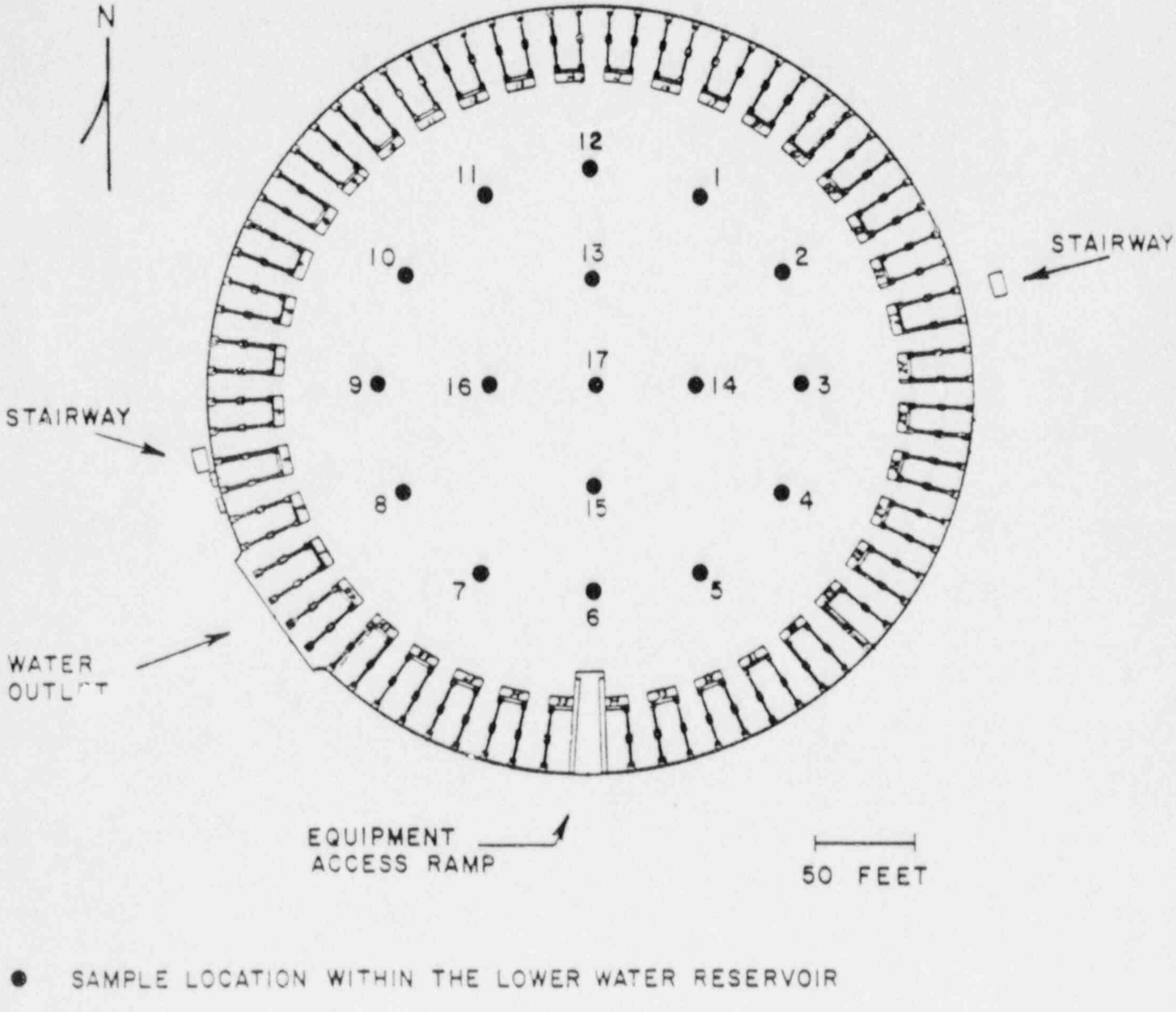


FIGURE V-I-2

Corbicula MONITORING PROGRAM SAMPLING STATIONS OF THE LOWER RESERVOIR OF UNIT I COOLING TOWER BVPS 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. Survey of the auxiliary intake was also made.

(River)
Field collections were generally made during the same week as in-plant collections. Samples were collected using either a regular Ponar (9x9") or a petite Ponar (6x6") 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-3).

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-3). In May and September samples were collected which included a single left shore, right shore, and mid-channel station. The collection and laboratory methods were identical to those used for samples from the plant.

Results
(Unit 1 Cooling Tower)
Results of the April and December Corbicula surveys of Unit 1 cooling tower are presented in Table V-I-1A and V-I-1B respectively. 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 clams inhabiting this area was 20

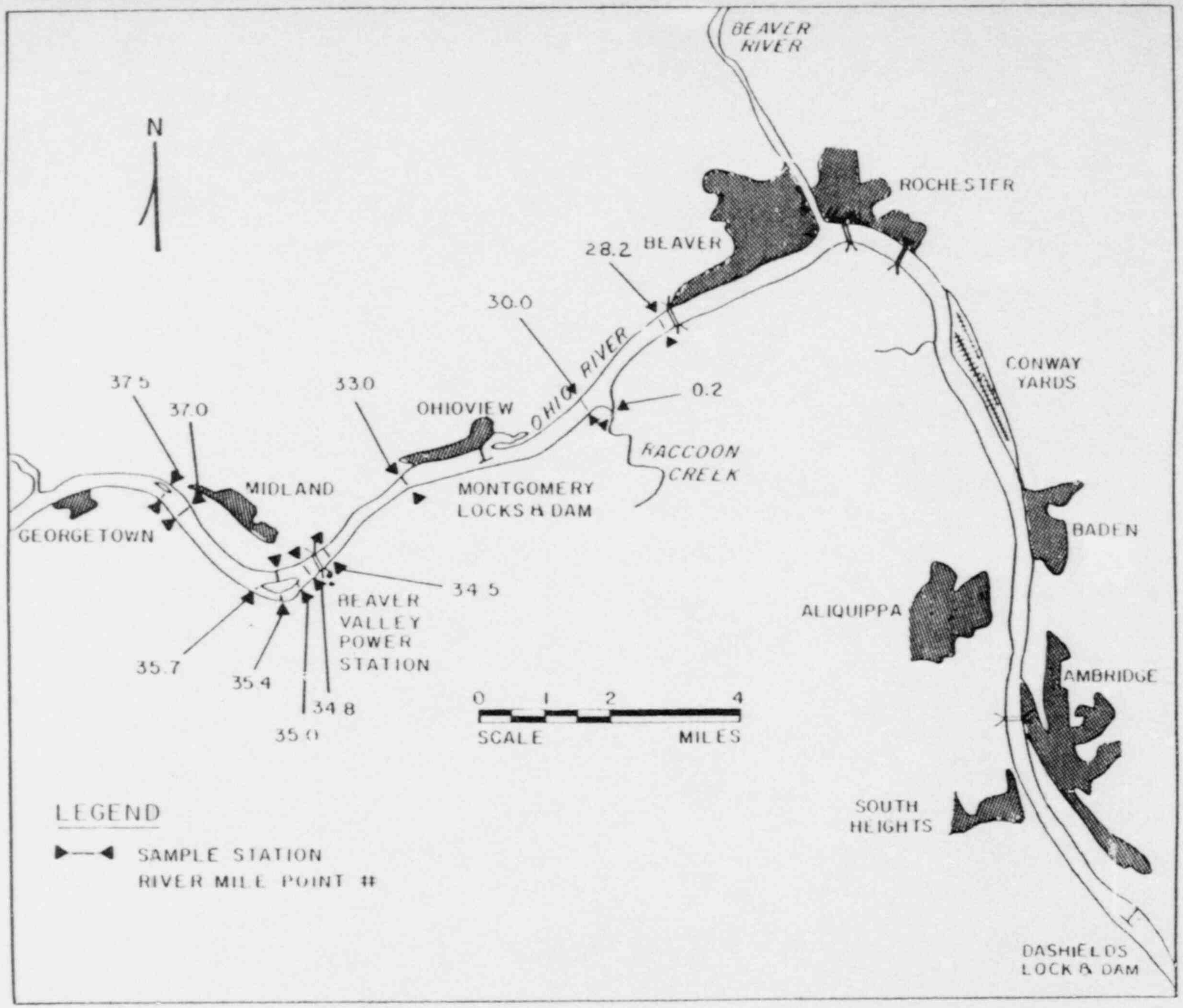


FIGURE V-I-3

Corbicula MONITORING PROGRAM SAMPLING STATIONS,
OHIO RIVER SYSTEM
BVPS

DUQUESNE LIGHT COMPANY
1987 ANNUAL ENVIRONMENTAL REPORT

TABLE V-I-1A

Corbicula COLLECTED IN UNIT 1 COOLING TOWER
APRIL 29, 1987
BVPS

Sample Location	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Upper Reservoir				
Northeast	sil	0	26	0
East A	sil	0	238	0
East B	sil	0	157	0
Southeast	sil	0	11	0
Lower Reservoir				
1	sil	1	1	43
2	sil	22	2	947
3	sil	0	0	0
4	sil	100	4	4,306
5	sil	39	4	1,679
6	sil	0	0	0
7	sil	0	0	0
8	sil	11	4	474
9	sil	0	0	0
10	sil	79	2	3,401
11	sil	89	2	3,832
12	sil	198	4	8,525
13	sil	0	0	0
14	sil	10	0	431
15	sil	57	5	2,454
16	sil	0	0	0
17	sil	0	0	0

Substrate Codes:

sil - silt

DUQUESNE LIGHT COMPANY
1987 ANNUAL ENVIRONMENTAL REPORT

V-I-1B

Corbicula COLLECTED IN UNIT 1 COOLING TOWER
DECEMBER 15, 1987
BVPS

Sample Location	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Upper Reservoir				
Qualitative Sample (East)	sil	0	214	0
Lower Reservoir				
1	sil	339	10	14,596
2	sil	353	16	15,199
3	sil	310	3	13,347
4	sil	288	1	12,400
5	sil	443	5	19,074
6	sil	809	15	34,832
7	sil	139	7	5,985
8	sil	0	0	0
9	sil	731	23	31,474
10	sil	309	5	13,304
11	sil	326	3	14,036
12	sil	400	2	17,222
13	sil	215	2	9,257
14	sil	231	1	9,946
15	sil	121	2	5,210
16	sil	105	0	4,521
17	sil	215	2	9,257

Substrate Codes:

sil - silt

million (29 April) of which 96% were alive and 178 million (15 December) of which 98% were alive. Sizes ranged from 1.0 to 26.0 mm at the widest portion of the shell.

(Unit 2 Cooling Tower)

Results of the June Corbicula survey of Unit 2 cooling tower are presented in Table V-I-1C. No live Corbicula were collected in the reservoir; however, the presence of shells indicates that they were transported within the circulating water system.

(Intake)

While performing the innerbay cleaning operat on (October and November 1987), the divers observed clams in each of the bays close to the intake pumps. Approximately one 55 gallon drum of clams was removed from each of Bays A and D with a lesser amount from Bays B and C (Hammill 1987). A cut-away diagram of the intake structure is provided in Figure V-I-4. The auxiliary intake also was surveyed and divers reported clams around the intake pumps of Unit 1 and 2 (Hammill 1987).

(River)

The results of the Corbicula survey in the Ohio River are given in Tables V-I-2 (May) and V-I-3 (September). Dead clams were not counted in samples of the regular macroinvertebrate monitoring program.

The clams displayed a preference for sand and gravel dominated substrates. Fewer Corbicula were collected in May as compared to September's collection. The largest density of clams was found in September above Montgomery Lock and Dam, (M.P. 30.0).

Table V-I-4 summarizes Corbicula frequency in past macroinvertebrate collections for the BVPS (1973 through 1987). Peaks in population density are apparent in the years 1976 and 1981; no Corbicula were found during 1973, 1979 and 1980. Corbicula densities increased during fall collections.

Data, from collections of Corbicula during impingement sampling, are presented in Table V-I-5. Peak numbers of Corbicula occured in June

TABLE V-I-1C

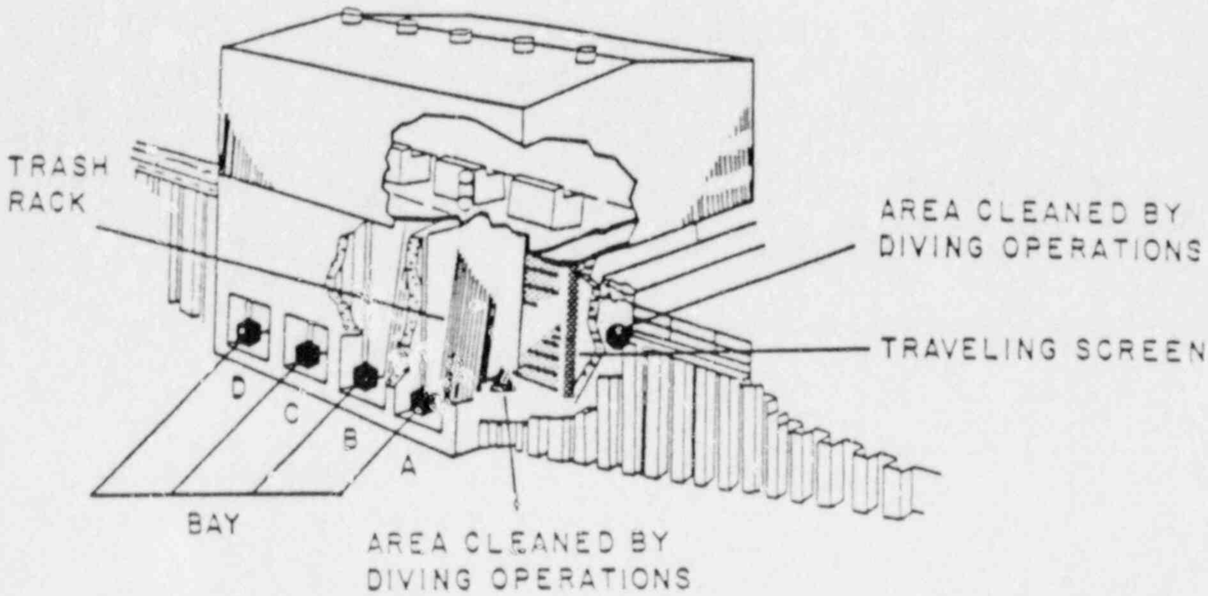
Corbicula COLLECTED IN UNIT 2 COOLING TOWER
JUNE 5, 1987
BVPS

Sample Location	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Lower Reservoir				
1	sil	0	0	0
2	sil	0	0	0
3	sil	0	0	0
4	sil	0	0	0
5	sil	0	0	0
6	sil	0	0	0
7	sil	0	1	0
8	sil	0	0	0
9	sil	0	1	0
10	sil	0	0	0
11	sil	0	0	0
12	sil	0	0	0
13	sil	0	0	0
14	sil	0	0	0
15	sil	0	0	0
16	sil	0	0	0
17	sil	0	1	0
18	sil	0	0	0
19	sil	0	0	0
20	sil	0	0	0
21	sil	0	0	0
22	sil	0	0	0

Substrate Codes:

sil - silt

(THREE DIMENSIONAL: CUTAWAY VIEW)



BAY D

(TWO DIMENSIONAL: SIDE VIEW)

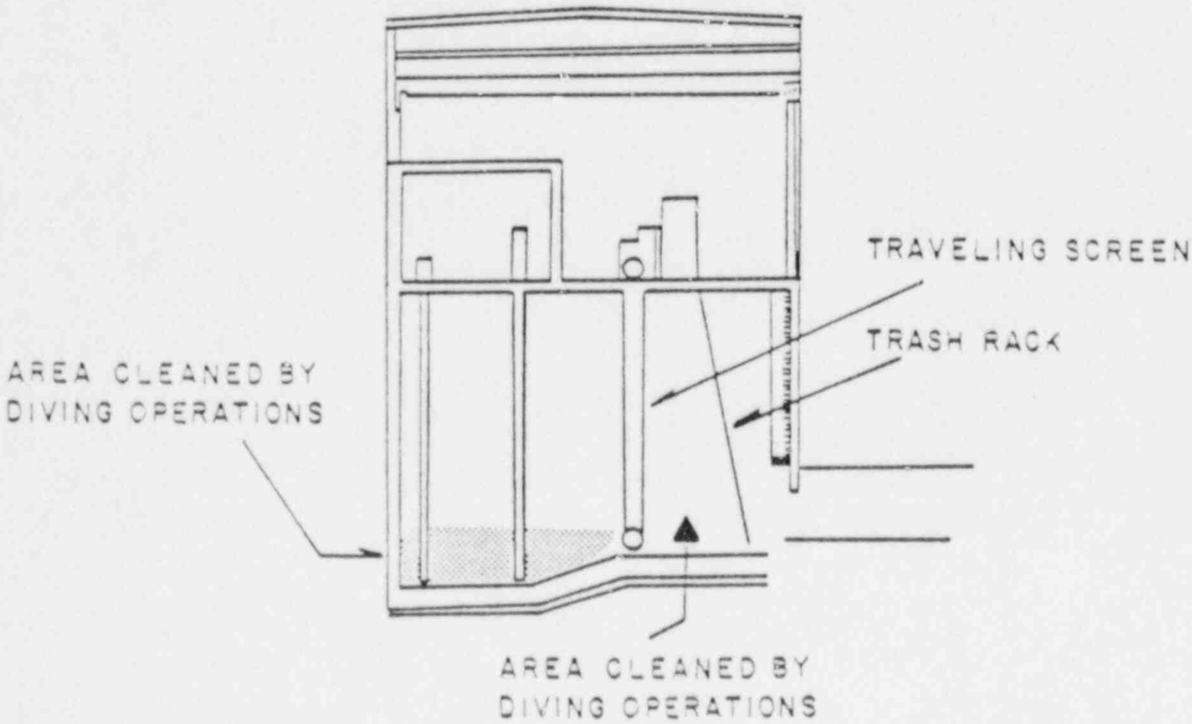


FIGURE V-I-4

Corbicula MONITORING PROGRAM SAMPLING STATIONS
INTAKE STRUCTURE
BVPS

DUQUESNE LIGHT COMPANY
1987 ANNUAL ENVIRONMENTAL REPORT

TABLE V-I-2

Corbicula COLLECTED IN THE OHIO RIVER
MAY 13, 1987
BVPS

Sample Location	River Mile	River Bank	Depth	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Raccoon Creek	0.3	R	4	sil	0	0	0
		M	5	sil/san	0	0	0
		L	2	sil	0	0	0
Ohio River	28.[illegible]	R	2	sil	0	0	0
		[illegible]	33	san/gra	0	1	0
		[illegible]	2	sil	0	1	0
	[illegible]	R	3	sil	0	0	0
		M	30	san	0	0	0
		L	6	sil	0	1	0
	[illegible]	R	2	san/gra	0	0	0
		M	19	san/gra	0	0	0
		L	3	sil	1	2	43
	34.5 (1)	R	3	sil	0	1	0
		M	22	bed	0	0	0
		L	2	sil	0	-	0
		L	2	sil	0	-	0
	34.8	R	4	sil	0	1	0
		M	23	gra	0	0	0
		L	22	sil	0	3	0
(Back Channel)	35.0	R	9	cla/sil	0	0	0
		M	25	sil/san	0	3	0
		L (HD)	2	sil	1	0	43
	35.4 (2A)	R	2	gra	0	0	0
		M	18	san/gra	0	0	0
		L	3	cla/san	0	-	0
		L	3	cla/san	1	-	20
(Back Channel)	35.4 (2B)	R	3	sil	0	-	0
		M	12	san/cob	0	-	0
		L	4	sil	3	-	59
(Back Channel)	35.7	R	2	sil/cob	1	2	43
		M	12	san/gra	0	1	0
		L	3	sil	0	0	0
	37.0 (3)	R (HD)	4	sil	1	2	43
		M	25	gra	1	0	43
		L	2	sil	2	-	39
		L	2	sil	1	-	20
	37.5	R	4	cla/sil/san	0	0	0
		M	23	gra	0	0	0
		L	3	gra	0	1	0
(Back Channel)	37.5	R	8	sil	0	0	0
		M	23	san	0	0	0
		L	2	sil/det/san	0	0	0

Substrate Codes:

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

Footnotes:

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

TABLE V-I-3

Corbicula COLLECTED IN THE
OHIO RIVER SEPTEMBER 16 & 17, 1987
BVPS

Sample Location	River Mile	River Bank	Depth	Substrate	Clams Collected Alive	Clams Collected Dead	Station Density Live Clams/m^2
Raccoon Creek	0.3	R	2	sil	0	0	0
		M	5	sil	0	0	0
		L	1	sil	0	0	0
Ohio River	28.2	R	1	sil	0	1	0
		M	33	sil	0	0	0
		L	1	sil	1	0	43
	30.0	R	1	sil	6	2	258
		M	28	san/gra	0	0	0
		L	5	gra	1	1	43
	33.0	R	1	san	3	4	129
		M	18	bed	0	0	0
		L	1	sil	3	8	129
	34.5 (1)	R	2	san/gra	0	3	0
		M	23	bed	0	0	0
		L	2	sil	2	-	39
		L	2	sil	1	-	20
	34.8	R	1	sil	2	4	86
		M	[illegible]	bed	0	0	0
		L	2	sil	1	4	43
(Back Channel)	35.0	R		sil	4	2	172
		M	24	sil	1	1	43
		L (HD)	1	sil	1	2	43
	35.4 (2A)	R	4	gra	1	1	43
		M	19	gra	5	1	215
		L	2	cla	5	-	99
		L	2	cla	7	-	138
(Back Channel)	35.4 (2B)	R	2	sil	2	-	39
		M	11	gra	4	-	79
		L	2	sil	3	-	59
(Back Channel)	35.7	R	1	sil	2	5	86
		M	12	gra	1	2	43
		L	2	sil/gra	1	3	43
	37.0 (3)	R (HD)	1	sil	0	5	0
		M	19	gra	0	0	0
		L	2	sil	3	-	59
		L	2	sil	7	-	138
	37.5	R	2	san	0	1	0
		M	22	bed	0	0	0
		L	4	gra	0	1	0
(Back Channel)	37.5	R	4	sil	0	1	0
		M	20	sil	2	2	86
		L	1	sil/san	1	3	43

Substrate Codes:

bed - bedrock
cla - clay
cob - cobble
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 DENSITIES (clams/m^2) SUMMARIZED FROM BENTHIC MACROINVERTEBRATE COLLECTIONS 1973 THROUGH 1987 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	-	-

(-) indicates area not sampled

DUQUESNE LIGHT COMPANY
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TABLE V-I-5

SUMMARY OF Corbicula COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1987
BVPS

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
January	2	0	1	0	0
	9	0	0	0	1
	16	0	0	0	0
	23	0	0	0	0
	30	0	0	0	0
February	6	0	0	0	0
	13	0	0	0	0
	20	0	1	0	0
	27	0	1	0	0
March	6	0	1	0	0
	13	0	0	0	1
	20	0	0	1	2
	27	0	1	0	1
April	3	0	0	0	1
	10	0	1	0	0
	17	1	0	0	0
	24	0	0	0	0
May	1	0	2	0	1
	8	0	3	0	1
	15	0	1	0	0
	22	3	11	0	0
	29	3	2	0	0
June	5	25	21	0	0
	12	27	20	0	0
	19	33	33	8	7
	26	53	38	8	5
July	3	13	16	7	5
	10	32	27	0	0
	17	8	12	5	6
	24	7	10	9	1
	31	32	37	0	0

TABLE V-I-5
(Continued)

Date		Number Collected			
		Operating Intake Bays		Non-Operating Intake Bays	
Month	Day	Alive	Dead	Alive	Dead
August	7	45	43	10	15
	14	27	23	0	0
	21	51	36	0	0
	28	45	46	7	21
September	4	48	77	0	0
	11	38	52	0	0
	18	12	52	0	0
	25	26	29	0	0
October	2	10	30	0	3
	9	12	19	0	1
	16	6	2	0	0
	23	2	5	0	0
	30(a)	-	-	-	-
November	7(a)	-	-	-	-
	13(a)	-	-	-	-
	15	5	16	4	16
	20	3	4	0	2
	27	0	4	0	0
December	4	0	0	1	0
	11	0	1	0	0
	18(b)	-	-	-	-
	24	0	1	0	0
TOTAL		567	679	60	90

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

through October; numbers gradually declined through the end of December (Figure V-I-5).

Summary

The results of the 1987 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 makes this area unsuitable for the clams. Corbicula survive in the lower reservoir with an estimated population of 20 million clams (96% alive) on 29 April and 178 million clams (98% alive) on 15 December. No live Corbicula were collected in the reservoir of Unit 2 cooling tower. From the river surveys conducted in May and September 1987, Corbicula inhabit the upper Ohio drainage, providing the opportunity for clams to enter BVPS.

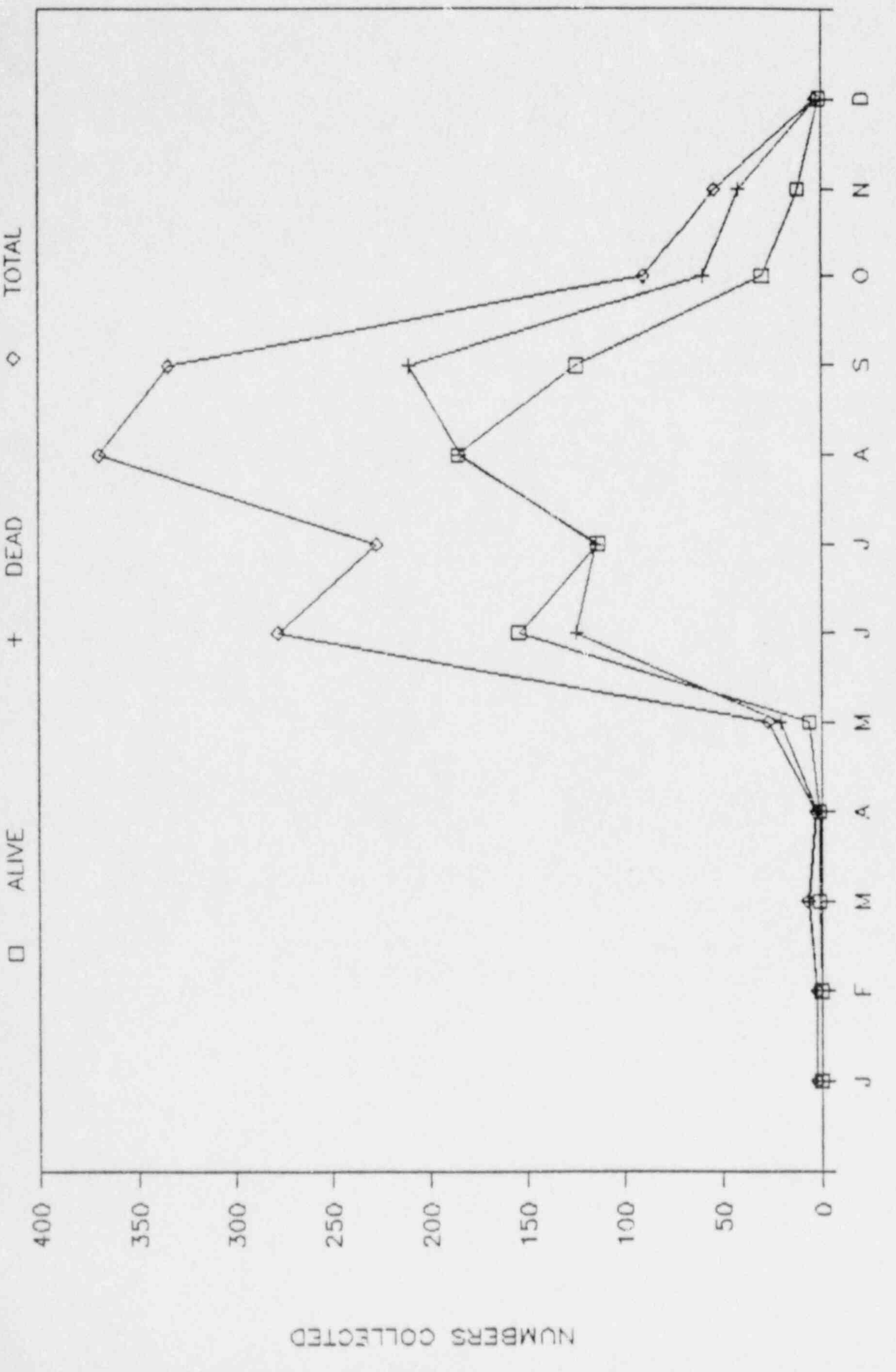


FIGURE V-I-5

SUMMARY OF Corbicula COLLECTED DURING IMPINGEMENT SURVEYS FOR ONE 24-HOUR PERIOD PER WEEK, 1987
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 square foot cages constructed of 1mm mesh fiberglass screening secured over a plastic frame and placed in the study areas. Because organisms generally slow in growth as they age, three size classes were chosen to calculate growth rates. Table V-I-6 lists the range of shell lengths used to determine each size class, locations where cages were placed, and number of clams (density) in each cage. Shell length (maximum anteroposterior dimension) was measured to the nearest 0.05mm with Vernier calipers.

Cages were placed in the Unit 1 cooling tower on July 2, 1987. Clams held in these cages originated from the population residing in the cooling tower. Cages were placed in the intake structure on July 17, 1987. Clams held in these cages had been removed from the cooling tower in early May and maintained in laboratory aquaria prior to their placement in the intake structure. Initial shell length measurements were made before each cage was placed in its respective location. Thirty clams were randomly selected from each size class, measured to the nearest 0.05 mm with Vernier calipers, and placed back into their respective cages.

Field measurements began on July 31, 1987 at the intake structure and Unit 1 cooling tower. Sampling procedures were the same as those used in the initial sampling; thirty clams were randomly selected, shell length was measured and recorded, and all individuals were returned to their original cages. An effort was made to keep each clam out of water for as little time as possible. Sampling continued every 28 days until mid-December when Unit 1 was taken off-line for refueling.

TABLE V-I-6

RANGES OF *Corbicula* SHELL LENGTHS MEASURED
FOR GROWTH STUDY, 1987
BVPS

Size Class	Location	Length Range (mm)	Density (n)
C-A	Unit 1 Cooling Tower	7.00-9.95	100
C-B	Unit 1 Cooling Tower	14.00-16.95	100
C-C	Unit 1 Cooling Tower	21.00-23.95	100
I-A	Intake Structure	7.00-9.95	83
I-B	Intake Structure	14.00-16.95	100
I-C	Intake Structure	21.00-23.95	100

Results

Table V-I-7 and Figures V-I-6 and V-I-7 summarize the growth data collected from the intake structure and Unit 1 cooling tower. The greatest average increase in shell length occurred among clams in size class A. Those maintained in the intake structure increased an average 8.9 mm during the study while those in the cooling tower had an average increase of 11.0 mm in shell length. Size class C had the smallest average increase, 3.6 mm in the intake structue and 2.9 mm in the cooling tower. Size class B increased an average 5.8 mm in the intake structure and 6.9 mm in the cooling tower.

Summary

The results obtained show that growth of Corbicula was more rapid in the cooling tower than in the intake structure, especially for the small clam group (size class A). The higher year round temperatures within the cooling tower system probably sustained growth rates longer than in the river. This may also be a result of increased nutrients present in the cooling tower due to the evaporation of water in the cooling tower heat loss process concentrating river water nutrients.

In general, for both the intake structure and cooling tower waters, clams of all sizes increased most rapidly during the first two months of analysis from July to September 1987 and tended to level off in growth thereafter.

TABLE V-I-7

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

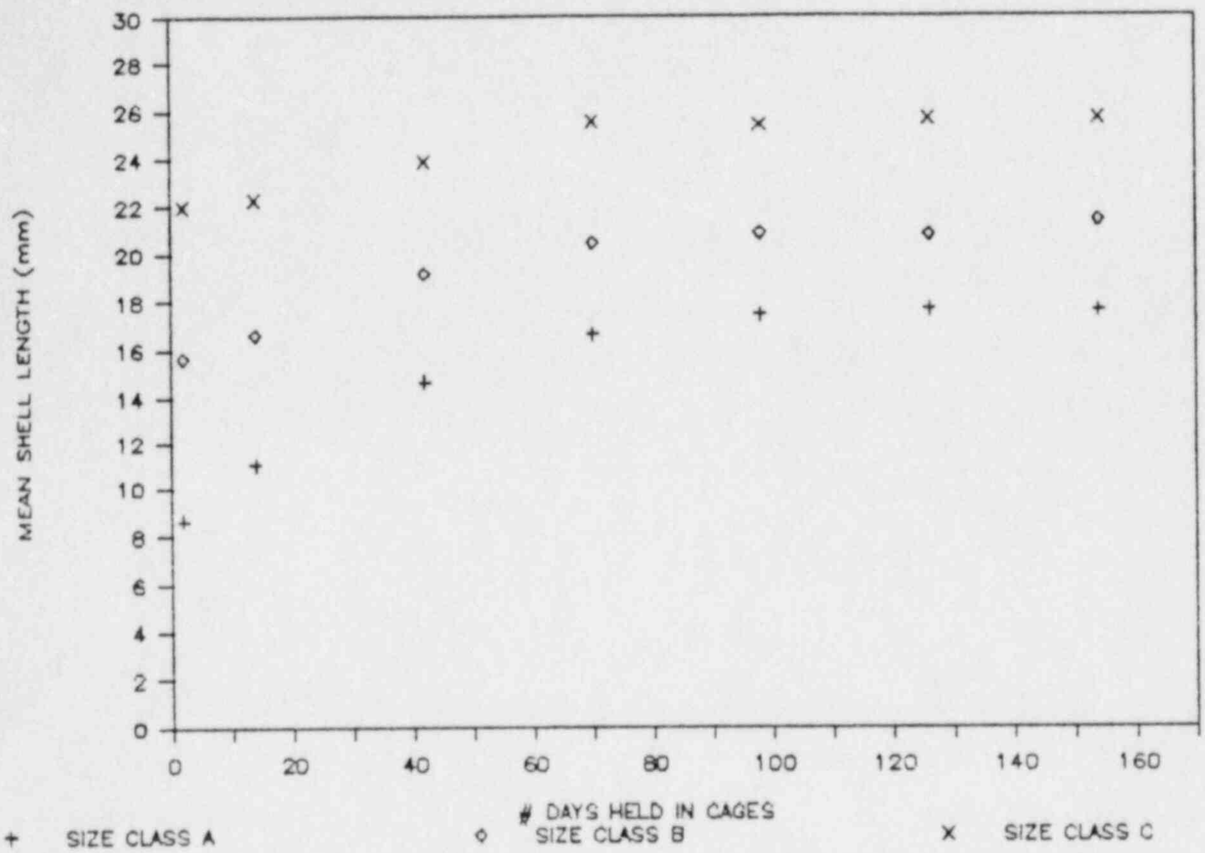
INTAKE STRUCTURE

Sampling Date	Size Class A $\bar{y}$	Size Class A s	Size Class A n	Size Class B $\bar{y}$	Size Class B s	Size Class B n	Size Class C $\bar{y}$	Size Class C s	Size Class C n
Jul 17	8.657	0.761660	30	15.633	0.928322	30	22.013	0.672993	30
Jul 31	10.966	0.806901	29	16.610	0.847756	30	22.307	0.556735	30
Aug 28	14.641	0.627466	28	19.168	0.850809	30	23.847	0.614892	30
Sep 25	16.626	0.769812	29	20.470	0.974202	30	25.497	0.737065	30
Oct 23	17.405	0.758451	28	20.857	0.983286	30	25.377	0.632010	30
Nov 20	17.650	0.763641	28	20.817	0.817938	30	25.625	0.634735	30
Dec 18	17.593	0.773873	29	21.387	0.809740	30	25.615	0.546801	30

UNIT 1 COOLING TOWER

Sampling Date	Size Class A $\bar{y}$	Size Class A s	Size Class A n	Size Class B $\bar{y}$	Size Class B s	Size Class B n	Size Class C $\bar{y}$	Size Class C s	Size Class C n
Jul 02	8.972	0.608940	30	15.280	0.899578	30	22.428	0.798456	30
Jul 31	13.652	0.416157	30	18.437	0.758735	30	23.472	0.647766	30
Aug 28	16.797	0.728713	30	19.883	0.668933	30	24.337	0.892008	30
Sep 25	17.435	2.014737	30	20.890	0.793660	30	24.813	0.668237	30
Oct 23	18.812	0.777006	30	21.175	0.590551	30	24.810	0.970283	30
Nov 20	19.675	0.745301	30	21.752	0.684620	30	25.202	0.611172	30
Dec 15	19.993	0.539114	30	22.178	0.553466	30	25.368	0.531342	30

MEAN SHELL LENGTH IN MILLIMETERS ($\bar{y}$), STANDARD DEVIATIONS (s), AND SAMPLE SIZE (n) CALCULATED FOR EACH SAMPLING DATE



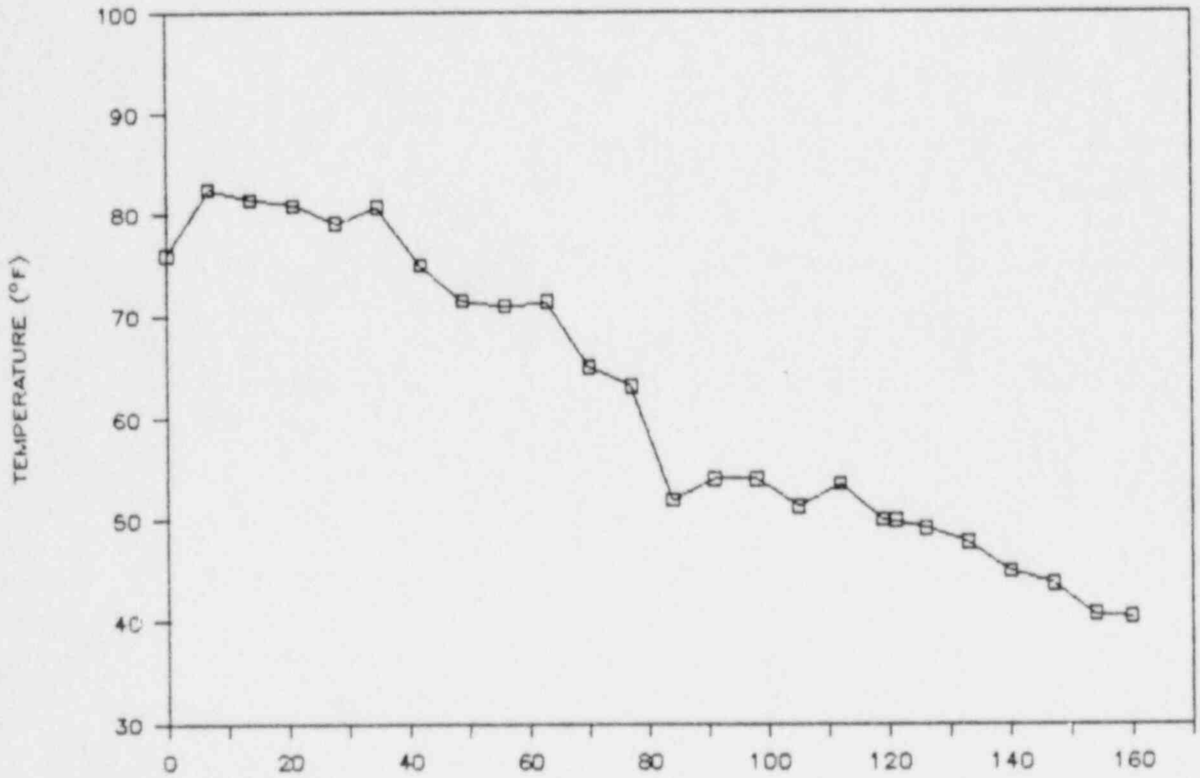


FIGURE V-I-6

SUMMARY OF Corbicula GROWTH DATA AND
WATER TEMPERATURES IN INTAKE STRUCTURE
BVPS

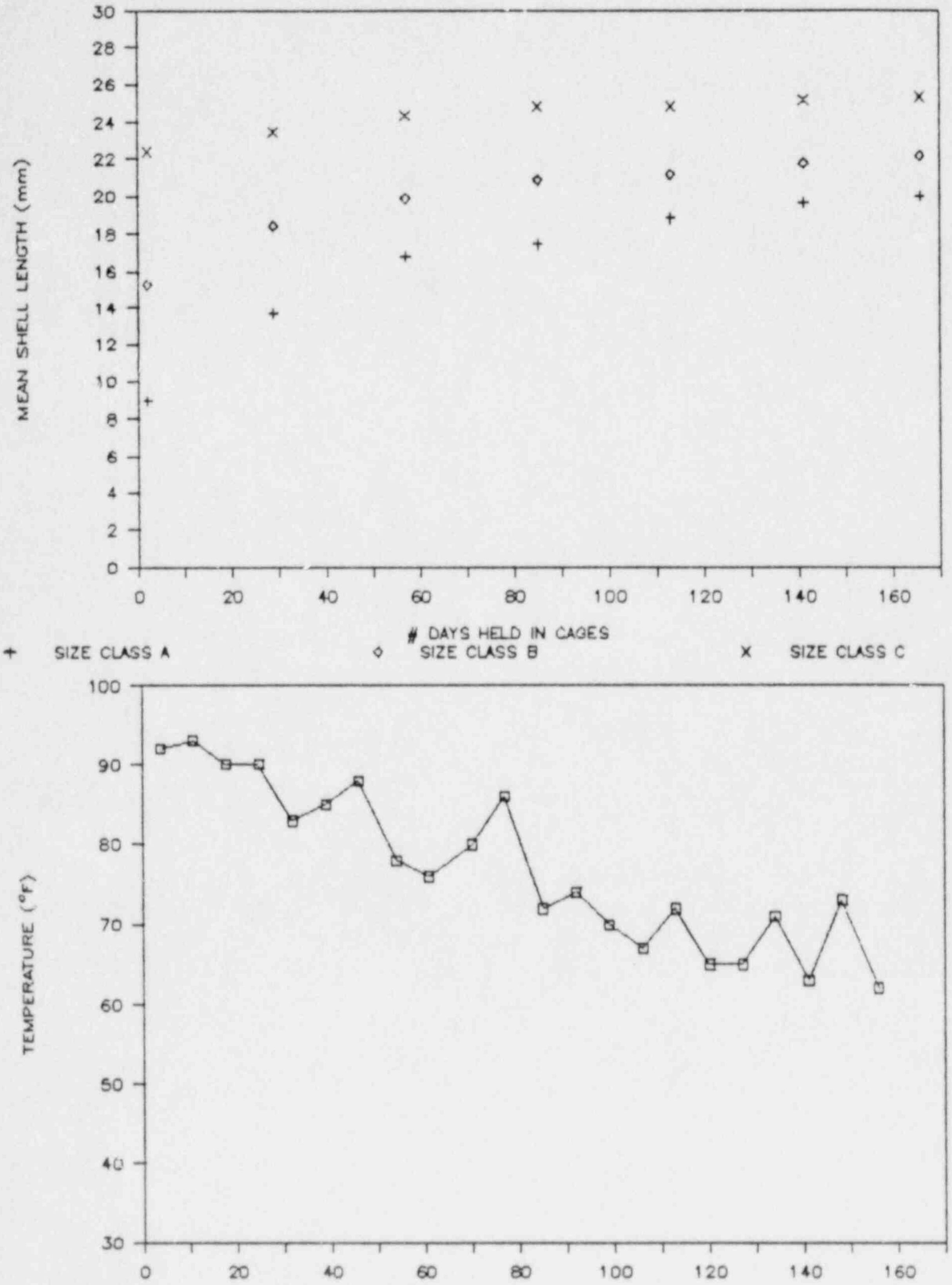


FIGURE V-I-7

SUMMARY OF *Corbicula* GROWTH DATA AND
WATER TEMPERATURES IN UNIT 1 COOLING TOWER
BVPS

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

One hundred (100) adult clams (those with a shell length >17.0 mm) were held in cages (described in methods section of Corbicula growth study) in the intake structure and Unit 1 cooling tower. Cages were placed in the cooling tower on July 2, 1987 and consisted of three (3) cages containing laboratory animals (A) and four (4) cages containing clams removed from the cooling tower (B). The intake structure cages were placed on July 17, 1987 and consisted of three (3) cages containing laboratory clams.

Sampling in the cooling tower began on July 17, 1987 and the intake structure was sampled on July 31, 1987. Thereafter, sampling occurred every fourteen (14) days.

On each sampling date, twenty (20) clams were removed from cages from each population held in the cooling tower and the single population held in the intake structure. Samples were transported to the laboratory dry 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, teased apart, and examined under magnification 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
1-49	few
50-100	moderate
101-500	many
>500	gorged

Results

The Corbicula spawning study data, expressed as the percentage of clams examined in each gravid condition, is illustrated graphically in Figures V-I-8 and V-I-9 for the intake structure and Unit 1 cooling tower respectively.

The greatest percentage of clams examined having pediveliger larvae in the inner gill in the intake structure occurred on August 28, 1987 when 70% were in a gravid condition. The greatest percentage of clams exhibiting a gorged condition in the intake structure occurred on July 31, 1987 when 20% of the clams examined were incubating more than 500 pediveliger larvae each.

In the cooling tower, the greatest percentage of clams in a gravid condition occurred on August 17, 1987 when 45% of the clams from the cooling tower population (B) were incubating larvae. At no time did any clams from either population (A or B) in the cooling tower exhibit a gorged condition.

Summary

The only period of potential larval release from gravid adult clams occurred from July 31, 1987 through August 28, 1987 at the intake structure. Two weeks later at the intake, larval release was over. Therefore, the larval release period took at least four weeks but probably less than six as clams were subjected to ambient river temperature conditions.

There was inconclusive data of a major larval release period in the Unit 1 cooling tower. Possibly, the consistently warm temperature conditions maintained within the tower may have retarded or prevented a spawning season. Many cold-blooded organisms require a cold period to re-establish their reproductive cycles. The reproductive cycles of Corbicula at BVPS is still under investigation.

The large population of clams found in the cooling tower is evidently being supplemented by small juvenile and adult clams circumventing the travelling screens in the intake structure. Gravid clams that enter the

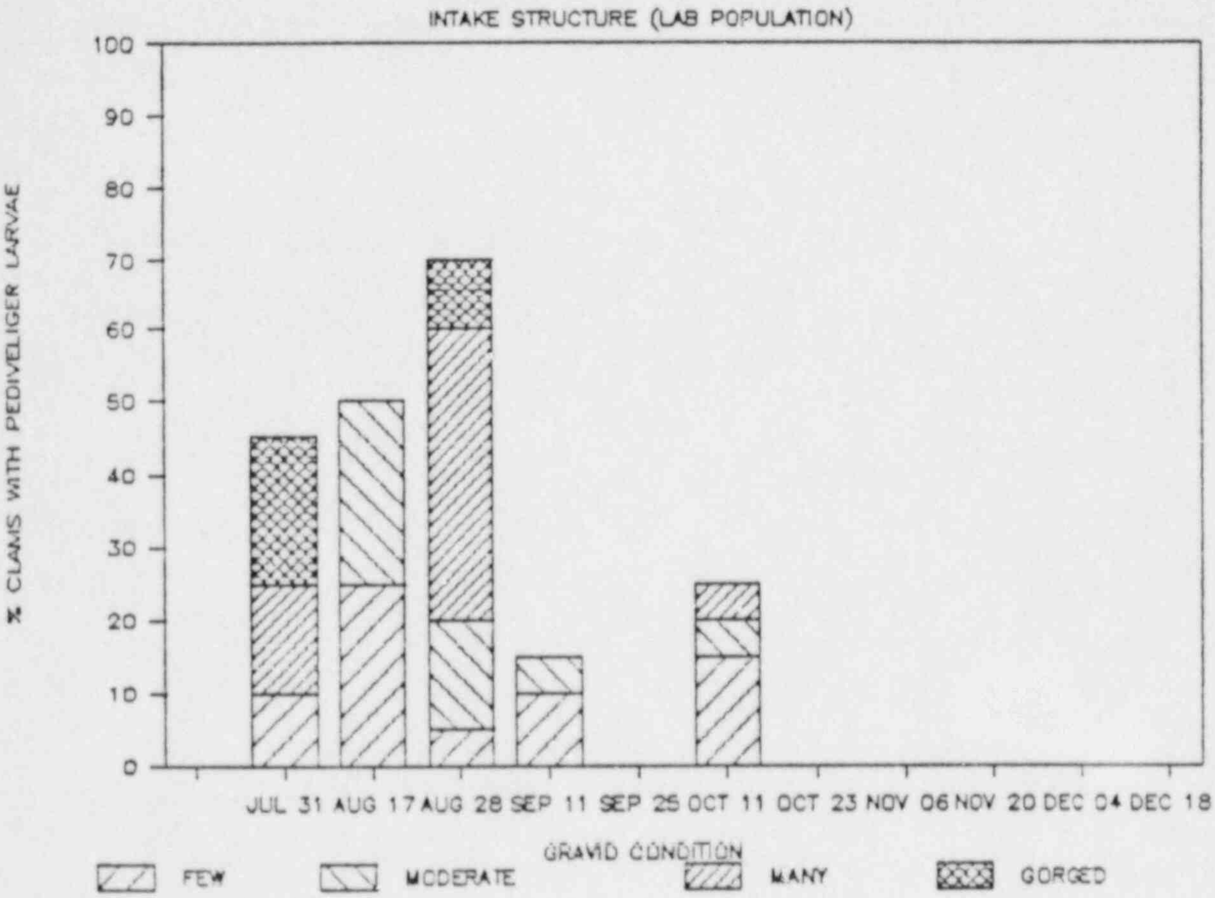


FIGURE V-I-8

RESULTS OF Corbicula SPAWNING STUDY
IN INTAKE STRUCTURE
BVPS

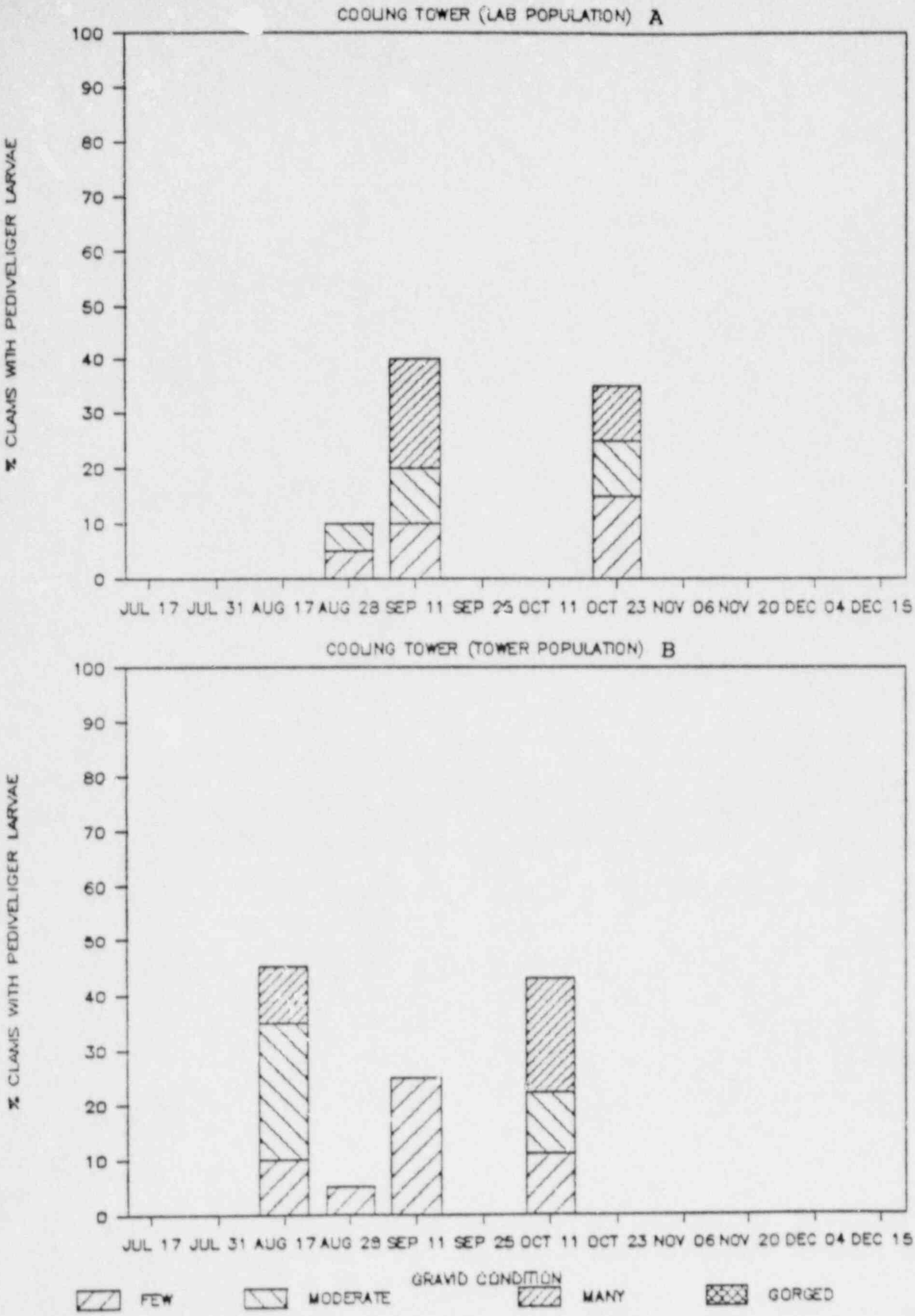


FIGURE V-I-9

RESULTS OF *Corbicula* SPAWNING STUDY
IN UNIT 1 COOLING TOWER
BVPS

tower then release their larvae which may remain in the cooling tower or are cycled back out into the river. Larvae, released from clams spawning in the river, may also enter the plant through the travelling screens and establish themselves in the cooling tower.

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