Limerick Generating Station
Units 1 & 2

License Renewal Project

Environmental Report

Response to Request for Additional Information (RAI) for the Review of LGS LRA ER, Dated February 28, 2012

Enclosure 2

Book 4 of 11

E2-9: Enclosure 2: Aquatic Ecology, item G

RMC (RMC Environmental Services). 1986. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1985. Prepared for Philadelphia Electric Company. September.

Exelon Response

The requested document is provided.

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PROGRESS REPORT

Non-Radiological Environmental Monitoring for Limerick Generating Station 1985

Prepared for

Philadelphia Electric Company

by

RMC-Environmental Services
Pottstown, Pennsylvania

SEPTEMBER 1986

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1.0 Executive Summary

This report summarizes nonradiological environmental monitoring studies related to Philadelphia Electric Company's Limerick Generating Station (LGS) conducted in 1985. Although LGS did not reach full power operation until 26 December 1985, the plant operated intermittently at 5% power throughout 1985. Therefore, this document is a postoperational report. Because the Point Pleasant diversion has not been completed, it did not operate in 1985.

The year 1985 was notable as a period of low flow. Monthly mean discharges on all four study water bodies were among the lowest observed in 10-15 years. The greatest discharges measured were those in response to heavy rains associated with the passage of Hurricane Gloria in late September.

A large fish kill occurred in the Schuylkill River study area during 31 July-2 August. Several thousand dead fish were observed. Although no definitive cause was established, governmental agency personnel hypothesized several possible causes involving industries located upstream of LGS. Portions of the fish kill occurred upstream of LGS and therefore plant operation was deemed not contributory to the kill.

Water quality in the Delaware River in 1985 was similar to that observed previously. Many of the new extremes recorded were

slightly outside of the established ranges. Ichthyoplankton species composition in 1985 was similar to that observed during 1982-1984.

Many new extremes of water quality parameters were measured in the East Branch Perkiomen Creek, most of them associated with low stream flow. Although a large percentage of them were slightly outside established ranges, new copper and zinc maxima were major range extensions. The macroinvertebrate communities present in 1985 were similar to those observed previously, except that total number was substantially higher. The composition of the small fish community (collected by seine) reflected low stream flow conditions. Species such as golden shiner that preferred sluggish flow and weedy habitat were abundant. The composition of the large fish community (collected by electrofishing) changed in terms of relative abundance of the dominant species. Long-term improvement in stream habitat quality in the middle reach is reflected by differences in species composition from that reported in the EROL. Growth rates of several fish species in 1985 were similar to those observed in previous years. Although total fishing pressure in 1985 was lower than the average observed over previous study, the weight of seasonal harvest in 1985 appeared to be comparable to earlier estimates.

Relative densities of most of the common species of large fish in the Perkiomen Creek were higher in 1985 than in 1984, reflecting the catch of more young-of-year fish in late summer. The highest catch rates since 1981-1983 were observed at several stations. Lower fishing pressure in 1985 resulted in a lower total estimated catch than in previous years.

Water quality in the Schuylkill River in 1985 was similar to that observed in previous years. Most new extremes were associated with the sustained low and occasional high flow events and many of these were slightly outside of established ranges. The macroinvertebrate communities were not greatly changed from 1984 to 1985. No effects of LGS plant operation on down-river macroinvertebrate communities were observed. The large fish community was dominated by several species that evidently enjoyed extremely successful spawning due to unusually low, stable river flows observed throughout spring and early summer. Catch of larger adult fish of some species was reduced after the mid-summer fish kill. Age and growth data indicated that redbreast sunfish grew slowly in 1984 and at a much higher rate in 1985, the result of differing river flow and water temperature conditions. Fishing pressure in the Schuylkill River was the lowest measured in 6 years. Angler success was moderate, although the total catch also was the lowest observed in 6 years.

Low numbers of fish were observed in LGS impingement collections, except during high river flow associated with Hurricane Gloria.

Surveys of the presence of Asiatic clam (Corbicula) in 1985 indicated that the species' range has expanded in the Delaware River to within 11 miles of the intake for the proposed water diversion and in the Schuylkill River to within 3 miles and 11 miles of Cromby Generating Station and LGS, respectively.

Study of bird mortality due to impaction with the LGS cooling towers indicated that the number of birds killed in 1985 was insignificant compared to the large number of migrants passing through the area.

2.0 Introduction

The aquatic ecology of the Schuylkill and Delaware Rivers, and Perkiomen Creek and East Branch Perkiomen Creek (EBPC) as they relate to Limerick Generating Stations (LGS) have been studied for Philadelphia Electric Company (PECo) since 1970. A terrestrial ecological survey was conducted from 1972 through 1975, and aquatic chemistry investigation was incorporated into the monitoring program in May 1974. The basic objective of these studies, which are listed in Table 2.0-1, has been to document natural variation in the organisms or parameters under study, thereby developing a preoperational database which can be used to assess future change.

Progress reports have been prepared periodically for PECo and are listed in Table 2.0-2. The results of studies conducted 1971-1977 were integrated and analyzed in the Limerick Generating Station - Environmental Report: Operating License Stage (EROL) submitted to the Nuclear Regulatory Commission (NRC) by PECo (1981).

This report summarizes results of the aquatic ecological, water quality, and bird impaction studies conducted for PECo on all four stream systems in 1985. The emphasis is on presentation of study results and comparison of these findings with those reported in the LGS EROL and subsequent Progress Reports.

The year 1985 was a year of transition in LGS operation. The plant operated at no more than 5% power from January until August when a full power operating license was issued. LGS then began to operate at an increasing level of power output, reaching full power operation on 26 December. Therefore 1985 is considered an operational year for purposes of Schuylkill River data analysis.

It is important to note that any LGS operational effects would be observed only in terms of water withdrawal from and discharge to the Schuylkill River. A number of the components of the Point Pleasant Water Diversion has not as yet been completed. Therefore, no water was pumped from the Delaware River, nor has any been discharged to the East Branch Perkiomen Creek at Elephant Road. Construction of the Graterford Intake on the Perkiomen Creek is complete, but to date little if any water has been withdrawn.

In general, discharge of the Delaware and Schuylkill Rivers and the East Branch Perkiomen and Perkiomen Creeks in 1985 was the lowest observed over the period 1970-1985. Discharge was low in all months in the interval January through early November, although it occasionally increased in response to precipitation. Of particular interest was the passage through the area of heavy rains associated with Hurricane Gloria on 26-28 September. River and stream discharge increased rapidly from low flows to the highest levels recorded during 1985.

Table 2.0-1. Ecological and water quality studies conducted on the Delaware River, East Branch Perkiomen Creek, Perkiomen Creek, and Schuylkill River in relation to Limerick Generating Station.

DELAWARE RIVER

Program	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Water Quality				x	x	x	x	x	x	x	x	x	x	x	x
Fisheries Survey		x	x												
Macroinvertebrate Drift		x	x												
Larval Fish												x	x	x	x
Asiatic Clam												x	x	x	x

EAST BRANCH PERKIOMEN CREEK

Program	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Water quality				x	x	x	x	x					x	x	x
Periphyton			x	x											
Benthic Macroinvertebrates		x	x	x		x							x	x	x
Larval Fish			x	x											
Seine					x	x	x				x	x	x	x	x
Large Fish Population Estimate				x	x	x									
Electrofishing							x	x			x	x	x	x	x
Age and Growth			x		x		x				x		x	x	x
Creel Survey										x	x		x		x

Table 2.0-1. (Continued)

PERKIOMEN CREEK

Program	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Water Quality				x	x	x	x	x	x	x	x	x	x	x	x
Phytoplankton				x											
Periphyton			x												
Benthic Macroinvertebrates		x	x	x		x									
Larval Fish			x	x	x	x									
Seine					x	x	x	x							
Small Fish Population Estimate					x	x									
Large Fish Population Estimate				x	x	x									
Electrofishing							x	x			x	x	x	x	x
Age and Growth			x			x		x							
Creel Survey										x	x		x		x
Asiatic Clam													x	x	x

SCHUYLKILL RIVER

Program	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Water Quality				x	x	x	x	x	x	x	x	x	x	x	x
Phytoplankton			x	x											
Periphyton			x	x											
Macrophytes							x								
Benthic Macroinvertebrates		x	x	x	x	x	x	x					x	x	x
Larval Fish			x	x	x	x									
Seine					x	x	x	x			x	x	x	x	x
Small Fish Population Estimate			x	x	x	x									
Large Fish Population Estimate			x	x	x		x								
Electrofishing						x	x	x			x	x	x	x	x
Trap Net	x	x	x	x	x	x									
Age and Growth			x		x		x				x		x	x	x
Creel Survey										x	x	x	x	x	x
Asiatic Clam												x	x	x	x
Cooling Tower Bird Mortality											x	x	x	x	x
Impingement															x

Table 2.0-2. List of progress reports which pertain to non-radiological environmental monitoring for Limerick Generating Station, 1970 - 1985.

Denoncourt, R. F., and C. H. Hocutt. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part One).

Brett, J. J., and R. F. Denoncourt. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part Two).

Denoncourt, R. F., C. H. Hocutt, and C. B. Milstein. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part One - Fishes).

Brett, J. J., R. F. Denoncourt, and R. J. Stira. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part Two - Macroinvertebrates).

Harmon, P. L., W. A. Potter, K. W. Knopf, and R. H. Ellis. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 2.

Molzahn, R. F. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part One - Fishes).

Knopf, K. W. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part Two - Macroinvertebrates).

Ellis, R. H., T. P. Poe, and D. C. Stefan. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 3. (Volume I).

Harmon, P. L., R. F. Molzahn, T. M. Kincaid, A. K. Megay, R. J. Stira, and R. W. Blye. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report. No. 3. (Volume II).

Molzahn, R. F., and R. P. Rutter. 1973. An ecological study of the East Branch Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 3.

Harmon, P. L., and Associates. 1974. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 4.

Harmon, P. L., and Associates. 1974. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 4.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 5.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 5.

Edinger, J. E., E. M. Buchak, and H. J. Reisinger. 1976. Limerick Water Chemistry Program. 1974 Annual Report. J. E. Edinger Associates, Inc. and Ichthyological Associates, Inc.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Radiation Management Corporation, Schuylkill Progress Report No. 6.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Radiation Management Corporation, Perkiomen Progress Report No. 6.

RMC-Environmental Services. 1984. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1979-1983. Prepared for Philadelphia Electric Company.

RMC-Environmental Services. 1985. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1984. Prepared for Philadelphia Electric Company.

3.0 Delaware River at Point Pleasant

The Delaware River, a major river system of the eastern United States, drains 12,765 square miles in Delaware, Maryland, New Jersey, New York, and Pennsylvania. It flows 370 miles in a southerly direction from the state of New York to Delaware Bay and is tidal to Trenton, New Jersey, at river mile 133.

The Delaware River at Point Pleasant (river mile 157) is the subject of study because water will be withdrawn, when needed, by the Point Pleasant Pumping Station (PPPS) for diversion to Limerick Generating Station. PPPS is to have an ultimate (projected for year 2020) capacity of 95 million gallons per day (147 cfs) of which 46 mgd (65 cfs) will be released to the upper reaches of East Branch Perkiomen Creek and flow by gravity in the stream channel to a diversion point near Graterford and then via transmission main to LGS.

The PPPS site is located on the west bank of the Delaware River near the southern limits of the village of Point Pleasant in Plumstead Township, Bucks County. The study reach consists of about 1 mile of river centered on the PPPS site. Tohickon Creek which drains a 112 sq. mile watershed that includes an impoundment, Lake Nockamixon, enters the study area just upriver of the intake location.

The intake for PPPS consists of an assembly of profile wire screens located at a point about 245 feet off shore. Withdrawal rates for LGS use will be subject to several regulatory agency limitations but, in general, will range from a low of 10 cfs (a minimum conservation flow to protect East Branch Perkiomen Creek instream uses) to a maximum 65 cfs with two Limerick units in full-power operation.

Although in-river construction at PPPS is complete, no water was pumped from the Delaware River in 1985 because the pumphouse, associated pipeline, and Bradshaw Reservoir were not yet built. Therefore, the limited operation of LGS in 1985 did not affect the Delaware River.

Biological studies were conducted on behalf of PECo at Point Pleasant from July 1972 to December 1973 and are described in Smith and Harmon (1974). Studies of water quality were initiated in 1974 and continued through 1985. Ichthyoplankton collections made in 1982-1984 and water quality investigations conducted in 1979-1984 were reported in previous progress reports (RMC-Environmental Services 1984 and 1985). The results of these studies conducted in 1985 are reported below.

To aid in comprehension of sample station locations, the stations are designated by the letter A for Delaware River stations and followed by a number that indicates the distance in

meters upstream from an arbitrary reference point of river mile 150.

3.1 Water Quality

Summary

1. Delaware River water quality continued to be monitored on a biweekly basis in 1985. Subsurface grab samples were collected at a sampling site some 500 m upstream of the Tohickon Creek confluence.

2. Low flows characterized most of 1985, but high flow events also were observed. Most of the new minimum and maximum water quality constituent values observed in 1985 were directly related to flow conditions, but many of these new extreme values were just slightly outside of the previously established post-EROL period ranges.

3. The 1985 data show that Delaware River water quality was quite similar to that reported in the EROL and post-EROL progress reports.

Introduction and Methods

Water quality of the Delaware River at Point Pleasant was investigated from 1974 through 1985 to chemically characterize the river and to permit comparisons of Delaware River water quality with the water quality of the streams that will receive water from the diversion. Results of water quality analyses conducted

from 1975 through 1978 were reported in the EROL and the Environmental Report for the Bradshaw Reservoir, Transmission Main, East Branch, and Perkiomen Creek (PECo 1979). Results of water quality sampling on the Delaware River near Point Pleasant Pumping Station (PPPS) in 1985 are reported herein.

Surface water grab samples were collected biweekly beginning 2 January about 15 m off the Pennsylvania shore at the Point Pleasant Canoe Outfitters boat ramp, Station A11760. This station is located in a free-flowing reach of the river about 500 m upstream of the intake location.

Samples were analyzed using analytical procedures approved or accepted by state and federal regulatory agencies.

Results and Discussion

Low flows characterized most of 1985 (Table 3.1-1). Mean monthly flows in 1985 were below the monthly mean values calculated for the period 1977-1985 in eight months (Table 3.1-2). Median monthly flows in 1985 were less than corresponding median flows for the period 1977-1985 in nine months (Table 3.1-2). However, only one new minimum flow (2100 cfs on 18 September) was established for the 1977-1985 period.

Tables 3.1-3 and 3.1-4 provide seasonal summaries of Delaware River water quality data for the period 1979 through 1985 and for

1985 alone, respectively. Several new minimum and maximum values were observed in 1985 (Tables 3.1-5 and 3.1-6, respectively). Many of these new extremes were only slightly outside the ranges established from 1979 through 1984.

Most new minima established in 1985 were related to flow events. For example, total hardness, total dissolved solids, sodium, and the major cations vary inversely with flow, and dates on which new minimum values were established for these parameters coincided with high flow events, e.g., 20 November. On 24 April during an unusually low flow and warm temperature period, a new low dissolved oxygen value was recorded.

New maximum values were established in all but the summer quarter. In winter, the high dissolved oxygen value obtained on 2 January approximated the saturation level of dissolved oxygen at the water temperatures observed on this date.

In the spring quarter new chloride and potassium maxima were established. The chloride value is not high in comparison to established water quality standards, and is less than the maxima previously established for two other quarters. The new potassium maximum is less than that observed in all other quarters.

In fall the new orthophosphate phosphorous maximum was obtained during a very low flow period and was indicative of increased nutrient availability. The new manganese value was just

0.01 mg/l greater than the previous maximum for this quarter and was much less than maxima observed in every other quarter.

The water quality of the Delaware River at Point Pleasant in 1985 was quite similar to that observed in previous years. The new extrema established in 1985 and differences between median parameter values observed in 1985 as opposed to the previously reported 1979-1984 period were related to flow conditions.

The data obtained in 1985 indicate that Delaware River water quality was quite similar to that reported in the EROL and in post-EROL progress reports. Variations outside of previously established ranges were related to river flow conditions that were not experienced in prior years of monitoring.

Table 3.1-1. Mean daily Delaware River discharge (cu ft/sec) measured at the Trenton US Geological Survey gage in 1985.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	11700	3830	12500	6430	4160	7890	4270	5800	3390	26700	5560	33600
02	11200	3780	10900	7400	4150	8490	4440	5720	3570	18900	5380	33600
03	10800	3660	9910	8730	9820	7920	4210	5930	3620	16700	6680	36500
04	10200	3430	8820	9350	19200	7750	3960	5650	3410	15000	6600	33100
05	9590	3060	8380	8670	17800	7650	3640	4820	3080	13800	7080	26900
06	8780	3060	8630	8110	14200	8050	3440	4080	2500	13500	8550	23300
07	7860	3800	8510	8040	12000	8510	3460	3470	2360	19600	9760	21000
08	7420	3980	9080	7760	10500	7490	4310	3980	2690	16600	10200	18300
09	7250	3470	8660	8220	9360	7040	4200	4530	3030	12900	8760	16700
10	6110	3140	8560	8750	8440	6300	4620	4000	3040	10300	7050	15800
11	5290	3400	8110	8590	7530	5200	4330	3910	3600	8870	6220	15000
12	5230	5220	8090	7780	6940	4980	3780	3920	5880	8020	5840	15300
13	5110	12400	11700	7310	6570	4960	3920	3430	4670	7570	6860	17500
14	5310	10300	22700	6970	6150	4660	4800	3280	3640	7100	9160	18500
15	4960	8610	18000	6530	5400	4380	5650	3090	2980	6880	10900	17100
16	5720	7710	14900	6300	4850	5050	6720	2960	2550	7020	14200	14600
17	4490	6950	12800	6230	4620	8680	7180	2890	2290	6730	37800	13500
18	4460	6450	10900	6040	7590	8780	6760	3070	2100	6410	45900	13000
19	4380	5910	10000	5860	8070	8620	5430	3180	2710	6080	39800	11900
20	4690	5470	9650	5620	7880	7190	4430	2950	2970	5940	30900	10500
21	4170	5160	8400	5610	7680	5790	3880	2830	2990	5880	25000	9950
22	3110	5090	8640	5720	7400	4920	3330	2710	2950	5680	22400	10100
23	3240	5670	8230	5580	6850	4580	3280	2700	2970	5570	22900	9710
24	4990	7090	8120	5270	5720	4490	4960	2600	2790	5410	20200	11000
25	5530	9810	7460	5170	5320	4570	5140	2590	2810	5770	18200	11900
26	4550	16200	7110	5140	4920	4730	5070	4160	2750	6640	16800	10100
27	4390	18500	7630	5130	4470	4790	7870	3500	22900	6970	21000	8830
28	4200	14800	6400	5030	4250	4590	8020	3510	65400	6750	28200	8340
29	4040		5970	4810	4250	4470	5650	3390	62500	6080	38000	8260
30	3860		5930	4410	5980	4160	4630	2940	38000	5840	35900	6950
31	3820		6000		7590		4340	2980		5740		6820
Minimum	3110	3060	5930	4410	4150	4160	3280	2590	2100	5410	5380	6820
Mean	6015	6784	9700	6685	7731	6223	4830	3696	9005	9708	17727	16376
Median	5110	5345	8630	6365	6940	5495	4430	3430	3010	6970	12550	14600
Maximum	11700	18500	22700	9350	19200	8780	8020	5930	65400	26700	45900	36500

Table 3.1-2. Mean monthly Delaware River discharge (cu ft/sec) measured at the Trenton US Geological Survey gage, 1971 - 1985.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971										7639	9936	19719
1972	13032	10602	25448	23560	18699	33460	15396	4866	4055	4152	24992	25010
1973	20006	19376	15878	26680	23626	17852	18497	9157	5544	5111	6306	31066
1974	19442	16362	19255	26380	14616	7594	4826	5729	11695	8570	9254	19699
1975	18638	21507	23461	18120	16841	14764	13753	6694	12170	17679	16611	10473
1976	19774	26831	16448	13415	12665	7490	8610	8007	4800	18019	10800	7476
1977	3755	7511	38406	26528	11277	4454	3723	3515	8275	19926	17242	25552
1978	29116	12350	25049	23202	20596	9669	4818	6141	4289	4045	4127	8821
1979	34946	15170	30235	18343	19916	10538	5330	4366	9062	15490	14054	11310
1980	7532	4176	20283	26610	11920	4874	4008	3198	2981	3512	3986	3784
1981	2539	22787	7715	8100	18721	6836	5158	3524	3565	4500	6301	6695
1982	10321	13616	16599	25023	9298	13759	7424	5390	4430	4188	5129	6842
1983	8681	15607	23232	45187	18687	12404	5459	3879	3310	4030	8171	27813
1984	8081	20886	14741	34900	26758	18427	15937	5891	3667	3642	3559	7283
1985	6015	6784	9700	6685	7731	6223	4830	3696	9005	9708	17727	16376
Minimum	1900	2200	3370	4410	3760	3230	2440	2490	2100	2630	2570	2370
Mean	14420	15258	20461	23052	16525	12025	8412	5290	6203	8681	10546	15195
Median	10050	11100	17250	19200	13800	8515	5580	4460	4035	5410	7255	11000
Maximum	106000	88000	107000	129000	130000	109000	108000	23900	65400	58200	63100	107000

Table 3.1-3. Summary of Delaware River water quality at Station A11760, 20 March 1979 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	1.8	8.0	2.0	9.0	24.0	14.0	23.8	30.0	5.0	15.0	26.0	182
Dissolved Oxygen (mg/l)	8.2	12.4	15.3	7.5	11.0	17.2	5.0	8.3	14.0	7.2	10.3	14.4	193
Biochemical Oxygen Demand (mg/l)	0.4	1.8	5.1	0.0	1.5	3.5	0.1	2.0	7.7	0.2	1.8	6.8	195
Chemical Oxygen Demand (mg/l)	0.0	10.2	68.3	0.0	10.6	55.1	0.0	13.3	88.6	0.0	10.4	36.2	192
Total Organic Carbon (mg/l)	0.0	3.5	15.0	0.0	2.1	12.1	0.0	3.9	40.6	0.0	2.9	20.3	188
pH	7.03	7.53	8.58	6.55	7.51	8.79	6.78	7.95	9.02	7.15	7.82	8.98	195
Total Alkalinity (mg/l)	8.7	35.7	72.3	9.3	28.7	46.5	18.9	47.4	71.6	21.0	49.6	82.7	194
Total Hardness (mg/l)	25.4	58.4	128.5	18.5	47.0	71.1	42.7	67.1	97.2	27.8	67.2	134.7	194
Specific Conductance (usm/cm)	81	146	309	76	123	310	108	171	225	94	184	373	195
Total Suspended Solids (mg/l)	0	3	145	0	8	35	0	9	214	0	3	18	195
Total Dissolved Solids (mg/l)	16	112	224	37	93	158	43	143	223	50	128	260	195
Total Inorganic Carbon (mg/l)	10.1	45.6	75.1	10.6	34.7	47.0	27.9	48.6	73.5	22.9	51.4	82.1	116
Chloride (mg/l)	6.9	12.5	32.8	5.0	9.1	25.3	3.3	11.6	18.0	4.6	14.5	49.4	195
Sulfate (mg/l)	2.7	27.6	87.8	6.5	21.9	33.2	5.1	24.9	41.0	8.7	27.9	56.9	195
Sodium (mg/l)	3.72	8.29	19.70	3.10	6.03	13.70	4.45	8.18	15.40	4.45	9.40	36.10	195
Potassium (mg/l)	0.9	1.4	5.3	0.6	1.1	2.5	0.6	1.5	3.0	0.4	1.7	9.2	195
Calcium (mg/l)	7.0	14.0	29.7	4.2	9.5	25.3	0.0	13.5	27.1	8.7	14.2	26.6	195
Magnesium (mg/l)	0.00	6.55	13.60	1.60	4.60	8.80	3.88	7.42	12.05	2.47	8.23	14.10	195
Ammonia Nitrogen (mg/l)	0.000	0.133	0.700	0.000	0.080	0.270	0.000	0.050	0.260	0.000	0.072	0.570	195
Nitrite Nitrogen (mg/l)	0.000	0.018	0.061	0.000	0.017	0.080	0.000	0.033	0.220	0.000	0.044	0.093	195
Nitrate Nitrogen (mg/l)	0.29	1.16	3.48	0.16	0.77	5.90	0.00	0.94	6.11	0.00	1.20	12.57	195
Total Phosphate Phosphorus (mg/l)	0.00	0.09	0.27	0.00	0.06	0.20	0.00	0.11	1.09	0.00	0.11	0.76	183
Ortho Phosphate Phosphorus (mg/l)	0.00	0.06	0.16	0.00	0.03	0.11	0.00	0.07	0.13	0.00	0.07	0.26	193
Chromium (mg/l)	0.000	0.005	0.032	0.000	0.006	0.044	0.000	0.006	0.076	0.000	0.004	0.032	194
Copper (mg/l)	0.000	0.003	0.048	0.000	0.003	0.056	0.000	0.003	0.121	0.000	0.002	0.011	195
Iron (mg/l)	0.00	0.18	3.64	0.07	0.27	1.11	0.06	0.25	5.42	0.00	0.15	0.79	195
Lead (mg/l)	0.000	0.001	0.148	0.000	0.001	0.032	0.000	0.001	0.029	0.000	0.000	0.017	195
Manganese (mg/l)	0.00	0.00	0.46	0.00	0.05	0.15	0.00	0.05	0.42	0.00	0.00	0.09	195
Zinc (mg/l)	0.00	0.04	0.48	0.00	0.03	0.44	0.00	0.02	0.39	0.00	0.02	0.19	195
Cyanide (mg/l)	0.000	0.000	0.012	0.000	0.000	0.008	0.000	0.000	0.013	0.000	0.000	0.006	193
Phenols (mg/l)	0.000	0.000	0.021	0.000	0.000	0.012	0.000	0.000	0.088	0.000	0.000	0.051	194
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	4.1	0.0	0.0	0.0	166
Total Coliforms (c/.1l)	20	770	21500	6	400	32000	50	1100	154000	10	600	54000	189
Fecal Coliforms (c/.1l)	0	140	10000	4	75	870	3	200	40000	1	79	7000	188

Table 3.1-4. Summary of Delaware River water quality at Station A11760, 2 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	1.6	6.0	7.0	12.5	19.5	20.0	24.5	29.0	9.4	14.0	23.5	26
Dissolved Oxygen (mg/l)	8.3	10.8	15.3	7.5	10.6	12.2	8.2	9.3	11.1	8.0	10.3	10.4	25
Biochemical Oxygen Demand (mg/l)	0.6	1.4	4.1	0.5	1.4	2.3	0.8	1.2	1.8	0.2	0.9	2.4	26
Chemical Oxygen Demand (mg/l)	0.0	14.4	20.3	0.0	17.1	24.9	0.0	13.5	16.6	0.0	18.0	34.2	26
Total Organic Carbon (mg/l)	2.1	2.7	4.0	2.1	2.7	3.1	2.1	3.8	4.0	2.8	3.5	4.0	26
pH	7.03	7.25	7.59	7.42	7.89	7.97	7.35	8.19	8.87	7.35	7.76	8.78	26
Total Alkalinity (mg/l)	18.7	30.0	45.1	26.2	31.4	33.2	27.7	41.6	52.6	24.0	40.0	53.6	26
Total Hardness (mg/l)	25.4	49.2	64.8	40.0	45.1	47.5	43.1	48.2	64.2	27.8	37.8	47.2	26
Specific Conductance (usm/cm)	87	123	168	113	128	141	132	170	195	94	150	204	26
Total Suspended Solids (mg/l)	1	6	48	3	9	11	0	4	26	0	5	17	26
Total Dissolved Solids (mg/l)	16	70	112	61	108	148	67	131	154	63	88	161	26
Chloride (mg/l)	8.8	13.4	18.9	9.9	11.5	25.3	10.7	13.4	15.5	6.2	12.3	15.7	26
Sulfate (mg/l)	18.7	19.9	30.2	15.4	18.9	21.9	22.6	23.9	29.2	15.9	25.0	29.7	26
Sodium (mg/l)	3.72	6.19	11.12	5.95	7.18	9.49	5.57	8.62	10.69	4.45	7.24	10.58	26
Potassium (mg/l)	1.0	1.2	2.8	0.8	1.1	2.5	1.2	1.4	1.8	1.2	1.5	1.7	26
Calcium (mg/l)	7.0	10.1	14.0	11.8	14.2	22.5	13.5	18.6	21.8	8.7	15.1	19.3	26
Magnesium (mg/l)	3.01	4.69	7.55	3.61	5.09	5.96	5.01	7.42	8.83	2.47	6.50	8.30	26
Ammonia Nitrogen (mg/l)	0.000	0.071	0.308	0.034	0.109	0.198	0.045	0.078	0.180	0.000	0.123	0.191	26
Nitrite Nitrogen (mg/l)	0.008	0.010	0.047	0.017	0.032	0.061	0.014	0.033	0.059	0.011	0.037	0.072	26
Nitrate Nitrogen (mg/l)	0.68	0.92	1.36	0.65	0.84	0.87	0.53	0.77	0.98	0.66	0.74	1.05	26
Total Phosphate Phosphorus (mg/l)	0.04	0.08	0.20	0.04	0.09	0.19	0.09	0.12	0.16	0.04	0.08	0.16	25
Ortho Phosphate Phosphorus (mg/l)	0.00	0.04	0.12	0.01	0.05	0.09	0.06	0.07	0.13	0.03	0.07	0.26	24
Chromium (mg/l)	0.001	0.005	0.007	0.004	0.005	0.008	0.004	0.006	0.010	0.000	0.007	0.009	26
Copper (mg/l)	0.002	0.003	0.009	0.001	0.004	0.006	0.000	0.002	0.005	0.002	0.003	0.003	26
Iron (mg/l)	0.08	0.32	1.66	0.08	0.15	0.40	0.07	0.22	0.81	0.00	0.28	0.49	26
Lead (mg/l)	0.000	0.003	0.005	0.000	0.001	0.004	0.000	0.000	0.002	0.000	0.000	0.001	26
Manganese (mg/l)	0.00	0.09	0.25	0.00	0.03	0.07	0.00	0.05	0.07	0.00	0.03	0.09	26
Zinc (mg/l)	0.01	0.04	0.10	0.00	0.03	0.08	0.00	0.01	0.04	0.00	0.02	0.03	26
Cyanide (mg/l)	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (c/.1l)	20	800	3200	10	185	230	50	90	1900	50	890	2500	25
Fecal Coliforms (c/.1l)	0	160	400	4	47	180	24	125	580	15	150	180	25

Table 3.1-5. New minimum values observed for water quality parameters measured in 1985 at Station A 11760 on the Delaware River.

Season	Parameter	Value	Date
Dec, Jan, Feb	pH	7.03	12/18/85
	Total Hardness (mg/l)	25.4	12/04/85
	Total Dissolved Solids (mg/l)	16	02/27/85
	Sodium (mg/l)	3.72	12/04/85
	Calcium (mg/l)	7.0	01/02/85
	Fecal Coliforms (c/.1l)	0	01/30/85
	Total Coliforms (c/.1l)	20	01/30/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	7.5	04/24/85
Jun, Jul, Aug	Total Coliforms (c/.1l)	50	08/28/85
Sep, Oct, Nov	Total Hardness (mg/l)	27.8	11/20/85
	Specific Conductance (usm/cm)	94	11/20/85
	Sodium (mg/l)	4.45	11/20/85
	Calcium (mg/l)	8.7	11/20/85
	Magnesium (mg/l)	2.47	11/20/85

Table 3.1-6. New maximum values observed for water quality parameters measured in 1985 at Station A 11760 on the Delaware River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Dissolved Oxygen (mg/l)	15.3	01/02/85
Mar, Apr, May	Chloride (mg/l)	25.3	05/22/85
	Potassium (mg/l)	2.5	05/08/85
Sep, Oct, Nov	Manganese (mg/l)	0.09	10/09/85

3.2 Ichthyoplankton

Summary

1. Ichthyoplankton of the Delaware River near Point Pleasant were studied in 1985 to determine the identity, distribution and abundance of spawning fish, their spawning periods, and to estimate potential entrainment losses. Emphasis was placed on American shad and walleye.

2. Twenty taxa representing eight families were identified in ichthyoplankton collections. Species composition was similar to that of the previous three years of study, 1982 through 1984.

3. The majority of eggs collected were herrings (probably blueback herring and alewife); American shad and walleye comprised only a small percentage of the egg catch.

4. Herrings followed by sunfishes (Lepomis), carp and American shad comprised the majority of the larvae collected. No walleye larvae were taken.

5. Larval fish and fish eggs exhibited a diel pattern of abundance with generally greater densities collected at night.

6. Larval fish density was greatest in the eddy inshore of the intake location. Egg density was greatest in the river channel.

7. Although American shad likely spawn in the upstream vicinity of Point Pleasant, the study area is not an intensive spawning ground for American shad.

8. American shad and walleye will be subject to a low degree of potential entrainment with minimal impact to their populations.

Introduction and Methods

A study of ichthyoplankton near the Point Pleasant Pumping Station (PPPS) has been conducted during the spring and summer of 1982 through 1985. Ichthyoplankton is the assemblage of fish eggs and larval fish that have no or very limited powers of locomotion. The objectives of this study were to determine the identity, abundance and distribution of fish which spawn in the vicinity of the PPPS, to determine their spawning periods, and to estimate potential entrainment losses. The emphasis was on American shad and walleye because of their importance in the recreational fishery. Samples were collected during the day and night at four stations located at the pumping station intake, the

Pennsylvania shore near the intake and upstream and downstream of the intake.

In 1985 only Point Pleasant stations were sampled and the frequency of sampling was weekly in April, May and June and biweekly in July. No samples were collected in the vicinities of New Hope, or Yardley, Pennsylvania.

Results and Discussion

A total of 8,420 specimens was obtained in 112 ichthyoplankton samples collected from 9 April through 18 July 1985 (Tables 3.2-1 - 3.2-2). Eggs, larvae, or juveniles of 20 taxa representing eight families were identified.

Species Composition

Species composition of fish collected during the years 1982-1985 are presented in Tables 3.2-3 - 3.2-7. The most commonly occurring taxa were river herrings, sunfishes (Lepomis), carp, American shad, quillback, white suckers and channel catfish. Slight differences in species composition occurred during the years 1982-1985. Small numbers of yellow bullhead, largemouth bass and crappie (Pomoxis) were collected in 1982 only; margined madtom in 1983 and 1985 only; white perch in 1984 and 1985 only; and gizzard shad in 1985 only.

Relative Abundance

Larvae of most taxa tended to predominate in most collections because this is the life stage most susceptible to capture by the sampling gear employed in this study. The demersal or adhesive characteristics of the eggs of most species and spawning behaviors such as the use of nests and cavities for egg deposition limited the availability of the eggs to the sampling gear.

Herring eggs and larvae were most abundant and accounted for approximately 70% of all organisms collected. The herring taxon was comprised primarily of alewife and blueback herring, but could have included some unidentifiable American shad and gizzard shad larvae. As in 1982 through 1984 (RMC 1984, 1985), herrings comprised the majority of the eggs collected in 1985 (N=3,471, 97% of total), since they are open water spawners which broadcast their eggs and do not utilize nests. Results for 1982, 1983 and 1984 were 8,414 (86%), 4,610 (88%), and 2,106 (94%) respectively (Table 3.2-8). Five walleye eggs, 0.1% of total, were collected in 1985. Walleye eggs were not collected in 1982, 1983, or 1984 (Table 3.2-3). American shad comprised only a small part of the total egg catch for 1985 (13, 0.4%), quite similar to results observed in 1982 (5, 0.5%), 1983 (35, 0.7%) and 1984 (4, 0.2%) (Table 3.2-8).

The mean abundance between years of American shad eggs was very similar since very few eggs were collected in any year (Table 3.2-9-10). Peak densities of shad eggs during this study were 3.7/100m^3 in 1982; 11.6/100m^3 in 1983; 1.3/100m^3 in 1984 and 5.1/100m^3 in 1985 (Table 3.2-8). Eggs were collected as early as 17 April in 1985 (Table 3.2-1) and as late as 25 June in 1984 (RMC 1985). Temperatures at which eggs were collected ranged from 12.8 C to 26.7 C (RMC 1984).

Herrings (2414, 50%) were the most abundant larvae and juveniles collected in 1985, followed by sunfishes (Lepomis) (1,182, 24%), carp (447, 9%), American shad (247, 5%) and suckers (244, 5%) (Table 3.2-11). Walleye larvae were not collected in 1985. Only twenty were collected in 1984 and one larva was taken in 1982 and one in 1983 (Table 3.2-3).

A total of 1,741 American shad larvae and early juveniles were collected during 1982 through 1985 (Table 3.2-3). The American shad catch ranked third in both 1982 (387, 11%) and 1983 (715, 10%), fifth in 1984 (384, 6.6%) and fourth (246, 5.1%) in 1985. Larvae exhibited considerable variation in relative abundance between years. Mean abundance increased greatly from 1982 to 1983 and then decreased somewhat in 1984. Larvae were least abundant in 1985 (Tables 3.2-9 - 3.2-10). Peak densities during this study were 339.5/100m^3 in 1982; 947.6/100m^3 in 1983; 465.3/100m^3 in 1984 and 169.3/100m^3 in 1985 (Table 3.2-11).

Larvae were collected as early as 9 May in 1985 (Table 3.2-1) and as late as 11 July in 1984 (RMC 1985).

Periodicity

A diel pattern of egg and larval fish abundance was evident with greater densities almost always collected at night (Tables 3.2-12 - 3.2-13). American shad larvae exhibited a diel pattern of abundance, however eggs did not exhibit a similar abundance pattern (Tables 3.2-14 - 3.2-15). The phenomenon of diel periodicity in ichthyoplankton abundance was more fully discussed in the 1979-1983 Progress Report (RMC, 1984).

Spatial Distribution

The spatial distribution of ichthyoplankton observed from 1982 through 1985 was similar. Fewer eggs were taken at the eddy station (A11263-1), while greater numbers of eggs were collected at the other stations which are in the river channel (Table 3.2-12). This is a result of the spawning behavior of river herring, which comprised 89% of the total egg catch and prefer to spawn in the fast currents and the gravel - cobble substrate of the river channel rather than the slow current and silt bottom of the eddy. Conversely, larvae were primarily concentrated at the eddy station (A11263-1), probably because it serves as a nursery area

and refuge from the much faster current of the main river channel (Table 3.2-13).

Target Species

The target species of this study are the walleye and the American shad due to their importance in the recreational fishery. Walleye spawning activity within the vicinity of the study area has been minor since only five eggs and twenty-two larvae were collected during 1982 through 1985 (Table 3.2-3).

Spawning activity by American shad was not intense during 1982 through 1985 since egg densities never exceeded 11.6/100m^3. Most of the eggs likely drifted downstream to the vicinity of Point Pleasant from upstream spawning grounds (Table 3.2-16). In order to add perspective to the findings of this study a summary of the available information concerning American shad spawning activity in the Delaware River is provided below.

Prior to the early 1900's, American shad used as spawning grounds most of the freshwater areas of the Delaware River, including the freshwater tidal section, the East and West Branches and many tributaries (Mansuetti and Kolb 1953; Walburg and Nichols 1967; Chittenden 1976; Miller et al. 1982). The principal spawning ground was in tidal freshwater in the vicinity of Philadelphia (Cable 1945, cited in Mansuetti and Kolb 1953).

During the early 1900's, the principal spawning grounds shifted to upstream of the Delaware Water Gap (river mile 214) in the region from Port Jervis, New York (river mile 255) to Hancock, New York (river mile 330), and extending into the lower East Branch (Cable 1945 cited in Mansuetti and Kolb 1953; Sykes and Lehman 1957; Chittenden 1976). This shift was attributed to severe pollution of tidal waters in the region from Wilmington, Delaware (river mile 72) to Philadelphia, Pennsylvania (river mile 91 to 112) and coincided with a rapid decline in the size of Delaware River shad runs (Ellis 1947; Sykes and Lehman 1957; Chittenden 1969; Miller et al. 1982).

Ichthyoplankton surveys primarily conducted in the region downstream of the Delaware Water Gap from 1944 through the mid-1970's indicated a minimal level of spawning by American shad. Cable (1945 cited in Mansueti and Kolb 1953) documented spawning from Bordentown, New Jersey (river mile 128) to Equinunk, Pennsylvania (river mile 323) in samples collected during early May through early June 1944. Very few eggs were taken at any of the collecting stations and most of the eggs collected below Milford, Pennsylvania (river mile 247) were dead when taken. Normal survival was found only in samples collected at the mouth of the Lackawaxen River (river mile 278) and Equinunk. No numbers or densities of eggs and larvae were available for comparison to the present study.

Barker (1965) made ichthyoplankton collections at Belvidere, New Jersey (river mile 198), Easton, Pennsylvania (river mile 186) and Milford, New Jersey (river mile 168) in May and early June of 1963 and at Easton, Milford, Lumberville, Pennsylvania (river mile 156) and West Trenton, New Jersey (river mile 140) in May and early June of 1964. Densities of eggs and larvae were not given but were estimated for 1963 by considering gear type, flow rate and length of sample time. In 1963, 27 eggs and 67 larvae were collected at densities estimated to range from 1 to 13/100 m^3 and 2 to 20/100 m^3 respectively at Belvidere. At Easton 27 eggs and 10 larvae were collected at estimated densities of from 1 to 6/100 m^3 and 1 to 5/100 m^3 respectively. At Milford, 4 larvae were taken at estimated densities of 1 to 2/100 m^3. In 1964 a total of only 8 eggs was collected and they were taken at Easton. Spawning at Belvidere and Easton is strongly indicated since twenty of the eggs collected at Belvidere and fifteen of those collected at Easton in 1963 were at the one cell stage of embryonic development, having been spawned approximately two hours previously. Spawning activity at Belvidere and Easton was apparently not intense and the downstream terminus of spawning in the early 1960's was probably in the vicinity of Easton.

More recently Didun (1978) reported the collection of 4 eggs and 9 larvae in densities ranging from 7 to 23/100 m^3 and 5 to

23/100 m^3 respectively near Portland, Pennsylvania (river mile 206) in May through August 1977. Samples collected during 13 April to 18 May 1978 yielded no eggs or larvae. Weston (1977) did not report any eggs or larvae from samples collected during 12 April through 29 June 1976 near Martins Creek, Pennsylvania (river mile 195). At Gilbert Generating Station (river mile 171) 80 eggs were collected at densities of 2 to 15/100 m^3 and 3 larvae were taken at a density of 3/100 m^3 during April through August 1976 (Willis and Harmon 1977). Apparently the low spawning intensity of the 1960's continued through the mid-1970's.

Numerous ichthyoplankton surveys conducted in the tidal region from Wilmington, Delaware to Trenton, New Jersey (river mile 134) during the 1970's yielded virtually no American shad eggs or larvae. (Anselmini 1974a, b, c; 1976; Potter et al. 1974a, b; Preddice 1974; Harmon and Smith 1975; Molzann and Associates 1975; Didun and Harmon 1976; Morrisson and Associates 1976; Philadelphia Electric Company 1977a, b, c, d, e, f; Ichthyological Associates 1979a, b.)

Additionally, river-wide studies involving observations and collections of adult and juvenile shad conducted during the early 1950's and the mid-1960's indicated that very little spawning occurred downstream of the Delaware Water Gap. The chief spawning grounds were determined to be in the region from Port Jervis, New

York (river mile 255) to Hancock, New York (river mile 331) and extending into the East Branch (Sykes and Lehman 1957; Chittenden 1976).

This study and an ichthyoplankton survey conducted near Hutchinson, New Jersey (river mile 192) in April through July from 1981 through 1984 suggest a greater level of spawning activity in recent years in the region between Trenton, New Jersey and the Delaware Water Gap. This resurgence in spawning activity by American shad is likely related to improved water quality in the tidal region between Wilmington and Philadelphia (Albert 1982).

At Hutchinson densities of eggs and larvae were almost always much greater than what was reported from nearby areas in previously mentioned studies by Barker (1965) and Weston (1977). Spawning activity by American shad was observed on numerous occasions and a total of 18,555 eggs and 7,033 larvae was collected. Peak densities of eggs and larvae were 71/100m^3 and 7/100m^3 in 1981; 85/100m^3 and 189/100m^3 in 1982; 2122/100m^3 and 635/100m^3 in 1983 and 469/100m^3 and 673/100m^3 in 1984 (Charles T. Main, Inc. 1982, 1983, 1984, 1985).

Spawning activity in the region of Point Pleasant to Trenton is very limited in intensity. Spawning was not documented below Easton, Pennsylvania, 29 river miles upstream of Point Pleasent,

Pennsylvania in the mid-1960's (Barker 1965). The findings of Harmon and Willis (1977) may suggest potential spawning near Gilbert Generating Station, 14 river miles upstream of Point Pleasant, Pennsylvania in 1976. However those specimens may have drifted downstream from upstream spawning grounds. At Point Pleasant spawning activity was not observed during this study. Only 58 eggs, most of which were in an advanced state of embryological development, were collected at low densities and had likely drifted downstream from upstream spawning grounds (Table 3.2-16). However two specimens collected on 30 May 1985, 3.4% of the total, were likely spawned in close proximity to Point Pleasant. The large densities of larvae collected there further suggest that spawning activity is now likely occurring in the upstream vicinity. The collection of 33 larvae, most of which still had yolk sacs, at densities ranging from 1 to 20/100m^3, in the vicinities of New Hope and Yardley, Pennsylvania (RMC 1985) suggests that some spawning may occur as far downstream as Trenton, New Jersey.

Entrainment

As discussed previously, American shad eggs and larvae will be subjected to a low degree of entrainment by the Point Pleasant intake (RMC 1984). In 1985, American shad eggs were collected at the intake station (A11263-3) on only two sample dates, 17 April

and 30 May (Table 3.2-15). American shad larvae were collected at this station on only one date, 16 May (Table 3.2-14). The estimated worst case loss of eggs and larvae in 1985, if they had been entrained in the same densities at which they occurred in the river, is 10,733 and 1,928 respectively (Table 3.2-17). The potential effects of entrainment of American shad eggs and larvae on the Delaware River American shad stocks are limited and are discussed more fully in RMC (1984).

Table 3.2-1. Total catch of ichthyoplankton collected in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Common Name	Life-Stage	4/09	4/17	4/24	5/01	5/09	5/16	5/23	5/30	6/05	6/13	6/19	6/26	7/01	7/18	Total
Lampreys	Larvae	-	-	-	-	-	-	-	15	1	2	2	-	-	-	20
Herrings	Eggs	-	14	53	1201	2052	42	82	8	8	-	10	1	-	-	3471
	Larvae	-	-	1	245	7	2025	107	6	3	9	4	6	1	-	2414
American shad	Eggs	-	2	-	1	-	1	-	10	-	-	-	-	-	-	14
	Larvae	-	-	-	-	1	17	26	76	71	40	10	5	-	-	246
	Juvenile	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Gizzard shad	Eggs	-	-	-	-	-	2	3	-	1	-	-	-	-	-	6
	Larvae	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2
Minnows and carps	Eggs	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4
	Larvae	-	-	-	-	-	1	3	16	-	6	7	10	4	3	50
	Juvenile	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Carp	Eggs	-	-	-	-	-	-	-	7	3	-	3	1	-	-	14
	Larvae	-	-	-	45	-	36	3	326	-	-	8	18	1	10	447
Suckers	Eggs	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Quillback	Larvae	-	-	-	-	1	111	51	13	1	-	1	-	-	-	178
White sucker	Eggs	8	-	-	-	1	-	-	-	-	-	-	-	-	-	9
	Larvae	1	-	13	4	18	6	11	3	3	-	-	-	-	-	59
	Juvenile	-	-	-	-	-	-	-	1	4	1	1	-	-	-	7
White catfish	Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
	Juvenile	-	-	-	-	-	-	-	-	-	-	1	4	1	1	7
Brown bullhead	Juvenile	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Channel catfish	Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	32	32
	Juvenile	-	-	-	-	-	-	-	-	-	-	-	21	13	60	94
Margined madtom	Juvenile	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
White perch	Larvae	-	-	-	-	-	11	5	2	-	-	-	-	-	-	18
Rock bass	Larvae	-	-	-	-	-	-	-	23	20	1	-	-	-	-	44
Lepomis	Larvae	-	-	-	-	-	8	29	296	26	208	432	124	30	20	1173
	Juvenile	-	-	-	-	-	-	-	-	-	-	7	1	-	1	9
Smallmouth bass	Larvae	-	-	-	-	-	-	-	5	-	-	-	-	-	-	5
	Juvenile	-	-	-	-	-	-	-	-	2	-	1	-	-	-	3
Tessellated darter	Larvae	-	-	1	1	2	2	1	-	-	-	-	-	-	-	7
	Juvenile	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Shield darter	Larvae	-	-	-	4	-	-	-	-	-	-	-	-	-	-	4
Walleye	Eggs	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Unidentified fish	Larvae	-	-	-	1	-	2	4	6	2	1	1	-	-	-	17
Unidentified eggs	Eggs	2	-	-	4	2	17	26	-	1	-	-	-	1	-	53
*Total	Eggs	15	16	53	1206	2056	66	111	25	13	-	13	2	1	-	3577
	Larvae	1	-	15	300	29	2220	241	787	127	267	465	163	36	66	4717
	Juvenile	-	-	-	-	-	-	-	1	6	2	13	28	14	62	126
*Mean Water Temp (C)		9.0	13.6	16.2	20.9	18.0	20.7	18.9	22.4	20.8	21.3	22.6	21.6	22.8	26.6	19.7

Table 3.2-2. Total numbers of ichthyoplankton collected in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Common Name	Scientific Name	Lifestage	A10960-3 1985	A11263-1 1985	A11263-3 1985	A11760-3 1985	Total
Lampreys	Petromyzontidae	Larvae	15	1	4	-	20
Herrings	Clupeidae	Eggs	464	29	2322	656	3471
		Larvae	77	279	1966	92	2414
American shad	Alosa sapidissima	Eggs	6	-	4	4	14
		Larvae	2	241	1	2	246
		Juvenile	-	1	-	-	1
Gizzard shad	Dorosoma cepedianum	Eggs	1	-	5	-	6
		Larvae	1	-	1	-	2
Minnows and carps	Cyprinidae	Eggs	1	-	3	-	4
		Larvae	2	41	7	-	50
		Juvenile	-	1	-	-	1
Carp	Cyprinus carpio	Eggs	-	10	2	2	14
		Larvae	46	339	48	14	447
Suckers	Catostomidae	Eggs	1	-	-	-	1
Quillback	Carpiodes cyprinus	Larvae	27	69	53	29	178
White sucker	Catostomus commersoni	Eggs	-	-	7	2	9
		Larvae	10	28	19	2	59
		Juvenile	1	-	4	2	7
White catfish	Ictalurus catus	Larvae	1	-	-	-	1
		Juvenile	2	-	4	1	7
Brown bullhead	Ictalurus nebulosus	Juvenile	-	-	1	-	1
Channel catfish	Ictalurus punctatus	Larvae	32	-	-	-	32
		Juvenile	43	1	36	14	94
Margined madtom	Noturus insignis	Juvenile	-	1	1	-	2
White perch	Morone americana	Larvae	2	3	8	5	18
Rock bass	Ambloplites rupestris	Larvae	-	44	-	-	44
Lepomis	Lepomis	Larvae	2	1168	3	-	1173
		Juvenile	-	9	-	-	9
Smallmouth bass	Micropterus dolomieui	Larvae	-	5	-	-	5
		Juvenile	-	3	-	-	3
Tessellated darter	Etheostoma olmstedi	Larvae	2	2	3	-	7
		Juvenile	-	-	1	-	1
Shield darter	Percina peltata	Larvae	1	3	-	-	4
Walleye	Stizostedion vitreum	Eggs	1	-	4	-	5
Unidentified fish	Unidentified fish	Larvae	5	6	4	2	17
Unidentified eggs	Unidentified eggs	Eggs	11	21	4	17	53
			756	2305	4515	844	8420

Table 3.2-3. Total numbers of ichthyoplankton collected in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

Common Name	Scientific Name	Lifestage	1982	1983	1984	1985	Total
Lampreys	Petromyzontidae	Larvae	20	25	6	20	71
Herrings	Clupeidae	Eggs	8414	4610	2106	3471	18601
		Larvae	1150	3374	3281	2414	10219
		Juvenile	-	-	3	-	3
American shad	Alosa sapidissima	Eggs	5	35	4	14	58
		Larvae	387	715	384	246	1732
		Juvenile	8	-	-	1	9
Gizzard shad	Dorosoma cepedianum	Eggs	-	-	-	6	6
		Larvae	-	-	-	2	2
Minnows and carps	Cyprinidae	Eggs	189	3	-	4	196
		Larvae	81	183	103	50	417
		Juvenile	3	-	-	1	4
Goldfish	Carassius auratus	Larvae	-	-	1	-	1
Goldfish or carp	Goldfish or carp	Larvae	-	70	6	-	76
Carp	Cyprinus carpio	Eggs	-	1	7	14	22
		Larvae	161	1485	469	447	2562
Cutlips minnow	Exoglossum maxillingua	Juvenile	1	-	-	-	1
Notropis	Notropis	Larvae	32	-	-	-	32
Common shiner	Notropis cornutus	Larvae	-	1	-	-	1
Spottail shiner	Notropis hudsonius	Larvae	133	1	-	-	134
		Juvenile	2	3	-	-	5
Swallowtail shiner	Notropis procne	Juvenile	-	1	-	-	1
Spotfin shiner	Notropis spilopterus	Larvae	-	1	-	-	1
		Juvenile	1	-	-	-	1
Suckers	Catostomidae	Eggs	40	39	9	1	89
		Larvae	1319	292	1	-	1612
		Juvenile	10	-	-	-	10
Quillback	Carpiodes cyprinus	Larvae	-	12	666	178	856
White sucker	Catostomus commersoni	Eggs	-	21	23	9	53
		Larvae	-	167	560	59	786
		Juvenile	-	1	-	7	8
Creek chubsucker	Erimyzon oblongus	Larvae	89	8	-	-	97
Freshwater catfishes	Ictaluridae	Eggs	3	-	-	-	3
		Larvae	-	-	1	-	1
White catfish	Ictalurus catus	Larvae	-	-	-	1	1
		Juvenile	-	2	2	7	11
Yellow bullhead	Ictalurus natalis	Juvenile	2	-	-	-	2
Brown bullhead	Ictalurus nebulosus	Juvenile	1	10	-	1	12
Channel catfish	Ictalurus punctatus	Larvae	-	7	-	32	39
		Juvenile	230	140	80	94	544
Margined madtom	Noturus insignis	Juvenile	-	1	-	2	3
Killifishes	Cyprinodontidae	Juvenile	-	1	-	-	1
Banded killifish	Fundulus diaphanus	Larvae	-	-	3	-	3
White perch	Morone americana	Larvae	-	-	1	18	19
Rock bass	Ambloplites rupestris	Larvae	7	10	24	44	85
Lepomis	Lepomis	Larvae	144	322	178	1173	1817
		Juvenile	-	1	-	9	10
Smallmouth bass	Micropterus dolomieui	Larvae	1	3	11	5	20
		Juvenile	-	-	1	3	4
Largemouth bass	Micropterus salmoides	Larvae	1	-	-	-	1
Pomoxis	Pomoxis	Larvae	1	-	-	-	1
Tessellated darter	Etheostoma olmstedi	Larvae	12	26	31	7	76
		Juvenile	-	-	-	1	1
Shield darter	Percina peltata	Larvae	21	20	14	4	59
Walleye	Stizostedion vitreum	Eggs	-	-	-	5	5
		Larvae	1	1	20	-	22
Unidentified fish	Unidentified fish	Larvae	-	265	14	17	296
Unidentified eggs	Unidentified eggs	Eggs	1115	545	96	53	1809
			13584	12402	8105	8420	42511

Table 3.2-4. Total numbers of ichthyoplankton collected at Station A10960-3 in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

Common Name	Lifestage	1982	1983	1984	1985	Total
Lampreys	Larvae	10	14	6	15	45
Herrings	Eggs	2409	1000	671	464	4544
	Larvae	27	248	37	77	389
American shad	Eggs	2	11	1	6	20
	Larvae	2	5	1	2	10
	Juvenile	1	-	-	-	1
Gizzard shad	Eggs	-	-	-	1	1
	Larvae	-	-	-	1	1
Minnows and carps	Eggs	1	-	-	1	2
	Larvae	28	8	14	2	52
Goldfish or carp	Larvae	-	17	2	-	19
Carp	Eggs	-	1	4	-	5
	Larvae	31	329	147	46	553
Spottail shiner	Larvae	1	-	-	-	1
Suckers	Eggs	5	9	2	1	17
	Larvae	297	72	-	-	369
Quillback	Larvae	-	4	444	27	475
White sucker	Eggs	-	14	8	-	22
	Larvae	-	10	60	10	80
	Juvenile	-	1	-	1	2
Creek chubsucker	Larvae	37	-	-	-	37
White catfish	Larvae	-	-	-	1	1
	Juvenile	-	1	-	2	3
Yellow bullhead	Juvenile	1	-	-	-	1
Brown bullhead	Juvenile	1	3	-	-	4
Channel catfish	Larvae	-	2	-	32	34
	Juvenile	41	27	27	43	138
White perch	Larvae	-	-	1	2	3
Rock bass	Larvae	2	-	8	-	10
Lepomis	Larvae	3	1	22	2	28
Smallmouth bass	Larvae	-	-	2	-	2
Largemouth bass	Larvae	1	-	-	-	1
Tessellated darter	Larvae	1	5	11	2	19
Shield darter	Larvae	6	4	1	1	12
Walleye	Eggs	-	-	-	1	1
	Larvae	1	-	-	-	1
Unidentified fish	Larvae	-	36	5	5	46
Unidentified eggs	Eggs	332	126	18	11	487
		3240	1948	1492	756	7436

Table 3.2-5. Total numbers of ichthyoplankton collected at Station A11263-1 in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

Common Name	Lifestage	1982	1983	1984	1985	Total
Lampreys	Larvae	1	1	-	1	3
Herrings	Eggs	95	22	47	29	193
	Larvae	263	2513	3161	279	6216
	Juvenile	-	-	3	-	3
American shad	Larvae	384	699	380	241	1704
	Juvenile	7	-	-	1	8
Minnows and carps	Larvae	19	157	75	41	292
	Juvenile	1	-	-	1	2
Goldfish	Larvae	-	-	1	-	1
Goldfish or carp	Larvae	-	12	1	-	13
Carp	Eggs	-	-	-	10	10
	Larvae	109	412	47	339	907
Cutlips minnow	Juvenile	1	-	-	-	1
Notropis	Larvae	32	-	-	-	32
Spottail shiner	Larvae	132	1	-	-	133
	Juvenile	2	2	-	-	4
Swallowtail shiner	Juvenile	-	1	-	-	1
Spotfin shiner	Larvae	-	1	-	-	1
	Juvenile	1	-	-	-	1
Suckers	Eggs	8	-	-	-	8
	Larvae	674	48	-	-	722
	Juvenile	8	-	-	-	8
Quillback	Larvae	-	-	78	69	147
White sucker	Eggs	-	1	-	-	1
	Larvae	-	130	404	28	562
Creek chubsucker	Larvae	20	8	-	-	28
Freshwater catfishes	Larvae	-	-	1	-	1
Channel catfish	Larvae	-	2	-	-	2
	Juvenile	1	-	4	1	6
Margined madtom	Juvenile	-	-	-	1	1
Banded killifish	Larvae	-	-	1	-	1
White perch	Larvae	-	-	-	3	3
Rock bass	Larvae	4	9	10	44	67
Lepomis	Larvae	138	312	122	1168	1740
	Juvenile	-	-	-	9	9
Smallmouth bass	Larvae	1	3	1	5	10
	Juvenile	-	-	1	3	4
Pomoxis	Larvae	1	-	-	-	1
Tessellated darter	Larvae	3	13	10	2	28
Shield darter	Larvae	9	11	11	3	34
Walleye	Larvae	-	1	20	-	21
Unidentified fish	Larvae	-	41	7	6	54
Unidentified eggs	Eggs	16	41	22	21	100
		1930	4441	4407	2305	13083

Table 3.2-6. Total numbers of ichthyoplankton collected at Station A11263-3 in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

Common Name	Lifestage	1982	1983	1984	1985	Total
Lampreys	Larvae	4	10	-	4	18
Herrings	Eggs	1821	2243	526	2322	6912
	Larvae	44	448	52	1966	2510
American shad	Eggs	1	10	1	4	16
	Larvae	-	8	1	1	10
Gizzard shad	Eggs	-	-	-	5	5
	Larvae	-	-	-	1	1
Minnows and carps	Eggs	188	-	-	3	191
	Larvae	10	5	11	7	33
Goldfish or carp	Larvae	-	41	2	-	43
Carp	Eggs	-	-	2	2	4
	Larvae	14	470	131	48	663
Common shiner	Larvae	-	1	-	-	1
Spottail shiner	Juvenile	-	1	-	-	1
Suckers	Eggs	4	17	4	-	25
	Larvae	210	120	-	-	330
	Juvenile	2	-	-	-	2
Quillback	Larvae	-	-	76	53	129
White sucker	Eggs	-	2	8	7	17
	Larvae	-	16	67	19	102
	Juvenile	-	-	-	4	4
Creek chubsucker	Larvae	18	-	-	-	18
White catfish	Juvenile	-	-	1	4	5
Yellow bullhead	Juvenile	1	-	-	-	1
Brown bullhead	Juvenile	-	2	-	1	3
Channel catfish	Larvae	-	2	-	-	2
	Juvenile	178	25	33	36	272
Margined madtom	Juvenile	-	1	-	1	2
Killifishes	Juvenile	-	1	-	-	1
Banded killifish	Larvae	-	-	2	-	2
White perch	Larvae	-	-	-	8	8
Rock bass	Larvae	1	-	6	-	7
Lepomis	Larvae	3	5	27	3	38
	Juvenile	-	1	-	-	1
Smallmouth bass	Larvae	-	-	5	-	5
Tessellated darter	Larvae	6	5	6	3	20
	Juvenile	-	-	-	1	1
Shield darter	Larvae	2	3	-	-	5
Walleye	Eggs	-	-	-	4	4
Unidentified fish	Larvae	-	133	1	4	138
Unidentified eggs	Eggs	249	199	17	4	469
		2756	3769	979	4515	12019

Table 3.2-7. Total numbers of ichthyoplankton collected at Station A11760-3 in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

Common Name	Lifestage	1982	1983	1984	1985	Total
Lampreys	Larvae	5	-	-	-	5
Herrings	Eggs	4089	1345	862	656	6952
	Larvae	816	165	31	92	1104
American shad	Eggs	2	14	2	4	22
	Larvae	1	3	2	2	8
Minnows and carps	Eggs	-	3	-	-	3
	Larvae	24	13	3	-	40
	Juvenile	2	-	-	-	2
Goldfish or carp	Larvae	-	-	1	-	1
Carp	Eggs	-	-	1	2	3
	Larvae	7	274	144	14	439
Suckers	Eggs	23	13	3	-	39
	Larvae	138	52	1	-	191
Quillback	Larvae	-	8	68	29	105
White sucker	Eggs	-	4	7	2	13
	Larvae	-	11	29	2	42
	Juvenile	-	-	-	2	2
Creek chubsucker	Larvae	14	-	-	-	14
Freshwater catfishes	Eggs	3	-	-	-	3
White catfish	Juvenile	-	1	1	1	3
Brown bullhead	Juvenile	-	5	-	-	5
Channel catfish	Larvae	-	1	-	-	1
	Juvenile	10	88	16	14	128
White perch	Larvae	-	-	-	5	5
Rock bass	Larvae	-	1	-	-	1
Lepomis	Larvae	-	4	7	-	11
Smallmouth bass	Larvae	-	-	3	-	3
Tessellated darter	Larvae	2	3	4	-	9
Shield darter	Larvae	4	2	2	-	8
Unidentified fish	Larvae	-	55	1	2	58
Unidentified eggs	Eggs	518	179	39	17	753
		5658	2244	1227	844	9973

Table 3.2-8. Period of occurrence and maximum density (number/100 cu. meter) of American shad eggs and herring eggs collected in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

	Total Number Collected	Date First Collected	Water Temp. (C)	Date Last Collected	Water Temp. (C)	Maximum Density	Date of Maximum Density	Location of Maximum Density	Water Temp. (C)
American shad									
1982	5	04/28	14.5	05/13	18.0	3.7	05/13	A10960-3	18.0
1983	35	05/04	14.0	06/16	26.5	11.6	05/26	A11760-3	18.0
1984	4	05/10	13.0	06/25	22.0	1.3	06/25	A11760-3	21.0
1985	14	04/17	15.0	05/30	22.0	5.1	05/30	A10960-3	22.0
Herrings									
1982	8414	04/28	14.5	06/22	21.0	4236.1	05/13	A11760-3	20.0
1983	4610	05/04	14.0	06/16	26.2	730.6	06/03	A11263-3	19.5
1984	2106	05/02	14.5	06/15	25.0	652.5	05/14	A11760-3	14.5
1985	3471	04/17	14.0	06/26	22.0	1531.5	05/09	A11263-3	16.5

Table 3.2-9. Daytime mean densities (numbers per 100 m^3) of American shad eggs and larvae collected from the Delaware River at Point Pleasant, Pennsylvania.

Date		1982		1983		1984		1985	
		eggs	larvae	eggs	larvae	eggs	larvae	eggs	larvae
April	15-20	0	0					<1	0
	21-25							0	0
	26-30	<1	0			0	0		
May	1-5			2	0	0	0	0	0
	6-10	0	0			<1	0	0	0
	11-15	0	0	<1	0	0	0		
	16-20	0	0	0	0			0	4
	21-25					0	0	0	10
	26-31	0	<1	5	1			1	9
June	1-5	0	17	0	9			0	10
	6-10	0	21	1	4	0	30		
	11-15					0	102	0	<1
	16-20	0	20	<1	121			0	3
	21-25	0	0	0	3	<1	10		
	26-30	0	3	0	10			0	0
July	1-5					0	5	0	0
	6-10	0	0	0	0				

Table 3.2-10. Nighttime mean densities (numbers per 100 m^3) of American shad eggs and larvae collected from the Delaware River at Point Pleasant, Pennsylvania.

Date		1982		1983		1984		1985	
		eggs	larvae	eggs	larvae	eggs	larvae	eggs	larvae
April	15-20	0	0					<1	0
	21-25							0	0
	26-30	0	0			0	0		
May	1-5			0	0	0	0	<1	0
	6-10	<1	0					0	<1
	11-15	<1	0	0	0	0	0		
	16-20	0	16	0	0			<1	8
	21-25					0	0	0	12
	26-31	0	13	<1	2			2	42
June	1-5	0	3	<1	63			0	33
	6-10	0	85	0	8	<1	6		
	11-15					0	32	0	28
	16-20	0	16	<1	238			0	4
	21-25	0	32	0	71	0	117	0	0
	26-30	0	62	0	9	0	7	0	4
July	1-5					0	0	0	0
	6-10	0	3	0	0				
	11-15					0	<1		

Table 3.2-11. Period of occurrence and maximum density (number/100 cu. meter) of larvae and juveniles of selected taxa collected in the Delaware River near Point Pleasant, Pennsylvania during 1982 - 1985.

	Total Number Collected	Date First Collected	Water Temp. (C)	Date Last Collected	Water Temp. (C)	Maximum Density	Date of Maximum Density	Location of Maximum Density	Water Temp. (C)
American shad									
1982	395	05/19	20.0	07/07	23.5	339.5	06/10	A11263-1	20.0
1983	715	05/26	18.0	06/30	25.5	947.6	06/16	A11263-1	28.0
1984	384	06/08	24.0	07/11	22.0	465.2	06/22	A11263-1	23.5
1985	247	05/09	18.0	06/26	21.0	169.3	05/30	A11263-1	21.0
Carp									
1982	161	05/13	18.0	07/21	26.0	322.7	05/13	A11263-1	18.0
1983	1485	05/12	11.5	06/30	24.0	1018.3	06/16	A11263-1	28.0
1984	469	06/08	22.0	06/25	22.0	107.3	06/15	A11263-1	23.0
1985	447	05/01	20.0	07/18	26.0	359.8	05/30	A11263-1	21.0
Herrings									
1982	1150	05/06	20.0	06/22	20.0	863.8	05/19	A11760-3	20.0
1983	3374	05/12	13.0	06/22	25.0	5605.5	05/26	A11263-1	18.5
1984	3284	05/02	15.5	07/26	25.0	4019.6	06/08	A11263-1	22.0
1985	2414	04/24	16.0	07/01	22.0	2429.0	05/16	A11263-3	20.0
Lepomis									
1982	144	06/02	18.0	07/21	26.0	500.0	07/21	A11263-1	28.0
1983	323	06/16	28.0	08/04	27.5	496.2	07/21	A11263-1	28.5
1984	178	06/15	25.0	08/09	26.0	113.2	06/25	A11263-1	22.5
1985	1182	05/16	21.0	07/18	26.0	1081.2	06/19	A11263-1	22.0
Suckers									
1982	1418	04/28	14.5	06/22	21.0	1875.9	06/02	A11263-1	18.0
1983	480	05/12	11.5	06/30	24.0	297.1	06/03	A11263-1	19.5
1984	1227	05/02	14.0	06/25	22.0	670.1	05/21	A11263-1	16.0
1985	244	04/09	8.0	06/19	24.0	167.7	05/16	A11263-1	20.0

Table 3.2-12. Density (number/100 cu. meter) of all eggs collected during day and night ichthyoplankton sampling in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Date	Water Temp (C)	Downstream A10960-3 Day	Night	Mean	Eddy A11263-1 Day	Night	Mean	Intake A11263-3 Day	Night	Mean	Boat Ramp A11760-3 Day	Night	Mean
1985													
04/09	9.0	-	1.3	0.7	3.2	-	1.6	-	14.9	7.4	2.6	-	1.3
04/17	13.6	1.2	-	0.6	-	-	-	1.4	10.4	5.9	5.4	1.1	3.3
04/24	16.2	-	1.3	0.7	-	-	-	40.7	9.2	25.0	2.6	7.0	4.8
05/01	20.9	11.3	40.3	25.8	13.2	13.5	13.3	65.5	826.8	446.2	112.5	223.7	168.1
05/09	18.0	168.7	310.5	239.6	9.7	66.2	38.0	293.5	1531.5	912.5	69.5	336.5	203.0
05/16	20.7	13.4	5.7	9.6	-	-	-	15.1	24.1	19.6	19.0	10.6	14.8
05/23	18.9	15.6	18.5	17.0	63.0	-	31.5	21.2	34.7	28.0	13.2	17.9	15.6
05/30	22.4	2.7	5.1	3.9	8.6	-	4.3	8.5	1.2	4.8	6.7	5.5	6.1
06/05	20.8	-	1.2	0.6	-	7.2	3.6	5.5	1.3	3.4	2.1	1.1	1.6
06/13	21.3	-	-	-	-	-	-	-	-	-	-	-	-
06/19	22.6	4.6	-	2.3	-	7.6	3.8	3.7	2.4	3.1	-	1.2	0.6
06/26	21.6	-	-	-	-	2.9	1.5	1.2	-	0.6	-	-	-
07/01	22.8	-	-	-	-	3.3	1.6	-	-	-	-	-	-
07/18	26.6	-	-	-	-	-	-	-	-	-	-	-	-
	*Mean	16.3	27.0	21.7	5.7	6.8	6.3	31.1	177.9	104.5	16.0	43.6	29.8

Table 3.2-13. Density (number/100 cu. meter) of all larvae collected during day and night ichthyoplankton sampling in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Date	Water Temp (C)	Downstream A10960-3 Day	Night	Mean	Eddy A11263-1 Day	Night	Mean	Intake A11263-3 Day	Night	Mean	Boat Ramp A11760-3 Day	Night	Mean
1985													
04/09	9.0	-	-	-	-	-	-	-	1.4	0.7	-	-	-
04/17	13.6	-	-	-	-	-	-	-	-	-	-	-	-
04/24	16.2	-	2.6	1.3	-	31.3	15.6	1.1	3.4	2.3	-	2.8	1.4
05/01	20.9	1.3	4.0	2.6	39.5	209.5	124.5	-	220.3	110.1	-	7.4	3.7
05/09	18.0	-	5.0	2.5	-	56.3	28.1	-	11.0	5.5	-	-	-
05/16	20.7	10.8	56.8	33.8	35.3	984.5	509.9	26.0	2492.9	1259.5	1.3	81.0	41.1
05/23	18.9	11.4	74.1	42.7	145.7	109.8	127.7	15.9	62.5	39.2	21.0	34.4	27.7
05/30	22.4	17.2	58.8	38.0	554.3	1251.3	902.8	23.9	32.9	28.4	16.1	5.5	10.8
06/05	20.8	-	1.2	0.6	48.5	244.0	146.3	-	2.7	1.3	-	3.4	1.7
06/13	21.3	1.2	2.3	1.8	8.7	711.9	360.3	-	10.8	5.4	-	-	-
06/19	22.6	-	2.6	1.3	39.2	1124.4	581.8	-	1.2	0.6	1.2	2.3	1.8
06/26	21.6	-	-	-	-	473.7	236.8	-	-	-	-	1.2	0.6
07/01	22.8	-	1.1	0.6	3.2	111.1	57.1	-	-	-	-	-	-
07/18	26.6	-	31.6	15.8	39.1	49.4	44.3	-	1.1	0.6	-	-	-
	*Mean	3.1	17.0	10.0	62.9	411.2	237.1	4.3	184.1	94.2	2.8	10.0	6.4

Table 3.2-14. Density (number/100 cu. meter) of American shad larvae and juveniles collected during day and night ichthyoplankton sampling in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Date	Water Temp (C)	Downstream A10960-3 Day	Night	Mean	Eddy A11263-1 Day	Night	Mean	Intake A11263-3 Day	Night	Mean	Boat Ramp A11760-3 Day	Night	Mean
1985													
04/09	9.0	-	-	-	-	-	-	-	-	-	-	-	-
04/17	13.6	-	-	-	-	-	-	-	-	-	-	-	-
04/24	16.2	-	-	-	-	-	-	-	-	-	-	-	-
05/01	20.9	-	-	-	-	-	-	-	-	-	-	-	-
05/09	18.0	-	-	-	-	3.3	1.7	-	-	-	-	-	-
05/16	20.7	-	1.4	0.7	16.0	31.1	23.5	1.4	-	0.7	-	-	-
05/23	18.9	-	1.3	0.7	39.4	45.7	42.6	-	-	-	-	-	-
05/30	22.4	-	-	-	34.3	169.3	101.8	-	-	-	-	-	-
06/05	20.8	-	-	-	38.8	128.0	83.4	-	-	-	-	2.3	1.1
06/13	21.3	-	-	-	2.9	110.2	56.5	-	-	-	-	-	-
06/19	22.6	-	-	-	9.8	15.2	12.5	-	-	-	-	-	-
06/26	21.6	-	-	-	-	17.5	8.8	-	-	-	-	-	-
07/01	22.8	-	-	-	-	-	-	-	-	-	-	-	-
07/18	26.6	-	-	-	-	-	-	-	-	-	-	-	-
	*Mean	-	0.2	0.1	9.8	41.5	25.7	0.1	-	0.0	-	0.2	0.1

Table 3.2-15. Density (number/100 cu. meter) of American shad eggs collected during day and night ichthyoplankton sampling in the Delaware River near Point Pleasant, Pennsylvania during 1985.

Date	Water Temp (C)	Downstream A10960-3 Day	Night	Mean	Eddy A11263-1 Day	Night	Mean	Intake A11263-3 Day	Night	Mean	Boat Ramp A11760-3 Day	Night	Mean
1985													
04/09	9.0	-	-	-	-	-	-	-	-	-	-	-	-
04/17	13.6	-	-	-	-	-	-	1.4	1.3	1.4	-	-	-
04/24	16.2	-	-	-	-	-	-	-	-	-	-	-	-
05/01	20.9	-	1.3	0.7	-	-	-	-	-	-	-	-	-
05/09	18.0	-	-	-	-	-	-	-	-	-	-	-	-
05/16	20.7	-	1.4	0.7	-	-	-	-	-	-	-	-	-
05/23	18.9	-	-	-	-	-	-	-	-	-	-	-	-
05/30	22.4	-	5.1	2.6	-	-	-	2.8	-	1.4	2.7	2.8	2.7
06/05	20.8	-	-	-	-	-	-	-	-	-	-	-	-
06/13	21.3	-	-	-	-	-	-	-	-	-	-	-	-
06/19	22.6	-	-	-	-	-	-	-	-	-	-	-	-
06/26	21.6	-	-	-	-	-	-	-	-	-	-	-	-
07/01	22.8	-	-	-	-	-	-	-	-	-	-	-	-
07/18	26.6	-	-	-	-	-	-	-	-	-	-	-	-
	*Mean	-	0.5	0.3	-	-	-	0.3	0.1	0.2	0.2	0.2	0.2

Table 3.2-16. Approximate state of embryonic development of American shad eggs collected at Point Pleasant during 1982-1985[1].

Approximate state of Embryonic development	Development time in hours	Number of eggs	Percentage of eggs
Morula	1 - 2	2	3.4
Blastula	3 - 5	6	10.3
Gastrula	5 - 14	18	31
Primitive streak	14 - 25	6	10.3
Early Embryo	25 - 33	13	22.4
Tail Free Embryo	33 - 35	1	1.7
Indeterminate	-	12	20.6

[1]Based on Marcy (1976)

Table 3.2-17. Estimated entrainment of American shad eggs and larvae at the Point Pleasant intake station, 1985[1].

Eggs

Sample Date	Interval	Cubic meters of water withdrawn during interval	Mean Density (No./100 m^3)	Estimated Number Entrained
4/17	4/13-4/20	215,080	1.4	3,011
5/30	5/27-6/2	551,567	1.4	7,722

Larvae

Sample Date	Interval	Cubic meters of water withdrawn during interval	Mean Density (No./100 m^3)	Estimated Number Entrained
5/16	5/13-5/19	275,359	.7	1,928

[1]Potential entrainment was calculated using the total projected Delaware River water withdrawals for 1985 which include the requirements for public water supply, Limerick Units I and II and maintenance flows (Table 1, Pennsylvania Department of Environmental Resources 1982). The projected 1985 withdrawal schedule was used since it most closely approximated the study period.

4.0 East Branch Perkiomen Creek

East Branch Perkiomen Creek (EBPC) is a warmwater stream which drains 158 km^2 of the Piedmont physiographic province in southeastern Pennsylvania. It flows southwest approximately 39 km from its source in Bedminster Township to its confluence with Perkiomen Creek just below Schwenksville. The creek has a low gradient (1.9 m/km) and consists of riffle and run habitats with few natural pools. Several small man-made impoundments are located in the lower half. The stream supports a diverse and productive flora and fauna. Much of the watershed is used for agriculture but land is increasingly being developed for residential use. The major population concentration occurs midpoint on the creek at Sellersville-Perkasie.

Low natural base flows and frequent localized storms produce an extremely variable, often flashy, flow regime. Spring flows are generally high due to snow melt and precipitation. As summer approaches flows become lower and in late summer and fall surface flow in upper reaches often ceases but may fluctuate rapidly due to local thunderstorms. Riffle habitat is much reduced or eliminated in about one-third of the stream length and the creek becomes a series of pools or quiescent reaches connected by subsurface percolation.

The proposed diversion discharge point is located about 150 m upstream of Elephant Road, thus the East Branch Perkiomen Creek study area includes the creek from just above Elephant Road bridge downstream to the confluence with Perkiomen Creek. For a further description of this area, refer to LGS EROL Section 6.1. Sample stations are designated by common name and by the letter 'E' followed by a number that indicates the distance in meters upstream from the mouth of the Creek. Where stations include several meters of stream, site numbers designate the downstream end of the station.

The biota and water quality of East Branch Perkiomen Creek were studied extensively from 1970 through 1978 and were summarized in the EROL (Section 2.2.2.3). Additional studies of water quality, benthic macroinvertebrates, and fishes conducted in 1979-1984 were summarized in subsequent progress reports (RMC-Environmental Services 1984 and 1985). The results of these studies conducted in 1985 are summarized below.

The East Branch Perkiomen Creek was not affected by LGS operation in 1985. The pipeline and discharge structure that would introduce diversion water from the Delaware River have not yet been built.

4.1 Water Quality

Summary

1. Water quality samples were collected at two week intervals at three stations in EBPC.

2. Many new extremes were recorded, most of them associated with the extended low stream flows observed. A large percentage of them were slightly outside the established ranges.

3. New maxima recorded for copper (E32300) and zinc (all stations) were major extensions of their established ranges.

Introduction and Methods

East Branch Perkiomen Creek water quality in relation to future LGS water supply was studied from May 1974 through December 1978 and again from January 1983 through the present. The results of samples collected in 1985 are summarized below. The objectives of this program are to monitor existing water quality conditions on EBPC to provide a more extensive database with which to predict and assess diversion-induced water quality changes, and to provide water quality information for concurrent aquatic ecological programs.

As in previous years, three sample stations were located within the study area which extended from the upper reach near Branch Road bridge to near the confluence with Perkiomen Creek. Station E32300 is immediately downstream of Branch Road (Bucks County, PA) bridge over EBPC and about 4.7 km downstream from the diversion outfall location. Station E22880 is downstream of the Cathill Road (Bucks County, PA) bridge and some 3.2 km downstream of the Pennridge Sewage Treatment Plant. E2800 is upstream of the Garges Road (Montgomery County, PA) bridge.

Sampling began on 2 January and all stations were sampled once every 2 weeks. All samples were collected as subsurface grab samples and were analyzed according to standard, widely accepted methods.

Results and Discussion

EBPC flow data obtained by the USGS in 1985, the first full year of operation of the Bucks Road gage, are presented in Tables 4.1-1 and 4.1-2. Overall, 1985 was characterized by unusually low flows punctuated with only a few high flow events. Many new maximum and minimum parameter values for the post-EROL period (1983-1985) were recorded in 1985. Most were associated with the extended low flows, but a few were due to infrequent high flow events. Overall, many of the exceedances of the established seasonal ranges were only slightly outside the previously esta-

blished ranges or they were more characteristic of the normally drier months of the year. In some cases (e.g., sulfide), the exceedances were due to the limited record available for comparison.

E32300

Seasonal summaries of water quality data obtained for this station for 1983-1985 are shown in Table 4.1-3 and 1985 alone in Table 4.1-4. Several new maximum and minimum values were recorded for 1985 when compared to the data obtained in 1983 and 1984 (Tables 4.1-5 and 4.1-6). In winter, the high ammonia nitrogen concentration occurred during a period of particularly high flow. Coincidentally, several new minima were established on this date for parameters which tend to vary inversely with flow. The new zinc maximum was a major extension of the established range for the winter quarter. In spring, the new maxima established for alkalinity, total dissolved solids, calcium, and magnesium were all associated with the unusually low flows. In summer, the new copper and zinc maxima occurred on the same date and were major extensions of their respective ranges.

E22880

Seasonal summaries of water quality data obtained at this location are provided for 1983-1985 in Table 4.1-7 and for 1985 alone in Table 4.1-8.

As with the upstream station, several new extreme values were established in each quarter and most were due to the extended low flow period or coincided with isolated high flow events (Tables 4.1-9 and 4.1-10). In winter, the new potassium and nitrate nitrogen maxima were substantially higher than those previously established, and approximated the values usually seen in the normally drier summer and fall quarters. Likewise, in spring during an unusually dry period in April nine new maxima were established on the same sampling date. Again, these new high values were unusual for spring, and approximated values that had previously been observed in summer and fall. The new zinc maximum was much higher than observed in 1983-1984, but was substantially lower than the new maximum recorded in summer. New maxima were also recorded for chloride and potassium in both summer and fall.

E2800

The 1983-1985 water quality data are summarized in Table 4.1-11 and for 1985 alone in Table 4.1-12. As described for the other EBPC sampling stations, the several new seasonal extremes

established in 1985 were associated with the unusual flows observed. New maxima were established for sodium, chloride, and potassium in all quarters and all were related to extremely low flows (Tables 4.1-13 and 4.1-14). The new zinc maximum was well outside the previously established range as was the new nitrate nitrogen maximum in spring.

All of the new maxima recorded in spring occurred on the same sampling date in April. This date was near the end of a 2-month long period of consistently low stream flow, an unusual condition for spring. The new maxima recorded in fall and winter were also associated with the extended low flow conditons. Most of the new maxima established in spring were associated with the high flows sampled on 13 February and due to the fact that the affected parameters tend to vary inversely with flow.

Table 4.1-1. Mean daily East Branch Perkiomen Creek discharge (cu ft/sec) measured at the Bucks Road US Geological Survey gage in 1985.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	6	1	3	5	0	6	0	0	0	2	0	43
02	20	1	3	2	1	1	0	0	0	2	0	27
03	9	2	2	2	56	1	0	0	0	21	0	8
04	5	2	2	2	11	0	0	0	0	12	0	5
05	6	2	4	1	4	5	0	0	0	10	5	4
06	5	2	2	1	3	2	0	0	0	6	3	4
07	5	2	2	1	2	1	0	0	0	3	2	5
08	5	2	2	1	2	3	0	0	0	2	1	5
09	2	2	2	1	1	2	0	0	0	1	1	4
10	1	2	2	1	1	1	0	0	0	1	1	4
11	2	2	2	1	1	1	0	0	0	1	1	3
12	1	177	9	1	1	1	0	0	0	1	1	4
13	1	37	5	1	1	1	0	0	0	1	1	8
14	1	17	3	1	1	0	0	0	0	1	1	10
15	1	8	2	1	0	0	0	0	0	1	1	4
16	1	6	2	1	0	5	0	0	0	2	59	3
17	1	5	2	0	2	2	0	0	0	5	82	2
18	1	4	1	0	7	1	0	0	0	5	12	2
19	1	5	1	0	2	1	0	0	0	3	7	1
20	1	5	1	0	1	1	0	0	0	2	5	1
21	1	4	1	0	1	0	0	0	0	2	4	1
22	1	6	1	0	1	0	0	0	0	2	40	1
23	1	13	2	0	1	0	0	0	0	33	16	1
24	1	12	2	0	1	0	0	0	0	0	7	1
25	1	10	2	0	1	0	0	0	0	1	5	1
26	1	7	1	0	1	0	0	0	0	1	20	1
27	1	7	1	0	0	0	1	0	372	1	26	1
28	1	4	1	1	0	0	1	0	10	1	78	1
29	1		1	0	0	0	0	0	4	1	32	1
30	1		1	0	0	0	0	0	2	0	23	0
31	1		1		0		0	0		0		0
Minimum	1	1	1	0	0	0	0	0	0	0	0	0
Mean	3	12	2	1	3	1	0	0	13	4	15	5
Median	1	4	2	1	1	1	0	0	0	2	4	3
Maximum	20	177	9	5	56	6	1	0	372	33	82	43

Table 4.1-2. Mean monthly East Branch Perkiomen Creek discharge (cu ft/sec) measured at the Bucks Road US Geological Survey gage, 1984 - 1985.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984										1	2	6
1985	3	12	2	1	3	1	0	0	13	4	15	5
Minimum	1	1	1	0	0	0	0	0	0	0	0	0
Mean	3	12	2	1	3	1	0	0	13	3	8	5
Median	1	4	2	1	1	1	0	0	0	1	1	3
Maximum	20	177	9	5	56	6	1	0	372	33	82	43

Table 4.1-3. Summary of East Branch Perkiomen Creek water quality at Station E32300, 30 March 1983 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	1.0	8.0	1.0	9.0	21.0	17.0	21.0	26.0	5.0	13.1	21.5	57
Dissolved Oxygen (mg/l)	10.6	11.8	14.4	6.1	12.0	13.9	3.8	7.3	9.6	3.4	9.0	11.6	62
Biochemical Oxygen Demand (mg/l)	0.0	1.4	4.2	0.4	1.2	3.2	0.2	1.5	3.9	0.0	1.0	5.9	63
Chemical Oxygen Demand (mg/l)	0.0	11.5	65.7	0.0	14.4	41.1	0.0	20.4	223.0	0.0	15.9	36.6	64
Total Organic Carbon (mg/l)	0.0	3.2	25.8	0.0	3.6	13.3	0.9	4.7	111.8	1.7	3.8	27.8	60
pH	6.86	7.10	7.45	6.95	7.57	8.57	7.04	7.70	8.06	7.23	7.46	8.03	64
Total Alkalinity (mg/l)	10.1	29.2	63.4	14.6	33.6	65.4	0.0	62.6	91.7	18.5	54.2	114.3	64
Total Hardness (mg/l)	38.9	66.8	98.3	12.7	67.0	96.1	47.1	84.7	188.7	61.5	88.8	105.0	64
Specific Conductance (usm/cm)	121	167	224	126	171	255	142	229	289	179	240	313	64
Total Suspended Solids (mg/l)	0	4	431	0	4	73	0	9	331	0	3	20	64
Chloride (mg/l)	10.0	19.8	33.3	5.4	12.3	25.8	7.4	19.0	28.8	12.0	19.1	26.9	64
Sulfate (mg/l)	16.1	29.9	35.9	15.1	26.5	37.5	19.5	29.7	93.3	16.6	33.3	40.7	64
Sodium (mg/l)	6.25	10.29	15.09	6.58	8.74	14.09	5.74	12.20	20.58	8.80	12.04	16.11	64
Potassium (mg/l)	1.5	2.1	3.3	1.4	1.7	2.8	1.9	2.8	4.4	2.3	3.3	4.3	64
Calcium (mg/l)	5.8	14.3	18.4	5.7	13.1	24.9	7.0	16.0	28.8	8.2	21.6	28.5	64
Magnesium (mg/l)	5.25	8.29	13.71	4.46	8.97	14.19	7.20	11.80	16.68	8.26	12.64	17.77	64
Ammonia Nitrogen (mg/l)	0.000	0.000	0.246	0.000	0.031	0.068	0.021	0.046	0.164	0.000	0.000	0.061	64
Nitrite Nitrogen (mg/l)	0.000	0.008	0.030	0.000	0.007	0.076	0.000	0.003	0.135	0.000	0.000	0.020	64
Nitrate Nitrogen (mg/l)	1.43	2.19	3.31	0.00	1.35	2.46	0.00	0.24	2.06	0.00	0.45	3.88	64
Total Phosphate Phosphorus (mg/l)	0.00	0.04	0.35	0.00	0.03	0.07	0.00	0.03	0.26	0.00	0.04	0.19	61
Ortho Phosphate Phosphorus (mg/l)	0.00	0.02	0.12	0.00	0.02	0.07	0.00	0.02	0.26	0.00	0.00	0.06	62
Chromium (mg/l)	0.001	0.005	0.014	0.002	0.004	0.009	0.000	0.006	0.054	0.000	0.005	0.008	64
Copper (mg/l)	0.000	0.002	0.010	0.000	0.002	0.006	0.000	0.002	0.034	0.001	0.002	0.007	64
Iron (mg/l)	0.00	0.27	8.77	0.00	0.20	1.56	0.09	0.22	10.93	0.00	0.14	0.50	64
Lead (mg/l)	0.000	0.001	0.008	0.000	0.001	0.014	0.000	0.001	0.006	0.000	0.000	0.002	64
Manganese (mg/l)	0.00	0.00	0.33	0.00	0.00	0.07	0.00	0.00	0.20	0.00	0.00	0.30	64
Zinc (mg/l)	0.00	0.01	0.25	0.00	0.00	0.06	0.00	0.00	0.70	0.00	0.00	0.03	64
Cyanide (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.002	64
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.191	0.000	0.000	0.000	64
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	62
Total Coliforms (c/.1l)	20	600	4700	10	520	6000	250	2000	60000	60	710	13000	61
Fecal Coliforms (c/.1l)	14	70	3000	5	140	2900	89	430	17550	18	238	3500	61

Table 4.1-4. Summary of East Branch Perkiomen Creek water quality at Station E32300, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	0.0	1.0	8.0	5.0	10.5	18.5	19.0	22.0	25.0	11.5	13.0	18.0	25
Dissolved Oxygen (mg/l)	10.9	11.4	14.1	6.1	12.0	13.0	5.1	8.0	9.6	5.7	9.2	10.5	24
Biochemical Oxygen Demand (mg/l)	0.0	1.0	3.7	0.4	1.2	2.2	0.2	0.7	1.9	0.0	0.7	2.5	26
Chemical Oxygen Demand (mg/l)	0.0	14.0	21.5	0.0	15.4	19.5	0.0	16.2	31.6	0.0	18.1	36.6	26
Total Organic Carbon (mg/l)	1.8	2.5	5.2	2.1	3.1	3.9	2.8	4.2	4.7	3.3	3.7	6.3	26
pH	6.86	7.27	7.45	7.57	7.64	7.96	7.51	7.89	8.06	7.28	7.75	7.84	26
Total Alkalinity (mg/l)	10.1	34.9	63.4	29.9	45.4	65.4	65.7	82.9	91.7	35.5	63.7	114.3	26
Total Hardness (mg/l)	38.9	65.5	98.3	60.3	67.6	96.1	72.4	85.0	96.0	61.5	71.9	105.0	26
Specific Conductance (usm/cm)	121	168	224	172	220	255	235	273	286	189	237	313	26
Total Suspended Solids (mg/l)	0	3	48	0	4	7	0	3	22	1	3	10	26
Chloride (mg/l)	16.8	22.8	26.7	20.0	23.5	25.8	20.6	24.5	28.8	18.5	22.9	26.9	26
Sulfate (mg/l)	16.1	29.9	34.1	26.5	28.5	34.2	29.4	31.9	35.9	26.7	36.8	38.5	26
Sodium (mg/l)	9.42	11.60	13.37	12.07	13.44	14.09	12.48	14.81	16.76	11.37	13.12	16.11	26
Potassium (mg/l)	1.7	2.2	3.2	1.6	2.3	2.8	2.2	2.8	3.3	2.8	3.4	3.7	26
Calcium (mg/l)	5.8	14.6	18.4	16.8	20.5	24.9	22.0	26.7	28.8	17.3	22.3	28.5	26
Magnesium (mg/l)	5.81	8.63	13.71	9.60	10.74	14.19	12.16	14.90	16.68	9.60	13.19	17.77	26
Ammonia Nitrogen (mg/l)	0.000	0.020	0.246	0.000	0.017	0.054	0.034	0.045	0.094	0.000	0.017	0.061	26
Nitrite Nitrogen (mg/l)	0.000	0.008	0.018	0.006	0.013	0.076	0.000	0.000	0.028	0.000	0.004	0.015	26
Nitrate Nitrogen (mg/l)	1.73	2.19	2.52	0.00	1.24	1.93	0.00	0.00	0.79	0.00	0.91	2.32	26
Total Phosphate Phosphorus (mg/l)	0.00	0.05	0.10	0.00	0.02	0.03	0.00	0.00	0.05	0.00	0.02	0.05	25
Ortho Phosphate Phosphorus (mg/l)	0.00	0.02	0.07	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.05	24
Chromium (mg/l)	0.001	0.006	0.006	0.003	0.005	0.006	0.003	0.006	0.017	0.000	0.005	0.008	26
Copper (mg/l)	0.001	0.001	0.005	0.001	0.002	0.006	0.000	0.001	0.034	0.001	0.002	0.003	26
Iron (mg/l)	0.10	0.54	1.70	0.00	0.24	0.39	0.09	0.19	0.49	0.00	0.04	0.38	26
Lead (mg/l)	0.000	0.000	0.006	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.002	26
Manganese (mg/l)	0.00	0.00	0.08	0.00	0.00	0.07	0.00	0.06	0.10	0.00	0.03	0.18	26
Zinc (mg/l)	0.00	0.00	0.25	0.00	0.01	0.06	0.00	0.01	0.70	0.00	0.00	0.01	26
Cyanide (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25
Total Coliforms (c/.1l)	20	300	4200	10	320	6000	250	2100	12000	120	1400	13000	24
Fecal Coliforms (c/.1l)	20	56	1180	5	190	2900	130	360	690	110	240	3500	24

Table 4.1-5. New maximum values observed for water quality parameters measured in 1985 at Station E 32300 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Temperature (C)	8.0	01/02/85
	Ammonia Nitrogen (mg/l)	0.246	02/13/85
	Zinc (mg/l)	0.25	02/27/85
Mar, Apr, May	Total Alkalinity (mg/l)	65.4	04/24/85
	Total Dissolved Solids (mg/l)	252	05/22/85
	Calcium (mg/l)	24.9	04/24/85
	Magnesium (mg/l)	14.19	04/24/85
	Cyanide (mg/l)	0.001	03/27/85
	Fecal Coliforms (c/.1l)	2900	05/22/85
	Total Coliforms (c/.1l)	6000	05/22/85
Jun, Jul, Aug	pH	8.06	08/28/85
	Total Dissolved Solids (mg/l)	242	07/17/85
	Magnesium (mg/l)	16.68	08/14/85
	Copper (mg/l)	0.034	06/05/85
	Zinc (mg/l)	0.70	06/05/85
Sep, Oct, Nov	Total Alkalinity (mg/l)	114.3	09/11/85
	Magnesium (mg/l)	17.77	09/11/85
	Ammonia Nitrogen (mg/l)	0.061	10/23/85
	Chemical Oxygen Demand (mg/l)	36.6	10/09/85
	Fecal Coliforms (c/.1l)	3500	11/06/85
	Total Coliforms (c/.1l)	13000	11/06/85

Table 4.1-6. New minimum values observed for water quality parameters measured in 1985 at Station E 32300 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	pH	6.86	02/13/85
	Total Alkalinity (mg/l)	10.1	02/13/85
	Total Hardness (mg/l)	38.9	02/13/85
	Specific Conductance (usm/cm)	121	02/13/85
	Sulfate (mg/l)	16.1	02/13/85
	Calcium (mg/l)	5.8	02/13/85
	Total Coliforms (c/.1l)	20	01/30/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	6.1	04/24/85
	Iron (mg/l)	0.00	03/27/85
	Fecal Coliforms (c/.1l)	5	03/27/85
	Total Coliforms (c/.1l)	10	03/27/85
Jun, Jul, Aug	Iron (mg/l)	0.09	08/28/85
	Chemical Oxygen Demand (mg/l)	0.0	07/17/85
	Total Coliforms (c/.1l)	250	07/17/85
Sep, Oct, Nov	Iron (mg/l)	0.00	09/25/85
	Chemical Oxygen Demand (mg/l)	0.0	10/23/85

Table 4.1-7. Summary of East Branch Perkiomen Creek water quality at Station E22880, 30 March 1983 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	1.0	8.0	1.0	11.0	20.0	18.0	21.5	25.0	3.0	14.0	22.0	65
Dissolved Oxygen (mg/l)	8.3	11.4	14.0	6.3	9.9	13.2	4.9	7.3	10.9	5.8	8.7	11.9	69
Biochemical Oxygen Demand (mg/l)	0.1	1.5	4.2	0.3	1.3	8.1	0.5	1.4	7.6	0.1	1.4	6.7	72
Chemical Oxygen Demand (mg/l)	0.0	13.9	21.1	0.0	13.8	31.7	0.0	17.1	39.3	0.0	17.9	36.0	72
Total Organic Carbon (mg/l)	0.0	4.1	19.1	0.0	3.4	14.7	0.0	4.9	18.5	0.0	5.8	24.3	68
pH	6.94	7.37	7.68	6.97	7.58	8.25	7.00	7.62	8.42	6.64	7.57	8.08	72
Total Alkalinity (mg/l)	15.7	50.3	99.6	14.6	46.7	72.7	40.1	71.2	101.2	36.1	69.1	102.2	72
Total Hardness (mg/l)	51.6	91.3	184.5	22.8	83.2	184.6	70.9	131.4	228.1	75.7	156.5	363.2	72
Specific Conductance (usm/cm)	162	266	576	148	259	696	174	536	911	251	549	1158	72
Total Suspended Solids (mg/l)	0	8	429	0	7	99	0	7	52	0	4	23	72
Chloride (mg/l)	15.1	37.8	110.4	10.1	36.3	117.4	9.9	83.8	155.2	25.5	98.8	226.1	72
Sulfate (mg/l)	16.6	37.7	80.9	20.0	36.8	97.6	19.5	59.4	124.8	29.1	73.8	142.0	72
Sodium (mg/l)	9.01	21.94	71.48	9.78	22.56	73.88	9.37	48.84	96.82	16.46	65.51	157.84	72
Potassium (mg/l)	1.9	3.9	9.9	1.8	2.5	8.1	2.4	5.7	11.0	3.3	7.5	16.4	72
Calcium (mg/l)	10.1	21.7	41.1	8.1	18.7	51.4	12.0	33.9	65.6	16.0	29.2	80.3	72
Magnesium (mg/l)	7.05	11.29	19.95	5.46	11.55	20.13	8.52	16.44	25.10	9.35	19.05	27.05	72
Ammonia Nitrogen (mg/l)	0.000	0.213	2.092	0.000	0.085	1.210	0.000	0.049	0.136	0.000	0.046	0.352	72
Nitrite Nitrogen (mg/l)	0.000	0.025	0.402	0.007	0.029	0.158	0.007	0.036	0.057	0.000	0.041	0.176	72
Nitrate Nitrogen (mg/l)	1.65	3.40	8.45	1.14	2.77	7.71	1.65	5.76	12.66	2.05	7.28	29.70	72
Total Phosphate Phosphorus (mg/l)	0.02	0.09	0.34	0.03	0.06	0.12	0.04	0.08	0.18	0.04	0.10	0.26	69
Ortho Phosphate Phosphorus (mg/l)	0.02	0.06	0.21	0.01	0.04	0.13	0.02	0.06	0.11	0.01	0.05	0.22	70
Chromium (mg/l)	0.003	0.014	0.100	0.005	0.010	0.015	0.001	0.009	0.193	0.002	0.010	0.090	72
Copper (mg/l)	0.004	0.010	0.038	0.003	0.009	0.027	0.000	0.018	0.053	0.003	0.015	0.059	72
Iron (mg/l)	0.00	0.23	9.54	0.08	0.28	2.50	0.00	0.27	0.86	0.00	0.19	1.87	72
Lead (mg/l)	0.000	0.000	0.015	0.000	0.001	0.007	0.000	0.001	0.010	0.000	0.002	0.004	72
Manganese (mg/l)	0.00	0.05	0.32	0.00	0.00	0.10	0.00	0.00	0.14	0.00	0.06	0.13	72
Zinc (mg/l)	0.01	0.03	0.12	0.00	0.01	0.11	0.00	0.01	0.58	0.00	0.03	0.09	72
Cyanide (mg/l)	0.000	0.002	0.016	0.000	0.000	0.007	0.000	0.000	0.003	0.000	0.003	0.011	72
Phenols (mg/l)	0.000	0.000	0.029	0.000	0.000	0.005	0.000	0.000	0.039	0.000	0.000	0.000	72
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	2.2	0.0	0.0	0.0	71
Total Coliforms (c/.1l)	0	355	5100	50	585	10000	120	1950	97000	50	1900	27000	70
Fecal Coliforms (c/.1l)	0	21	1800	16	89	6100	160	495	15000	0	195	4700	71

Table 4.1-8. Summary of East Branch Perkiomen Creek water quality at Station E22880, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	-0.1	1.0	8.0	6.0	10.5	17.5	18.0	21.5	25.0	12.3	13.0	21.0	26
Dissolved Oxygen (mg/l)	8.3	10.6	14.0	6.3	9.9	11.2	6.4	8.2	10.9	5.8	8.5	9.6	25
Biochemical Oxygen Demand (mg/l)	0.1	0.5	4.2	0.3	1.2	2.1	0.6	0.9	1.5	0.1	0.6	3.8	26
Chemical Oxygen Demand (mg/l)	7.9	15.2	21.1	13.1	16.3	29.1	10.1	13.5	38.2	0.0	27.2	36.0	26
Total Organic Carbon (mg/l)	2.5	3.6	4.6	3.0	3.8	5.1	3.2	4.9	5.5	4.0	5.4	6.8	26
pH	6.94	7.38	7.67	7.58	7.71	8.25	7.53	7.84	8.42	7.33	7.76	8.08	26
Total Alkalinity (mg/l)	15.7	53.9	99.6	40.4	59.6	72.7	65.8	82.9	101.2	39.8	77.1	86.7	26
Total Hardness (mg/l)	51.6	91.9	184.5	81.4	114.1	184.6	131.4	167.1	205.4	75.7	121.1	239.1	26
Specific Conductance (usm/cm)	176	242	576	259	370	696	502	714	833	263	455	968	26
Total Suspended Solids (mg/l)	2	8	32	0	8	13	0	3	8	0	3	23	26
Chloride (mg/l)	26.0	39.0	110.4	40.2	53.4	117.4	83.8	128.0	155.2	28.2	66.0	226.1	26
Sulfate (mg/l)	16.6	38.2	80.9	32.1	46.1	97.6	66.5	101.6	110.8	35.1	59.3	80.3	26
Sodium (mg/l)	15.99	20.42	71.48	25.24	31.81	73.88	41.86	77.12	95.20	18.89	44.62	94.54	26
Potassium (mg/l)	2.6	4.0	9.9	3.1	4.3	8.1	5.7	9.2	11.0	3.7	7.5	16.4	26
Calcium (mg/l)	10.1	22.0	29.3	24.8	31.3	51.4	40.8	53.0	65.6	23.2	36.1	78.7	26
Magnesium (mg/l)	7.75	11.49	19.95	11.89	7.44	20.13	13.50	19.30	24.59	10.94	16.44	26.57	26
Ammonia Nitrogen (mg/l)	0.000	0.327	1.709	0.000	0.029	0.097	0.041	0.060	0.103	0.000	0.054	0.077	26
Nitrite Nitrogen (mg/l)	0.000	0.015	0.042	0.011	0.023	0.050	0.013	0.036	0.057	0.000	0.026	0.093	26
Nitrate Nitrogen (mg/l)	1.94	3.35	8.45	2.33	3.28	7.71	5.13	9.15	12.66	2.05	4.33	11.60	26
Total Phosphate Phosphorus (mg/l)	0.02	0.13	0.33	0.03	0.06	0.12	0.04	0.08	0.13	0.06	0.10	0.26	25
Ortho Phosphate Phosphorus (mg/l)	0.03	0.10	0.21	0.01	0.03	0.10	0.02	0.05	0.09	0.04	0.07	0.22	24
Chromium (mg/l)	0.003	0.010	0.025	0.005	0.007	0.009	0.003	0.008	0.014	0.005	0.008	0.010	26
Copper (mg/l)	0.004	0.005	0.015	0.007	0.011	0.023	0.007	0.021	0.037	0.003	0.007	0.028	26
Iron (mg/l)	0.00	0.23	1.11	0.08	0.15	0.56	0.00	0.16	0.31	0.00	0.14	1.87	26
Lead (mg/l)	0.000	0.000	0.002	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	26
Manganese (mg/l)	0.00	0.06	0.12	0.00	0.03	0.06	0.00	0.00	0.14	0.00	0.00	0.06	26
Zinc (mg/l)	0.01	0.04	0.12	0.01	0.03	0.11	0.01	0.03	0.58	0.00	0.02	0.03	26
Cyanide (mg/l)	0.000	0.004	0.006	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.008	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (c/.1l)	0	30	2800	50	280	2500	120	1650	2100	100	1300	16000	25
Fecal Coliforms (c/.1l)	0	6	300	16	59	2100	210	410	1400	0	173	600	25

Table 4.1-9. New maximum values observed for water quality parameters measured in 1985 at Station E 22880 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Temperature (C)	8.0	01/02/85
	Dissolved Oxygen (mg/l)	14.0	01/02/85
	Potassium (mg/l)	9.9	01/30/85
	Nitrate Nitrogen (mg/l)	8.45	01/30/85
	Chemical Oxygen Demand (mg/l)	21.1	02/13/85
Mar, Apr, May	Total Hardness (mg/l)	184.6	04/24/85
	Specific Conductance (usm/cm)	696	04/24/85
	Chloride (mg/l)	117.4	04/24/85
	Sulfate (mg/l)	97.6	04/24/85
	Sodium (mg/l)	73.88	04/24/85
	Potassium (mg/l)	8.1	04/24/85
	Calcium (mg/l)	51.4	04/24/85
	Magnesium (mg/l)	20.13	04/24/85
	Nitrate Nitrogen (mg/l)	7.71	04/24/85
	Zinc (mg/l)	0.11	03/13/85
	Trichloroethylene (ug/l)	5.2	04/11/85
Jun, Jul, Aug	Chloride (mg/l)	155.2	07/31/85
	Potassium (mg/l)	11.0	07/31/85
	Zinc (mg/l)	0.58	06/05/85
Sep, Oct, Nov	Chloride (mg/l)	226.1	09/25/85
	Potassium (mg/l)	16.4	09/25/85
	Chemical Oxygen Demand (mg/l)	36.0	10/09/85

Table 4.1-10. New minimum values observed for water quality parameters measured in 1985 at Station E 22880 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Biochemical Oxygen Demand (mg/l)	0.1	01/16/85
	pH	6.94	02/13/85
	Total Alkalinity (mg/l)	15.7	02/13/85
	Total Hardness (mg/l)	51.6	02/13/85
	Sulfate (mg/l)	16.6	02/13/85
	Calcium (mg/l)	10.1	02/13/85
	Ammonia Nitrogen (mg/l)	0.000	12/04/85
	Nitrite Nitrogen (mg/l)	0.000	12/18/85
	Total Phosphate Phosphorus (mg/l)	0.02	01/16/85
	Chromium (mg/l)	0.003	12/18/85
	Iron (mg/l)	0.00	12/04/85
	Total Coliforms (c/.11)	0	01/16/85
Mar, Apr, May	Biochemical Oxygen Demand (mg/l)	0.3	05/08/85
	Total Phosphate Phosphorus (mg/l)	0.03	04/24/85
	Ortho Phosphate Phosphorus (mg/l)	0.01	04/11/85
	Iron (mg/l)	0.08	04/24/85
	Total Coliforms (c/.11)	50	03/27/85
Jun, Jul, Aug	Total Phosphate Phosphorus (mg/l)	0.04	08/28/85
	Ortho Phosphate Phosphorus (mg/l)	0.02	07/31/85
	Iron (mg/l)	0.00	07/02/85
	Total Coliforms (c/.11)	120	07/17/85
Sep, Oct, Nov	Nitrite Nitrogen (mg/l)	0.000	10/09/85
	Iron (mg/l)	0.00	09/25/85
	Chemical Oxygen Demand (mg/l)	0.0	10/23/85
	Fecal Coliforms (c/.11)	0	11/20/85

Table 4.1-11. Summary of East Branch Perkiomen Creek water quality at Station E2800, 05 January 1983 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	1.0	8.0	1.0	9.0	21.0	18.0	21.5	26.0	2.0	14.0	23.5	70
Dissolved Oxygen (mg/l)	8.1	12.4	15.2	6.1	11.4	14.7	3.9	7.3	10.4	5.4	9.7	13.0	77
Biochemical Oxygen Demand (mg/l)	0.3	2.5	5.2	0.3	1.4	4.3	0.4	1.2	5.2	0.2	1.0	4.5	78
Chemical Oxygen Demand (mg/l)	0.0	11.8	44.0	0.0	17.6	46.3	0.0	15.6	88.7	0.0	17.0	30.2	78
Total Organic Carbon (mg/l)	0.0	3.3	19.4	0.0	3.5	10.5	0.0	4.8	14.0	0.0	5.4	33.4	73
pH	6.89	7.52	8.27	7.10	7.77	9.04	6.97	7.96	8.87	7.40	7.90	8.97	77
Total Alkalinity (mg/l)	12.5	52.9	88.2	6.0	44.6	79.4	32.4	85.1	105.3	28.2	89.8	110.5	78
Total Hardness (mg/l)	45.1	100.1	182.2	27.3	83.9	154.3	65.3	132.6	192.1	77.6	140.6	228.4	77
Specific Conductance (usm/cm)	155	318	583	166	274	580	168	494	793	241	543	832	78
Total Suspended Solids (mg/l)	0	3	536	0	2	333	0	3	29	0	3	12	78
Chloride (mg/l)	17.9	47.8	114.2	14.3	34.0	103.6	9.0	71.8	151.0	25.2	99.6	221.1	78
Sulfate (mg/l)	20.9	37.1	73.4	19.7	36.7	62.6	10.3	49.9	90.7	23.4	57.1	91.4	77
Sodium (mg/l)	11.44	26.75	69.79	10.58	21.29	56.71	9.06	50.34	91.99	16.14	62.28	106.08	78
Potassium (mg/l)	2.1	3.6	6.7	2.1	2.6	6.1	2.2	5.1	9.5	3.5	6.3	10.2	78
Calcium (mg/l)	8.4	17.4	39.3	6.1	19.4	39.7	8.7	27.1	47.5	14.8	30.0	64.4	78
Magnesium (mg/l)	6.46	12.33	19.52	6.56	10.66	17.19	7.58	15.57	22.10	8.55	18.40	24.10	78
Ammonia Nitrogen (mg/l)	0.000	0.137	1.268	0.000	0.036	0.346	0.000	0.034	0.104	0.000	0.028	0.096	78
Nitrite Nitrogen (mg/l)	0.012	0.033	1.099	0.014	0.035	0.128	0.000	0.018	0.062	0.007	0.031	0.142	78
Nitrate Nitrogen (mg/l)	1.90	3.78	6.90	1.26	2.52	4.63	0.00	1.76	3.58	0.90	3.50	5.81	78
Total Phosphate Phosphorus (mg/l)	0.06	0.13	0.59	0.00	0.10	0.18	0.00	0.11	0.25	0.03	0.13	0.26	72
Ortho Phosphate Phosphorus (mg/l)	0.06	0.10	0.23	0.00	0.08	0.20	0.00	0.10	0.20	0.01	0.10	0.18	76
Chromium (mg/l)	0.000	0.009	0.051	0.004	0.008	0.020	0.001	0.006	0.185	0.002	0.007	0.014	78
Copper (mg/l)	0.000	0.006	0.022	0.001	0.005	0.029	0.000	0.004	0.015	0.002	0.006	0.011	78
Iron (mg/l)	0.00	0.10	10.70	0.00	0.13	6.46	0.00	0.07	0.98	0.00	0.07	0.70	78
Lead (mg/l)	0.000	0.001	0.019	0.000	0.001	0.016	0.000	0.000	0.015	0.000	0.001	0.008	78
Manganese (mg/l)	0.00	0.00	0.41	0.00	0.00	0.27	0.00	0.00	0.09	0.00	0.00	0.07	78
Zinc (mg/l)	0.00	0.01	0.30	0.00	0.00	0.06	0.00	0.00	0.02	0.00	0.01	0.04	78
Cyanide (mg/l)	0.000	0.000	0.004	0.000	0.000	0.004	0.000	0.000	0.001	0.000	0.000	0.002	78
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.010	0.000	0.000	0.000	78
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	75
Total Coliforms (c/.1l)	10	315	10100	10	280	8300	60	750	12000	150	1050	9000	76
Fecal Coliforms (c/.1l)	2	79	4300	3	70	6800	34	295	9300	27	240	1300	77

Table 4.1-12. Summary of East Branch Perkiomen Creek water quality at Station E2800, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-0.1	1.0	8.0	6.0	10.5	18.5	18.0	20.8	25.0	11.5	12.8	21.0	25
Dissolved Oxygen (mg/l)	8.1	11.0	14.1	6.1	10.9	11.4	4.9	7.3	10.4	6.2	9.4	10.4	25
Biochemical Oxygen Demand (mg/l)	0.3	0.8	5.2	0.3	1.3	1.7	0.4	1.1	1.2	0.2	0.4	2.7	26
Chemical Oxygen Demand (mg/l)	7.6	10.6	27.2	13.6	17.9	23.0	0.0	15.6	88.7	0.0	17.5	30.2	26
Total Organic Carbon (mg/l)	2.5	3.4	4.2	3.2	3.5	5.2	2.5	4.8	5.6	4.0	5.0	5.7	26
pH	6.89	7.52	7.93	7.78	8.21	9.04	7.67	8.05	8.87	7.73	8.00	8.37	25
Total Alkalinity (mg/l)	12.5	56.9	88.2	50.9	60.9	79.4	73.4	98.6	105.3	48.7	82.1	110.5	26
Total Hardness (mg/l)	45.1	90.7	182.2	99.0	108.3	154.3	101.5	132.6	167.1	78.0	110.8	158.0	25
Specific Conductance (usm/cm)	155	268	583	321	405	580	414	494	697	249	449	806	26
Total Suspended Solids (mg/l)	0	3	40	0	2	8	0	1	9	0	2	5	26
Chloride (mg/l)	27.0	45.3	114.2	46.3	70.8	103.6	71.2	87.7	151.0	32.0	85.7	221.1	26
Sulfate (mg/l)	20.9	36.9	73.4	37.1	42.2	62.6	41.0	49.9	83.9	33.1	52.9	65.0	25
Sodium (mg/l)	15.99	23.36	69.79	32.23	40.67	56.71	33.14	62.00	85.90	20.59	47.60	88.11	26
Potassium (mg/l)	2.7	3.8	6.7	3.6	4.3	6.1	4.7	5.8	9.5	4.0	6.7	10.2	26
Calcium (mg/l)	8.4	21.3	27.9	29.2	32.8	39.7	31.7	35.8	47.5	24.1	35.5	55.8	26
Magnesium (mg/l)	6.46	10.58	19.52	12.85	13.89	17.19	11.40	15.66	20.42	10.78	16.73	22.72	26
Ammonia Nitrogen (mg/l)	0.028	0.086	0.338	0.000	0.013	0.101	0.021	0.048	0.091	0.000	0.047	0.064	26
Nitrite Nitrogen (mg/l)	0.015	0.021	0.053	0.014	0.044	0.088	0.010	0.015	0.037	0.007	0.017	0.040	26
Nitrate Nitrogen (mg/l)	2.03	3.50	6.90	1.34	3.01	3.13	0.57	1.48	2.26	0.90	2.48	4.90	26
Total Phosphate Phosphorus (mg/l)	0.06	0.16	0.29	0.07	0.11	0.14	0.14	0.17	0.25	0.03	0.13	0.19	25
Ortho Phosphate Phosphorus (mg/l)	0.06	0.10	0.14	0.03	0.06	0.11	0.10	0.14	0.20	0.01	0.12	0.16	24
Chromium (mg/l)	0.000	0.007	0.014	0.004	0.006	0.007	0.004	0.006	0.008	0.002	0.006	0.008	26
Copper (mg/l)	0.002	0.005	0.011	0.005	0.007	0.029	0.002	0.004	0.007	0.002	0.005	0.011	26
Iron (mg/l)	0.00	0.10	1.49	0.00	0.00	0.23	0.00	0.00	0.09	0.00	0.05	0.33	26
Lead (mg/l)	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	26
Manganese (mg/l)	0.00	0.00	0.07	0.00	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.07	26
Zinc (mg/l)	0.00	0.01	0.30	0.00	0.02	0.06	0.00	0.01	0.02	0.00	0.01	0.01	26
Cyanide (mg/l)	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.001	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25
Total Coliforms (c/.1l)	10	120	5000	10	220	380	60	225	400	160	1050	8500	25
Fecal Coliforms (c/.1l)	2	50	600	4	76	160	34	145	340	50	275	1100	25

Table 4.1-13. New maximum values observed for water quality parameters measured in 1985 at Station E 2800 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Temperature (C)	8.0	01/02/85
	Biochemical Oxygen Demand (mg/l)	5.2	02/13/85
	Chloride (mg/l)	114.2	01/30/85
	Sodium (mg/l)	69.79	01/30/85
	Potassium (mg/l)	6.7	01/30/85
	Nitrate Nitrogen (mg/l)	6.90	01/30/85
	Zinc (mg/l)	0.30	02/27/85
Mar, Apr, May	Total Hardness (mg/l)	154.3	04/24/85
	Specific Conductance (usm/cm)	580	04/24/85
	Chloride (mg/l)	103.6	04/24/85
	Sodium (mg/l)	56.71	04/24/85
	Potassium (mg/l)	6.1	04/24/85
	Calcium (mg/l)	39.7	04/24/85
	Magnesium (mg/l)	17.19	04/24/85
Jun, Jul, Aug	Total Dissolved Solids (mg/l)	531	07/17/85
	Chloride (mg/l)	151.0	07/17/85
	Potassium (mg/l)	9.5	07/17/85
	Chemical Oxygen Demand (mg/l)	88.7	07/31/85
Sep, Oct, Nov	Chloride (mg/l)	221.1	09/25/85
	Potassium (mg/l)	10.2	09/25/85
	Chemical Oxygen Demand (mg/l)	30.2	09/11/85

Table 4.1-14. New minimum values observed for water quality parameters measured in 1985 at Station E 2800 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Dissolved Oxygen (mg/l)	8.1	01/16/85
	pH	6.89	02/13/85
	Total Alkalinity (mg/l)	12.5	02/13/85
	Total Hardness (mg/l)	45.1	02/13/85
	Specific Conductance (usm/cm)	155	02/13/85
	Total Dissolved Solids (mg/l)	102	02/13/85
	Sulfate (mg/l)	20.9	02/13/85
	Calcium (mg/l)	8.4	02/13/85
	Magnesium (mg/l)	6.46	02/13/85
	Total Phosphate Phosphorus (mg/l)	0.06	01/16/85
	Fecal Coliforms (c/.1l)	2	01/16/85
	Total Coliforms (c/.1l)	10	01/30/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	6.1	04/24/85
	Biochemical Oxygen Demand (mg/l)	0.3	05/08/85
	Nitrite Nitrogen (mg/l)	0.014	05/22/85
	Total Coliforms (c/.1l)	10	03/27/85
Jun, Jul, Aug	Fecal Coliforms (c/.1l)	34	08/14/85
	Total Coliforms (c/.1l)	60	08/14/85
Sep, Oct, Nov	Total Phosphate Phosphorus (mg/l)	0.03	09/25/85
	Ortho Phosphate Phosphorus (mg/l)	0.01	09/25/85

4.2 Benthic Macroinvertebrates

Summary

1. Samples were collected at 6 stations on 31 January, 20 March, 21 May, 9 July, 26 September, and 12 November 1985.

2. In 1985, a total of 93 taxa was collected at all stations with 45-60 collected at individual stations. Taxonomic composition generally was similar at all stations.

3. Total macroinvertebrate standing crop (mean number/m^2) generally was lowest in the stream headwaters. Standing crop was substantially higher at the other stations on most dates.

4. Cheumatopsyche, Chironomidae, Simuliidae, and Stenelmis were present in large numbers at nearly all stations. Several other taxa were numerous at particular stations.

5. The macroinvertebrate communities present in 1985 generally were similar to those observed in 1983 or 1984. The total number of taxa and taxonomic composition changed little. Nearly the same taxa were numerically important each year. The greatest change was a substantial increase in total macroinvertebrate numerical stand-

ing crop, including great increase in that of Simuliidae.

Introduction and Methods

Studies of the benthic macroinvertebrate community of the East Branch Perkiomen Creek were conducted in 1972-1974, 1976, 1983, and in 1984. Data obtained in the 1970's were used in preparation of the EROL and those obtained in 1983 and 1984 were reported in subsequent progress reports (RMC-Environmental Services 1984 and 1985).

Presently (1983-1985), samples are collected at six stations at approximately 60 day intervals. At each station, three replicate samples are collected using a Portable Invertebrate Box Sampler. Sample station location and all methods are fully described in the EROL (Section 6.1) and in RMC-Environmental Services (1984).

In 1985, samples were collected on 31 January, 20 March, 21 May, 9 July, 26 September, and 12 November. Samples were collected at all stations on all dates except at E29910, E36725, and E36985 in January due to ice conditions and in September due to absence of stream flow. There was no deviation from previously established sampling procedures.

However, laboratory handling procedures for certain samples were modified due to the large number of macroinvertebrate

specimens or volume of residue within them. They are shown in Table 4.2-1. Rather than sorting these samples in entirety, one-quarter subsamples of each were randomly selected for sorting. The total number of specimens of each macroinvertebrate taxon presumed to be present within an entire sample was obtained through multiplication by 4 of the number sorted from the subsample.

Results and Discussion

1985

Ninety-three macroinvertebrate taxa were collected (Table 4.2-2). They included Oligochaeta (worms), Decapoda (crayfish), Ephemeroptera (mayflies), Plecoptera (stoneflies), Coleoptera (beetles), Trichoptera (caddisflies), Diptera (true flies), and Mollusca (snails and clams). Similar total numbers of taxa (53-60) were collected at 5 of 6 stations. The lowest number (45) was collected at E23000. Taxonomic composition generally was similar at all stations.

Total macroinvertebrate standing crop (mean number/m^2) is shown in Table 4.2-3. The lowest standing crop generally was measured in the headwaters at E36725 and E36985. Standing crop was substantially higher at the other stations on most dates.

Standing crop (mean number/m^2) for all taxa measured during the entire study period is shown in Table 4.2-4. Several taxa were present in large numbers at nearly all stations: Cheumatopsyche, Chironomidae, Simuliidae, and Stenelmis. Other taxa were numerous at particular stations: E12500- Chimarra and Hydropsyche; E23000- Hydropsyche; E26700- Dugesia; E29910- Caenis, Campeloma, and Oligochaeta; E36725- Allocapnia; and E36985- Allocapnia.

The relative importance of individual taxa in the macroinvertebrate community as indicated by percentage of the community that they represented is shown in Table 4.2-5. Chironomidae were important at all stations (the most important taxon at several of them- E12500, E29910, and E36985), representing 15.3-46.8% of all macroinvertebrates collected at individual stations. Simuliidae also were important at all stations, including being the most important taxon at E23000 and E26700, and comprised 3.0-47.0% at individual stations. The most important taxon at E36725 was Allocapnia (36.2%), also important at E36985 (22.6%). Other important taxa included Cheumatopsyche (2.4-24.3%), Stenelmis (2.7-19.2%), Hydropsyche (6.3 and 12.8% at two stations), and Oligochaeta (2.0-5.2% at four stations).

1983-1985

All taxa collected in 1983-1985 are shown in Table 4.2-6. Nearly equal numbers of taxa were collected each year. In addition, the composition of the taxa was quite similar from year to year.

Annual numerical standing crop was highest at five of six stations in 1985 with the greatest 1983-1985 increase recorded at E23000 and E29910 (Table 4.2-7). In each year the largest standing crop was observed at E12500 with the smallest standing crops observed at several upstream stations.

The numerically important taxa (i.e., those representing ≥ 2.0% of the macroinvertebrates collected) at E12500 did not change greatly during the years 1983-1985 (Table 4.2-8). Chironomidae, Cheumatopsyche, and Stenelmis were among the most important taxa in each year with Simuliidae and Hydropsyche increasingly more important in 1984 and 1985. Standing crop of each of these taxa increased from year to year with the 1983 to 1984 increase of Simuliidae most striking. Standing crop of Physa substantially decreased from 1983 to 1984, and remained steady in 1985.

Little change was observed in the numerically important taxa at E23000 during 1983-1985 (Table 4.2-9). Cheumatopsyche and Chironomidae were among the most important taxa in each year with

Simuliidae becoming most important in 1984 and 1985. Large year to year fluctuations in standing crop of nearly all taxa were observed. Standing crop increase of Simullidae through the entire period was substantial.

The numerically important taxa at E26700 were similar during 1983-1985 (Table 4.2-10). Chironomidae and Stenelmis were among the most important taxa in each year. Simuliidae rose in importance in 1984 and 1985 due to substantial increase in standing crop observed in both years. Decline in the importance of Oligochaeta in 1984 reflected the observed substantial reduction in standing crop.

Little change was observed in the numerically important taxa at E29910 during 1983-1985 (Table 4.2-11). Chironomidae and Stenelmis were the most important taxa each year with oligochaeta, Cheumatopsyche, and Caenis also very important in particular years. Increases in most of these taxa were observed in each year, some of them substantial.

The numerically important taxa at E36725 did not change greatly during 1983-1985 (Table 4.2-12). Although Chironomidae, Allocapnia, and Stenelmis were among the most important taxa in each year, changes in relative importance among them were observed from year to year. Of these taxa, only the standing crop of Allocapnia changed substantially between particular years.

Little change in the numerically important taxa at E36985 during 1983-1985 was observed (Table 4.2-13). Allocapnia and Chironomidae were the most important taxa each year. Standing crop of these taxa increased each year and was much greater than that of any other taxon.

In summary, the macroinvertebrate communities present at the sample stations in 1985 generally were similar to those observed in 1983 or 1984. The number of taxa and composition of the taxa changed very little. The composition of the numerically important taxa was similar each year, although some change in relative importance among them was observed. The greatest change observed was a large increase in total macroinvertebrate numerical standing crop. Increase in standing crop of many taxa was observed, with that of Simuliidae at several downstream stations particularly great.

Table 4.2-1. Replicate samples collected in 1985 that were subsampled in the laboratory prior to sorting.

	Station			
Date	E12500	E23000	E26700	E29910
21 May	1,3	1,2	2	1
9 July	1,3	1,2,3	3	-
12 November	2,3	-	2,3	1,2,3

Table 4.2-2. Macroinvertebrate taxa collected in the East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Acroneuria				X		
Agabus						X
Allocapnia	X	X	X	X	X	X
Ameletus				X		
Amphinemura	X	X	X	X	X	X
Ancyronyx	X				X	X
Argia	X	X	X	X		
Asellus	X		X		X	
Baetis	X	X	X	X	X	X
Berosus	X	X	X	X	X	X
Caenis	X	X	X	X	X	X
Cambarus		X	X		X	X
Campeloma			X	X		
Ceraclea			X	X		
Ceratopogonidae	X	X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X
Chimarra	X	X	X	X	X	X
Chironomidae	X	X	X	X	X	X
Chloroperlidae						X
Choroterpes				X	X	X
Corydalus	X	X				
Dineutus		X				
Dromogomphus	X					
Dubiraphia	X	X	X	X	X	X
Dugesia	X	X	X	X	X	
Dytiscidae				X		
Ectopria	X					
Empididae	X	X	X	X	X	X
Enochrus						X
Ephemera				X	X	
Ephemerella	X		X	X		
Erpobdella	X		X	X		X
Erythemis			X			
Ferrissia	X	X	X	X	X	X
Gyraulus	X	X	X	X	X	
Helisoma	X	X	X	X		
Helobdella	X		X	X	X	
Hyalella	X	X	X	X	X	X
Hydrophilidae			X			
Hydroporus			X	X	X	X
Hydropsyche	X	X	X	X	X	X
Hydroptila	X	X	X	X	X	X
Ischnura	X	X	X			
Isonychia			X	X		
Isoperla	X	X	X		X	X
Lanthus	X			X		
Lepidostoma			X			X
Leucotrichia	X	X	X	X		
Lymnaea	X	X	X			
Macromia			X			
Macronemum	X	X				
Macronychus				X		
Microcylloepus	X	X	X	X		
Microvelia			X		X	X
Musculium	X		X	X		
Mystacides		X			X	
Neureclipsis	X	X				
Nigronia	X	X			X	
Nyctiophylax	X			X		X
Oecetis	X	X	X	X	X	X
Oligochaeta	X	X	X	X	X	X
Optioservus	X	X	X	X	X	X
Orconectes			X	X		
Paracymus					X	
Paraleptophlebia	X		X	X	X	X
Parargyractis	X	X	X		X	
Peltodytes				X	X	X
Perithemis						X
Perlesta	X	X	X	X	X	X
Physa	X	X	X	X	X	X
Pilaria					X	X
Pisidium	X		X	X	X	X
Placobdella						X
Polycentropus			X	X	X	
Prostoia	X				X	X

Table 4.2-2. Macroinvertebrate taxa collected in the East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Prostoma	X	X	X	X	X	X
Psephenus	X	X	X	X	X	X
Ptilostomis						X
Sciomyzidae					X	X
Sialis	X	X	X	X	X	X
Sigara					X	X
Simuliidae	X	X	X	X	X	X
Sphaerium	X		X	X		
Stenacron	X		X	X	X	X
Stenelmis	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X
Tabanidae			X	X	X	X
Taeniopteryx	X					
Tipula		X	X	X	X	X
Tipulidae					X	X
Triaenodes				X		X
Tricorythodes	X	X	X	X		
Wormaldia				X		X
Total Number of Taxa	57	45	60	60	53	54

Table 4.2-3. Total macroinvertebrate standing crop (mean number/sq. meter) measured in the East Branch Perkiomen Creek during 1985.

Date	E12500	E23000	E26700	E29910	E36725	E36985
Jan	77063.3	9193.3	8886.7	-	-	-
Mar	52796.7	10383.3	40193.3	55110.0	18973.3	28023.3
May	66486.7	158053.3	118660.0	40513.3	8303.3	12976.7
Jul	43160.0	65996.7	24350.0	30023.3	5363.3	7620.0
Sep	45053.3	25226.7	21113.3	-	-	-
Nov	20986.7	6360.0	20260.0	31703.3	14910.0	12873.3
Mean	50924.4	45868.9	38910.6	39337.5	11887.5	15373.3

Table 4.2-4. Macroinvertebrate standing crop (mean number/sq. meter) measured in East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Acroneuria	-	-	-	3.3	-	-
Agabus	-	-	-	-	-	3.3
Allocapnia	14.4	10.6	214.4	815.0	4306.7	3471.7
Ameletus	-	-	-	3.3	-	-
Amphinemura	5.0	0.6	5.0	10.0	122.5	280.0
Ancyronyx	2.2	-	-	-	0.8	1.7
Argia	210.6	201.7	100.0	70.8	-	-
Asellus	1.7	-	12.2	-	0.8	-
Baetis	957.8	658.3	26.7	141.7	23.3	17.5
Berosus	36.1	27.2	47.8	167.5	2.5	0.8
Caenis	666.7	6.7	686.1	3244.2	349.2	227.5
Cambarus	-	3.3	0.6	-	0.8	4.2
Campeloma	-	-	749.4	1161.7	-	-
Ceraclea	-	-	6.7	3.3	-	-
Ceratopogonidae	10.6	5.0	21.1	79.2	35.8	65.8
Cheumatopsyche	9268.3	11124.4	938.9	2670.0	580.8	1302.5
Chimarra	2326.1	18.9	101.1	655.0	12.5	1.7
Chironomidae	12080.0	7023.3	8342.2	14942.5	3599.2	7196.7
Chloroperlidae	-	-	-	-	-	2.5
Choroterpes	-	-	-	0.8	147.5	51.7
Corydalus	156.1	6.7	-	-	-	-
Dineutus	-	0.6	-	-	-	-
Dromogomphus	0.6	-	-	-	-	-
Dubiraphia	8.9	5.6	3.9	10.8	10.8	30.0
Dugesia	44.4	293.9	1291.1	489.2	17.5	-
Dytiscidae	-	-	-	0.8	-	-
Ectopria	10.0	-	-	-	-	-
Empididae	172.8	54.4	237.8	164.2	44.2	93.3
Enochrus	-	-	-	-	-	0.8
Ephemera	-	-	-	6.7	0.8	-
Ephemerella	1.1	-	0.6	1.7	-	-
Erpobdella	1.7	-	186.7	75.8	-	5.8
Erythemis	-	-	0.6	-	-	-
Ferrissia	33.3	0.6	186.1	160.0	6.7	7.5
Gyraulus	198.3	11.7	20.6	51.7	1.7	-
Helisoma	23.9	2.2	43.3	27.5	-	-
Helobdella	1.1	-	10.0	32.5	0.8	-
Hyalella	146.1	2.2	15.6	14.2	59.2	22.5
Hydrophilidae	-	-	2.2	-	-	-
Hydroporus	-	-	0.6	23.3	60.0	137.5
Hydropsyche	6525.0	2874.4	17.2	130.8	1.7	3.3
Hydroptila	18.9	23.3	11.1	18.3	4.2	0.8
Ischnura	3.9	1.1	3.3	-	-	-
Isonychia	-	-	4.4	54.2	-	-
Isoperla	0.6	0.6	0.6	-	13.3	28.3
Lanthus	0.6	-	-	2.5	-	-
Lepidostoma	-	-	0.6	-	-	0.8
Leucotrichia	323.3	132.2	3.9	40.0	-	-
Lymnaea	0.6	16.7	5.0	-	-	-
Macromia	-	-	0.6	-	-	-
Macronemum	482.2	0.6	-	-	-	-
Macronychus	-	-	-	0.8	-	-
Microcylloepus	31.7	0.6	1.1	0.8	-	-
Microvelia	-	-	0.6	-	15.8	7.5
Musculium	220.0	-	825.6	5.8	-	-
Mystacides	-	17.2	-	-	20.0	-
Neureclipsis	256.1	0.6	-	-	-	-
Nigronia	1.1	2.2	-	-	0.8	-
Nyctiophylax	0.6	-	-	1.7	-	0.8
Oecetis	30.6	1.7	1.7	0.8	0.8	0.8
Oligochaeta	32.8	32.8	997.8	2050.8	295.8	313.3
Optioservus	130.6	10.0	200.0	593.3	1.7	2.5
Orconectes	-	-	1.1	2.5	-	-
Paracymus	-	-	-	-	0.8	-
Paraleptophlebia	0.6	-	1.1	31.7	54.2	15.8
Parargyractis	141.1	385.6	5.6	-	0.8	-
Peltodytes	-	-	-	8.3	14.2	1.7
Perithemis	-	-	-	-	-	0.8
Perlesta	1.7	2.2	5.0	5.0	90.8	250.0
Physa	228.3	18.9	44.4	35.0	55.8	253.3
Pilaria	-	-	-	-	20.0	1.7
Pisidium	234.4	-	477.2	830.0	221.7	220.0
Placobdella	-	-	-	-	-	1.7
Polycentropus	-	-	2.2	66.7	2.5	-
Prostoia	0.6	-	-	-	10.8	10.8

Table 4.2-4. Macroinvertebrate standing crop (mean number/sq. meter) measured in East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Prostoma	56.7	49.4	24.4	10.0	9.2	7.5
Psephenus	273.9	2.2	375.6	1385.8	45.8	0.8
Ptilostomis	-	-	-	-	-	0.8
Sciomyzidae	-	-	-	-	0.8	1.7
Sialis	27.8	7.8	36.7	104.2	207.5	169.2
Sigara	-	-	-	-	14.2	3.3
Simuliidae	7308.9	21572.8	15957.8	1160.8	703.3	670.8
Sphaerium	25.6	-	755.0	0.8	-	-
Stenacron	17.2	-	8.9	3.3	65.8	4.2
Stenelmis	8013.9	1256.1	5882.8	7549.2	625.8	460.0
Stenonema	57.2	0.6	5.6	126.7	0.8	0.8
Tabanidae	-	-	0.6	5.8	1.7	2.5
Taeniopteryx	1.7	-	-	-	-	-
Tipula	-	0.6	0.6	5.8	0.8	4.2
Tipulidae	-	-	-	-	1.7	1.7
Triaenodes	-	-	-	3.3	-	3.3
Tricorythodes	98.9	1.1	1.7	75.0	-	-
Wormaldia	-	-	-	0.8	-	3.3
*All Taxa	50924.4	45868.9	38910.6	39337.5	11887.5	15373.3

Table 4.2-5. Percent composition (by number) of macroinvertebrates collected in the East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Acroneuria	-	-	-	+	-	-
Agabus	-	-	-	-	-	+
Allocapnia	+	+	0.6	2.1	36.2	22.6
Ameletus	-	-	-	+	-	-
Amphinemura	+	+	+	+	1.0	1.8
Ancyronyx	+	-	-	-	+	+
Argia	0.4	0.4	0.3	0.2	-	-
Asellus	+	-	+	-	+	-
Baetis	1.9	1.4	+	0.4	0.2	0.1
Berosus	+	+	0.1	0.4	+	+
Caenis	1.3	+	1.8	8.2	2.9	1.5
Cambarus	-	+	+	-	+	+
Campeloma	-	-	1.9	3.0	-	-
Ceraclea	-	-	+	+	-	-
Ceratopogonidae	+	+	+	0.2	0.3	0.4
Cheumatopsyche	18.2	24.3	2.4	6.8	4.9	8.5
Chimarra	4.6	+	0.3	1.7	0.1	+
Chironomidae	23.7	15.3	21.4	38.0	30.3	46.8
Chloroperlidae	-	-	-	-	-	+
Choroterpes	-	-	-	+	1.2	0.3
Corydalus	0.3	+	-	-	-	-
Dineutus	-	+	-	-	-	-
Dromogomphus	+	-	-	-	-	-
Dubiraphia	+	+	+	+	+	0.2
Dugesia	+	0.6	3.3	1.2	0.1	-
Dytiscidae	-	-	-	+	-	-
Ectopria	+	-	-	-	-	-
Empididae	0.3	0.1	0.6	0.4	0.4	0.6
Enochrus	-	-	-	-	-	+
Ephemera	-	-	-	+	+	-
Ephemerella	+	-	+	+	-	-
Erpobdella	+	-	0.5	0.2	-	+
Erythemis	-	-	+	-	-	-
Ferrissia	+	+	0.5	0.4	+	+
Gyraulus	0.4	+	+	0.1	+	-
Helisoma	+	+	0.1	+	-	-
Helobdella	+	-	+	+	+	-
Hyalella	0.3	+	+	+	0.5	0.1
Hydrophilidae	-	-	+	-	-	-
Hydroporus	-	-	+	+	0.5	0.9
Hydropsyche	12.8	6.3	+	0.3	+	+
Hydroptila	+	+	+	+	+	+
Ischnura	+	+	+	-	-	-
Isonychia	-	-	+	0.1	-	-
Isoperla	+	+	+	-	0.1	0.2
Lanthus	+	-	-	+	-	-
Lepidostoma	-	-	+	-	-	+
Leucotrichia	0.6	0.3	+	0.1	-	-
Lymnaea	+	+	+	-	-	-
Macromia	-	-	+	-	-	-
Macronemum	0.9	+	-	-	-	-
Macronychus	-	-	-	+	-	-
Microcylloepus	+	+	+	+	-	-
Microvelia	-	-	+	-	0.1	+
Musculium	0.4	-	2.1	+	-	-
Mystacides	-	+	-	-	0.2	-
Neureclipsis	0.5	+	-	-	-	-
Nigronia	+	+	-	-	+	-
Nyctiophylax	+	-	-	+	-	+
Oecetis	+	+	+	+	+	+
Oligochaeta	+	+	2.6	5.2	2.5	2.0
Optioservus	0.3	+	0.5	1.5	+	+
Orconectes	-	-	+	+	-	-
Paracymus	-	-	-	-	+	-
Paraleptophlebia	+	-	+	+	0.5	0.1
Parargyractis	0.3	0.8	+	-	+	-
Peltodytes	-	-	-	+	0.1	+
Perithemis	-	-	-	-	-	+
Perlesta	+	+	+	+	0.8	1.6
Physa	0.4	+	0.1	+	0.5	1.6
Pilaria	-	-	-	-	0.2	+
Pisidium	0.5	-	1.2	2.1	1.9	1.4
Placobdella	-	-	-	-	-	+
Polycentropus	-	-	+	0.2	+	-
Prostoia	+	-	-	-	+	+

Table 4.2-5. Percent composition (by number) of macroinvertebrates collected in the East Branch Perkiomen Creek during 1985.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Prostoma	0.1	0.1	+	+	+	+
Psephenus	0.5	+	1.0	3.5	0.4	+
Ptilostomis	-	-	-	-	-	+
Sciomyzidae	-	-	-	-	+	+
Sialis	+	+	+	0.3	1.7	1.1
Sigara	-	-	-	-	0.1	+
Simuliidae	14.4	47.0	41.0	3.0	5.9	4.4
Sphaerium	+	-	1.9	+	-	-
Stenacron	+	-	+	+	0.6	+
Stenelmis	15.7	2.7	15.1	19.2	5.3	3.0
Stenonema	0.1	+	+	0.3	+	+
Tabanidae	-	-	+	+	+	+
Taeniopteryx	+	-	-	-	-	-
Tipula	-	+	+	+	+	+
Tipulidae	-	-	-	-	+	+
Triaenodes	-	-	-	+	-	+
Tricorythodes	0.2	+	+	0.2	-	-
Wormaldia	-	-	-	+	-	+

+ = Less than 0.01%

Table 4.2-6. Macroinvertebrate taxa collected in the East Branch Perkiomen Creek during 1983 - 1985.

Taxon	1983	1984	1985
Acroneuria		X	X
Agabus			X
Allocapnia	X	X	X
Ameletus	X	X	X
Amphinemura	X	X	X
Ancyronyx		X	X
Antocha		X	
Argia	X	X	X
Asellus	X	X	X
Baetis	X	X	X
Berosus	X	X	X
Boyeria	X		
Caenis	X	X	X
Cambarus	X	X	X
Campeloma	X	X	X
Ceraclea	X		X
Ceratopogonidae	X	X	X
Chaoborus	X		
Cheumatopsyche	X	X	X
Chimarra	X	X	X
Chironomidae	X	X	X
Chloroperlidae	X	X	X
Choroterpes		X	X
Climacia	X		
Cloeon	X		
Corixidae	X		
Corydalus	X	X	X
Culicidae	X		
Dineutus			X
Dolichopodidae	X	X	
Dromogomphus			X
Dubiraphia	X	X	X
Dugesia	X	X	X
Dytiscidae	X	X	X
Ectopria	X	X	X
Empididae	X	X	X
Enallagma		X	
Enochrus	X		X
Ephemera	X	X	X
Ephemerella			X
Ephydridae	X		
Erpobdella	X	X	X
Erythemis	X		X
Ferrissia	X	X	X
Gerris		X	
Gomphidae		X	
Gyraulus	X	X	X
Helisoma	X	X	X
Helobdella	X	X	X
Hyalella	X	X	X
Hydraenidae	X		
Hydrophilidae	X	X	X
Hydroporus		X	X
Hydropsyche	X	X	X
Hydroptila	X	X	X
Ironoquia		X	
Ischnura		X	X
Isonychia	X	X	X
Isoperla	X	X	X
Lanthus		X	X
Lepidostoma			X
Leucotrichia	X	X	X
Libellulidae	X		
Liodessus		X	
Lymnaea	X	X	X
Macromia			X
Macronemum	X	X	X
Macronychus			X
Microcylloepus	X	X	X
Microvelia	X	X	X
Muscidae	X		
Musculium			X
Mystacides		X	X
Newoura	X		
Neophylax	X		

Table 4.2-6. Macroinvertebrate taxa collected in the East Branch Perkiomen Creek during 1983 - 1985.

Taxon	1983	1984	1985
Neureclipsis		X	X
Nigronia	X	X	X
Nyctiophylax			X
Oecetis	X	X	X
Oligochaeta	X	X	X
Optioservus	X	X	X
Orconectes	X		X
Paracymus			X
Paraleptophlebia	X	X	X
Parargyractis	X	X	X
Peltodytes	X		X
Perithemis			X
Perlesta	X	X	X
Perlidae	X		
Physa	X	X	X
Pilaria			X
Pisidium	X	X	X
Placobdella			X
Polycentropus	X		X
Promenetus		X	
Prostoia		X	X
Prostoma	X	X	X
Psephenus	X	X	X
Pseudocloeon		X	
Pseudolimnophila		X	
Psychoda	X		
Psychomyia	X		
Ptilostomis		X	X
Rhagovelia		X	
Sciomyzidae	X		X
Setodes	X		
Sialis	X	X	X
Sigara	X	X	X
Simuliidae	X	X	X
Sphaerium	X	X	X
Stenacron	X	X	X
Stenelmis	X	X	X
Stenonema	X	X	X
Stratiomyiidae	X		
Stygobromus	X		
Stylogomphus	X		
Tabanidae	X	X	X
Taeniopteryx		X	X
Telmatoscopus		X	
Tetragoneuria		X	
Tipula	X	X	X
Tipulidae	X	X	X
Triaenodes		X	X
Tricorythodes	X	X	X
Wormaldia		X	X
Total Number of Taxa	87	86	93

Table 4.2-7. Annual macroinvertebrate standing crop (mean number/sq. meter), all taxa combined, in the East Branch Perkiomen Creek, 1983 - 1985.

Station	1983	1984	1985
E12500	24039.3	38758.7	50924.4
E23000	11908.0	11476.0	45868.9
E26700	12784.7	29188.9	38910.6
E29910	6968.3	34824.0	39337.5
E36725	6293.3	12711.3	11887.5
E36985	7084.7	11293.3	15373.3

Table 4.2-8. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E12500 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Baetis	724.0	3.0	1915.3	4.9	957.8	1.9
Caenis	1121.3	4.7	520.7	1.3	666.7	1.3
Cheumatopsyche	3913.3	16.3	8084.0	20.9	9268.3	18.2
Chimarra	743.3	3.1	1454.7	3.8	2326.1	4.6
Chironomidae	5188.7	21.6	8304.0	21.4	12080.0	23.7
Hydropsyche	1404.0	5.8	4630.0	11.9	6525.0	12.8
Macronemum	475.3	2.0	862.7	2.2	482.2	0.9
Physa	2983.3	12.4	125.3	0.3	228.3	0.4
Psephenus	532.7	2.2	379.3	1.0	273.9	0.5
Simuliidae	430.7	1.8	5220.0	13.5	7308.9	14.4
Stenelmis	4157.3	17.3	5326.0	13.7	8013.9	15.7

Table 4.2-9. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E23000 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Cheumatopsyche	5609.3	47.1	2556.0	22.3	11124.4	24.3
Chironomidae	3036.0	25.5	3030.0	26.4	7023.3	15.3
Hydropsyche	1041.3	8.7	78.0	0.7	2874.4	6.3
Parargyractis	252.0	2.1	2.0	0.0	385.6	0.8
Simuliidae	62.0	0.5	4281.3	37.3	21572.8	47.0
Stenelmis	1024.0	8.6	1048.7	9.1	1256.1	2.7

Table 4.2-10. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E26700 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Allocapnia	55.3	0.4	1142.2	3.9	214.4	0.6
Caenis	485.3	3.8	418.3	1.4	686.1	1.8
Campeloma	732.7	5.7	583.9	2.0	749.4	1.9
Cheumatopsyche	140.0	1.1	1500.6	5.1	938.9	2.4
Chironomidae	4285.3	33.5	13308.9	45.6	8342.2	21.4
Dugesia	196.0	1.5	541.1	1.9	1291.1	3.3
Empididae	68.7	0.5	913.3	3.1	237.8	0.6
Musculium	-	-	-	-	825.6	2.1
Oligochaeta	3032.7	23.7	760.6	2.6	997.8	2.6
Physa	321.3	2.5	57.8	0.2	44.4	0.1
Psephenus	305.3	2.4	132.8	0.5	375.6	1.0
Simuliidae	320.0	2.5	3817.2	13.1	15957.8	41.0
Sphaerium	372.0	2.9	583.3	2.0	755.0	1.9
Stenelmis	1786.7	14.0	3348.3	11.5	5882.8	15.1

Table 4.2-11. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E29910 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Allocapnia	98.3	1.4	894.7	2.6	815.0	2.1
Baetis	40.8	0.6	2326.0	6.7	141.7	0.4
Caenis	513.3	7.4	1634.7	4.7	3244.2	8.2
Campeloma	23.3	0.3	217.3	0.6	1161.7	3.0
Cheumatopsyche	206.7	3.0	5734.7	16.5	2670.0	6.8
Chimarra	41.7	0.6	732.7	2.1	655.0	1.7
Chironomidae	3654.2	52.4	9398.7	27.0	14942.5	38.0
Hydropsyche	12.5	0.2	1265.3	3.6	130.8	0.3
Oligochaeta	747.5	10.7	1757.3	5.0	2050.8	5.2
Pisidium	51.7	0.7	70.0	0.2	830.0	2.1
Psephenus	321.7	4.6	123.3	0.4	1385.8	3.5
Simuliidae	82.5	1.2	1292.0	3.7	1160.8	3.0
Stenelmis	810.8	11.6	6496.7	18.7	7549.2	19.2

Table 4.2-12. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E36725 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Allocapnia	524.7	8.3	3750.0	29.5	4306.7	36.2
Amphinemura	485.3	7.7	415.3	3.3	122.5	1.0
Caenis	101.3	1.6	329.3	2.6	349.2	2.9
Cheumatopsyche	280.7	4.5	545.3	4.3	580.8	4.9
Chironomidae	2645.3	42.0	5302.7	41.7	3599.2	30.3
Oligochaeta	164.7	2.6	331.3	2.6	295.8	2.5
Paraleptophlebia	198.0	3.1	35.3	0.3	54.2	0.5
Perlesta	104.7	1.7	436.7	3.4	90.8	0.8
Simuliidae	84.7	1.3	349.3	2.7	703.3	5.9
Stenelmis	1300.7	20.7	529.3	4.2	625.8	5.3

Table 4.2-13. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station E36985 in the East Branch Perkiomen Creek, 1983 - 1985.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%
Allocapnia	2497.3	35.2	2942.7	26.1	3471.7	22.6
Amphinemura	660.7	9.3	620.0	5.5	280.0	1.8
Caenis	6.7	0.1	639.3	5.7	227.5	1.5
Cheumatopsyche	53.3	0.8	115.3	1.0	1302.5	8.5
Chironomidae	2739.3	38.7	4394.0	38.9	7196.7	46.8
Oligochaeta	22.7	0.3	252.0	2.2	313.3	2.0
Paraleptophlebia	158.0	2.2	194.7	1.7	15.8	0.1
Perlesta	50.7	0.7	659.3	5.8	250.0	1.6
Simuliidae	284.7	4.0	746.7	6.6	670.8	4.4
Stenelmis	384.0	5.4	284.7	2.5	460.0	3.0

4.3 Fishes Collected by Seine

Summary

1. Monthly seine collections yielded a total of 14,066 specimens of 29 species and sunfish hybrids from seven EBPC stations in 1985. An additional 1,521 fish of 22 species and 1,043 fish of 15 species were collected from one station each on Perkiomen Creek and Morris Run, respectively.

2. Small cyprinids were the most numerically important fishes in seine samples at most stations. Spotfin shiner was a dominant species at all stations except E36690 in the EBPC headwaters, where golden shiner was relatively more abundant, and the Morris Run station, where banded killifish was the numerically dominant species.

3. Judging from the number of YOY fish collected compared with numbers collected in earlier years, several minnow species exhibited relatively weak spawning success, while recruitment of white sucker and centrarchids, especially smallmouth bass, was relatively good.

4. Seine catches in 1985 generally corroborated earlier observations related to longitudinal succession of the EBPC fish community made by seining and electrofishing.

Introduction and Methods

A survey of fishes vulnerable to seining was conducted at monthly intervals in 1985 at seven EBPC stations, one station on Morris Run (a headwater tributary of EBPC), and one station on Perkiomen Creek upstream of its confluence with the EBPC. Similar surveys were made in 1975-1976 and in 1981-1984. The objective of this series of seine collections was to provide baseline data that can be compared to similar data that would be collected after the EBPC begins to receive water diverted from the Delaware River. The Morris Run and Perkiomen Creek stations were included to detect possible changes in the sampled fish community that occur within a larger portion of the drainage basin and that are unrelated to the diversion.

Examples of the kinds of biological information provided by the seining program include species composition and relative abundance of a target portion of the fish community (i.e., fish of small size such as minnows, darters, and young of rough, sport, and pan fishes), approximate time of spawning estimated from the dates that young-of-year (YOY) fish appeared in samples, relative spawning success based on the contribution of YOY fish to the sample, observations on preferred habitat, and incidence of disease and abnormalities. This report will focus primarily on the species composition and relative abundance of fishes in the 1985 seine collection, drawing on supporting information as

necessary to clarify particular observations or contrast 1985 data with data collected in previous years.

Fish were collected with a seine 2.4 m long, 1.2 m deep, having a 3.2 mm mesh. Sampling effort was standarized as a number of net sweeps within the bounds of each station. The number of net sweeps and area sampled varied among selected stations, but remained consistent within a station. Station boundaries were selected to include a variety of microhabitats characteristic of each local stream reach. These microhabitat types consisted of riffles, runs, and shallow pools with variable substrate and cover. To a varying degree, each type of microhabitat within a station was sampled, but stations by necessity excluded habitat too deep to wade. On the EBPC, water of such depth was primarily found in the larger downstream pools and small impoundments above low-head dams. Sampling of a variety of microhabitat types ensured a high probability of collecting most species present in the EBPC.

Any adult rough, pan, and sport fishes collected were measured to the nearest 5-mm interval fork length (FL), examined for disease, and released. All other specimens were preserved for laboratory processing. For each station, fish captured in different net sweeps were pooled to form a composite sample for a particular date. Thus, no attempt to quantify microhabitat use was made, but qualitative observations were sometimes made. In

the laboratory each collection of fish was sorted by species into 5-mm FL intervals. When a large number of fish (>200) of a given species was collected, a length distribution was determined for a random subsample of approximately 100 individuals. Counts of fish were expressed as percentages of species and sample totals. Presence of disease and other abnormalities of individual fish was also recorded.

Results and Discussion

Species Composition and Relative Abundance

East Branch Perkiomen Creek

A total of 29 species and Lepomis (sunfish) hybrids was collected by seine in 1985 (Tables 4.3-1, 4.3-2, and 4.3-3). Although a more comprehensive species list can be generated by seining than by the electrofishing methods employed on the EBPC (which excluded small species), some kinds of fish (e.g., American eel, adults of larger species), are more vulnerable to electrofishing than seining. Therefore, neither technique alone could be expected to collect all species present. Since 1970, however, both methods together have generated a collection list containing 44 species and four hybrid groups (EROL; RMC 1984, 1985).

In 1985, five species or hybrids were not seined from the EBPC, but were collected by electrofishing, including American eel, chain pickerel, carp x goldfish hybrid, brown bullhead, and margined madtom. Fishes on the EBPC collection list not taken by either method in 1985 included brook trout, muskellunge, muskellunge x northern pike hybrid, fathead minnow, silvery minnow, Notropis (minnow) hybrids, white catfish, mummichog, white crappie, black crappie, yellow perch, shield darter, and walleye. This latter group included fishes that were either naturally present only in low numbers, or were occasionally introduced by various means. Some may no longer be present in the stream.

A total of 14,066 specimens was collected by seine in 1985 (Table 4.3-1). Five species accounted for nearly 80% of the total sample, including spotfin shiner (51% of the total catch), satinfin shiner (7%), common shiner (7%), banded killifish (6%), and comely shiner (6%). No other species comprised more than 5% of the 1985 seine catch.

Although many of the more abundant species were numerically important at all stations, between-station differences were observed in the fish communities present that were related to differences in stream size and habitat diversity between the EBPC headwaters and progressively larger downstream reaches. Collections made at each station (Table 4.3-2) were therefore examined individually to illustrate the pattern of longitudinal

succession (Odum 1971) apparent in the stream fish community. The stream-wide catch by month is summarized in Table 4.3-3 to illustrate seasonal treands in the data and permit comparisons with similar tables in earlier progress reports (RMC 1984, 1985).

E36690

In 1985, eleven monthly seine collections at this headwater station yielded 804 fish of 17 species and sunfish hybrids. The most abundant species were golden shiner (54% of the total catch), green sunfish (12%), and pumpkinseed (9%). These species also comprised relatively high proportions of the 1985 electrofishing catch (Section 4.4). Two other species consistently taken with greater frequency in the EBPC headwaters than in downstream areas were redfin pickerel and bluegill. Previous seining and electrofishing surveys (EROL, RMC 1984, 1985) showed that redfin pickerel are locally abundant in the EBPC only in the headwaters. Its restricted distribution may result in this species being particularly susceptible to the effects of water diversion (EROL).

The catch of golden shiner at E36690 varied considerably in recent years, apparently as a result of differential year class strength. Total catch of golden shiner was relatively high in 1982, 1983, and again in 1985 when YOY fish comprised 90% or more of the total number of golden shiners collected. Although not an

obligate headwater species, the distribution of golden shiners within the stream was influenced by the location of areas of preferred habitat. Except for headwater pools and the short impounded reaches downstream, much of the EBPC lacked the sluggish, weedy habitat preferred by this species.

More adult green sunfish and pumpkinseed were collected in 1985 than in any previous year. Intermittent flow conditions in summer created a series of isolated pools in which these fish were concentrated and as a result they were more vulnerable to repeated capture. Both species comprised a greater percentage of the total sunfish catch here than at other seining stations. A similar trend was noted in electrofishing samples in that the headwater samples were comprised of relatively large proportions of both species compared to several downstream stations where redbreast sunfish predominated.

E29810

A total of 2,397 fish of 17 species and sunfish hybrids was taken in twelve monthly collections in 1985. A fish community different from the one at E36690 was present at this station, which was downstream of the immediate EBPC headwaters. Spotfin shiner was the most abundant species and comprised 54% of the yearly catch. Other numerically important species were common shiner (12%) and banded killifish (8%). The catch of common

shiner at E29810 was lower in 1985 than in all but one previous annual collection, while that of tesselated darter was the lowest recorded. Both species prefer areas of faster current, and low flow conditions in late summer may have been related to decreases in local population density through several possible mechanisms, including movement downstream, increased susceptibility to predation, and stranding and dessication. Many common shiners died in late summer when they became trapped in isolated puddles of water that later evaporated.

Golden shiner and spotfin shiner were the only species for which appreciable numbers of YOY fish were collected. Other species did not spawn well in the vicinity, although three YOY smallmouth bass were collected. E29810 is believed to be near the upper limit of smallmouth bass distribution within the EBPC. This recreationally important species was common in pools between the Morris Run confluence and Sellersville (RMC 1985) but was seldom collected by any method upstream in either Morris Run or the EBPC headwaters.

E26630

A total of 3,513 specimens of 24 species and sunfish hybrids was taken in 1985. Sample species richness was greater here than at any other station. Collections contained species that were important at downstream stations, species that were more abundant

in the headwaters, and species that were likely abundant in one of the larger of the small EBPC impoundments located immediately upstream of E26630. Included in this latter group of species were carp, goldfish, and largemouth bass. Largemouth bass was the most frequently collected centrarchid at E26630; nearly all of those taken were YOY fish which indicated that largemouth bass spawned successfully in the vicinity.

Spotfin shiner was the most abundant species at E26630, comprising 53% of the annual catch. Other numerically important species were banded killifish (13%), bluntnose minnow (6%) and comely shiner (5%). In contrast, comely shiners comprised 20% of the 1984 seine catch at E26630 and ranked second in overall relative abundance from this location. In 1985, a moderate decline in stream-wide catch for this species was observed as well. Using similar amounts of effort, an average of 1,184 comely shiners per year were seined during 1981-1984 but only 874 were collected by seine in 1985.

E22980

A total of 1,018 fish of 18 species was taken in 1985. Spotfin shiner catch and common shiner catch were almost identical (238 and 241 fish respectively) and for spotfin shiner was the lowest recorded catch for this species from E22980 in any 1 year. The catch of common shiner was more similar to that in

1981-1983 (172 to 327 fish) than in 1984 (66 fish). Overall, total catch from E22980 was the lowest recorded in any year surveyed, which suggested relatively weak recruitment of several of the more numerically abundant species, including spotfin shiner, comely shiner, and satinfin shiner. In contrast, catches of YOY white sucker, blacknose dace, and smallmouth bass were relatively high compared to catches made in previous years. Increased abundance of juvenile and adult smallmouth bass was also noted in electrofishing samples (Section 4.4).

E12440

A total 3,302 fish of 19 species was taken in 1985 which was considerably higher than the total catch in any year between 1981 and 1984. A newly felled tree near the downstream end of the station created a backwater in which many fish concentrated, and much of the 1985 seine catch came from this quiescent area. During winter months fish were collected nowhere else within the bounds of the station but in this backwater. Presence of this unusual condition confounded interpretation of catch as an index of relative fish density, but may not have affected sample species composition if fish vulnerable to the seine were equally attracted to the backwater.

Four species accounted for over nine-tenths of the seine catch at E12440, including spotfin shiner (64%), comely shiner

(12%), satinfin shiner (12%), and common shiner (4%). Numerous young redbreast sunfish, smallmouth bass, and white sucker also were taken. More YOY white sucker were collected at this station in 1985 than in any year since 1981, which was suggestive of above average recruitment for this species.

E5475

A total of 2,659 fish of 19 species was taken at this location in 1985. Spotfin shiner (59.2% of the total catch), satinfin shiner (17.3%) and common shiner (6.5%) were numerically important in the sample, but YOY of these species were not collected with the same frequency as in some earlier years. Relatively poor recruitment of small cyprinids was also noted at most other stations on the EBPC in 1985, judging from the contribution of YOY fish to the seine sample. In contrast, smallmouth bass and white sucker exhibited above average recruitment at many stations, including E5475.

E1890

This station consists of broad, shallow riffle-run habitat with few calm areas where small fishes tend to aggregate. Consequently, total fish catches from E1890 have remained consistently lower than those from other EBPC stations, but species composition has remained relatively stable. Spotfin shiner was

the most abundant species in the seine catch from this station, as it was from a majority of EBPC stations. Rank abundance of common shiner decreased considerably at E1890 in 1985, but the catch of YOY smallmouth bass was relatively high. Similar observations were made throughout most of the EBPC, which suggests that spawning success for many minnow species was relatively low while that of white sucker and centrarchids, especially smallmouth bass, was comparatively high.

Perkiomen Creek

In 1985, seine collections from Perkiomen Creek upstream of the EBPC influence yielded 1,521 fish of 22 species (Table 4.3-1). The most abundant species in the seine catch were spotfin shiner (68%), fallfish (6%), blacknose dace (4%) and smallmouth bass (4%). Shield darters were collected for the first time since 1983 when a single specimen was collected. Catches of YOY smallmouth bass by seining and electrofishing were relatively high at many localities within the drainage basin in 1985; P19775 was no exception.

Morris Run

Morris Run is a headwater tributary of the EBPC above Sellersville, Pennsylvania. Stream gradient is higher, and substrate rockier in Morris Run than in the EBPC above the con-

fluence of the two streams. Banded killifish and young redbreast sunfish were more abundant at the Morris Run station than at the headwater EBPC station, E36690. In all, 1,034 fish of 15 species were collected from M2900 in 1985 (Table 4.3-1).

Important Species

Several species were selected as important to the EBPC fish community according to criteria that consider a species' functional role in the community, its sensitivity to environmental change, and the likelihood of ecological impact (EROL). Redfin pickerel, yellow bullhead, white sucker, satinfin shiner, common shiner, spotfin shiner, redbreast sunfish, green sunfish, pumpkinseed, smallmouth bass, and tessellated darter were the species selected. For these important fishes, seine data were examined in more detail to describe aspects of each species' ecology in the EBPC.

Redfin pickerel

The redfin pickerel was locally abundant only in EBPC headwaters (E36690) and was commonly taken in low numbers as far downstream as E26630. Incidental seine catches were made from stations further downstream, but these amounted to only one or two fish per year. In a pattern that mirrored concurrent electrofishing results, the seine catch of redfin pickerel peaked in

1983 following two years of steady increase, and then declined markedly in 1984 and 1985.

Redfin pickerel catches were low in 1975 (EROL) and again in 1984 (RMC 1985). In both years, spates occurred frequently throughout the spring and summer. Redfin pickerel catch was also low in 1985, a dry year in which stream flow was much reduced in the EBPC headwaters. Abundance of redfin pickerel appeared to be quite variable and is possibly related to stream discharge although the nature of any relationship between these two variables is unclear.

Yellow bullhead

Although occasionally taken by seine, too few yellow bullheads were collected by this method to provide much information on the abundance and distribution of this species in the EBPC. Small yellow bullheads hide in crevices and under rocks and are not collected efficiently by seine, and adults usually inhabit deeper water. Due to "galvanotaxis" (forced movement within an electric field), YOY yellow bullhead were often taken by electrofishing along with many juveniles and adults. Present throughout the stream, this ubiquitous catfish was most often found in deep pools and weedy areas impounded by small dams.

White sucker

Although found throughout the stream, white suckers were more abundant in the middle EBPC than in either headwater or downstream reaches (EROL, RMC 1984, 1985). Large adult white suckers are very mobile and inhabit deeper pools, therefore, the seine sampled primarily YOY and juvenile white suckers. Seine collections indicated that this species spawned primarily in the EBPC headwaters. Over 50% of YOY were taken at the upper two stations (E36690 and E29810) in 6 out of 8 years in which seine collections were made.

Using the number of YOY white sucker collected per year (in parenthesis) as an index of relative spawning success, year classes produced in 1976 (1,462) and 1982 (935) were stronger than those produced in 1983 and 1984, when only 100 YOY were collected per year with similar amounts of effort. Relative abundance of YOY white sucker in other years was intermediate between these extremes.

Satinfin shiner

This species, which closely resembles the congeneric spotfin shiner, was a common inhabitant of the middle and lower EBPC. Seine catches were greatest at E22980, E12440, and E5475. None was ever collected from stations upstream of a dam in

Sellersville. During years of above-average stream flow (1975, 1982, 1984), the number of YOY collected was from 2-6 times the number collected in any other year. Highest catches of young came from E5475, a broad, shallow riffle-run area thought to provide optimum satinfin shiner spawning habitat. In 1985, year class production appeared to be very low. Only four YOY satinfin shiners were collected, compared to the next-lowest yearly total of 97 YOY satinfin shiners taken in 1983.

Common shiner

Present at all EBPC seining stations, common shiners were abundant in mid-reach, with peak densities observed at E29810. Relative abundance was stable as common shiner was the second-to-fourth-most numerous species in 7 out of 8 annual seine collections and ranked no lower than sixth in 1976. Relative abundance was more variable at two stations, however. At E22980, annual seine catches in 1977 and in 1981-1984 were approximately 10 times as great as the total collected each year in 1975-1976 and in 1985. In the headwaters, annual seine catches from E36690 in 1975-1976 were about five times the yearly total collected in 1977 and 1981-1985. Greatest reproductive success occurred in 1976 and 1982, years in which the most YOY common shiners were taken. (Note: 1977 seine data were never included in previous

reports. Therefore, Table 4.3-4 was included to reference seine collections made in that year.)

Spotfin shiner

The spotfin shiner was the most abundant fish species collected in each year, comprising over 50% of the number of fish taken by seine from the EBPC. Seine catches were highest at stations upstream of E26630 prior to 1984, while spotfin shiner catch was highest from E5475 and E12440 in 1984 and 1985, respectively.

Relative abundance of spotfin shiner appeared to be highly dependant on the degree of spawning success and over-winter survival of young fish, which in turn appeared to depend on late-summer stream flow conditions. Recruitment of young spotfin shiner was lowest in years when late-summer stream flow was unusually high or low.

Redbreast sunfish

More redbreast sunfish were taken by seine than any other species in the sunfish family in all but three years in which seining was conducted on the EBPC. More green sunfish than redbreast sunfish were taken in 1976-1977, and the seine catch of smallmouth bass exceeded that of redbreast sunfish in 1985.

Relative abundance of young redbreast sunfish taken by seine followed closely a pattern seen in the distribution of juveniles and adults taken by electrofishing. Redbreast sunfish was the dominant sunfish species at downstream stations (E5475 and E1890) and also just upstream of Sellersville at E32170. Prior to 1982, green sunfish was the most abundant sunfish at E22980 in the middle EBPC downstream of Sellersville. Seine catches of redbreast sunfish exceeded those of green sunfish in every year since 1982 at E22980, and electrofishing samples taken nearby at E22240 also were comprised of increasing proportions of redbreast sunfish that peaked in 1985 when for the first year more redbreast sunfish than green sunfish were taken (see section 4.4). Poor habitat conditions, including pollution stress, were at one time thought to severely limit redbreast sunfish populations in the middle EBPC (EROL). The present-day makeup of the fish community indicates that these conditions have been ameliorated.

Compared to 1983, when 375 were collected, the catch of 30 YOY redbreast sunfish in 1985 was considerably low, since similar amounts of effort were expended within the same seining areas. These values represent the extremes in YOY seine catch for this important species over the period of record. Fluctuations in recruitment were in part responsible for variation in the number of young redbreast sunfish collected, since age-structure analysis

(see section 4.5) showed that the 1983 year class was exceptionally strong.

Green sunfish

Seine catches of this important species followed trends that were similar to observations made by electrofishing. Green sunfish was the dominant Lepomis at the headwater station, E36690, but was not abundant at E5475 and E1890 downstream. In the middle EBPC, green sunfish once maintained a competitive advantage over other sunfishes due to its tolerance of the poor habitat quality and pollution stress once present in the reach below Sellersville (EROL). Although green sunfish remained abundant in this reach of stream, catches of redbreast sunfish by both seining and electrofishing increased steadily since 1982. As indicated in the previous section on redbreast sunfish, the decline in green sunfish dominance implies an improvement in stream conditions consistent with the relative increase in the abundance of less-tolerant species.

Pumpkinseed

This important species was more abundant in the upper EBPC than at downstream stations, but was never as abundant as green sunfish or redbreast sunfish. Electrofishing surveys indicated this species was common in the impoundments above small dams, but

this type of habitat was not sampled by seine. Greatest numbers of YOY pumpkinseed were taken in 1976 (144 fish) and in 1982 (77 fish). Only 7 young were taken collectively between 1983 and 1985, indicative of relatively weak recruitment through most of the stream during the last three years.

Smallmouth bass

A total of 215 smallmouth bass was taken in 1985. Most were YOY fish. This was the greatest number of smallmouth bass collected by seine in any 1 year since 1977, when 255 were captured. This relatively large catch was indicative of a successful spawn. In contrast, only 72 YOY were taken in 1984, a year in which smallmouth bass recruitment was poor. Young smallmouth bass were first recruited to the seine in June 1985 at a FL between 16 and 21 mm. By August, large numbers of YOY smallmouth bass greater than 50-mm FL were recruited to electrofishing gear (section 4.4) and by autumn, some had reached 120-mm FL or more (section 4.5).

Smallmouth bass were most abundant at downstream stations and were rarely taken in the headwaters above the Morris Run confluence. Only two smallmouth bass were seined in 8 years at E36630. In samples taken by electrofishing from E22240 downstream of Sellersville, smallmouth bass were considerably more numerous in 1981-1985 than in the mid-1970's. Many YOY smallmouth bass were collected in 1983 (31 fish) and in 1985 (58 fish)

from a nearby seining station (E22980) which indicated that the species was able to reproduce successfully in an area of the stream that at one time was too degraded to support a viable smallmouth bass population.

Tessellated darter

A total of 263 tessellated darters was taken in 1985. Seine catches in other years ranged between 196 in 1984 and 1,198 in 1976, the year when the most YOY were collected. Although present at all stations, tessellated darters were considerably more abundant at E26630 and E29810 that than at stations downstream of Sellersville.

Comparisons with EROL Findings

Earlier progress reports (RMC 1984, 1985) focused primarily on descriptions of annual species composition and relative abundance of fishes seined monthly from the EBPC over a period of years. Although some reference to EROL information was made, little emphasis was placed on the similarities and differences between recent (1981-1985) fish population information and that collected in the mid-1970's which was used in preparation of the EROL. Assessment of natural change is an important aspect of a monitoring program since it is against this background of variability that the significance of project impacts must be

judged. The following paragraphs are therefore included to compare present-day EBPC fish populations to those reported in the EROL.

Overall, species composition within the stream was similar among the two periods. Several species, including silvery minnow (one specimen in 1975), black crappie (not taken in 1975-1976), and fathead minnow (taken infrequently in 1981-1985) were rarely collected by seine and no young were ever found. The rock bass was common at downstream seining stations in 1981-1985 but was not collected by seine in 1975-1976. This species was taken by electrofishing in 1975-1976, and is more common today in the lower reaches of the EBPC than it was in the earlier period.

The overall pattern of longitudinal succession in species composition remained similar throughout the period of record. Pronounced replacement of headwater species (bridle shiner, golden shiner, creek chubsucker, and redfin pickerel) with those more abundant at midstream and downstream stations occurred in the vicinity of Sellersville. Certain species (rock bass, redbreast sunfish, fallfish, and smallmouth bass) were most abundant in the larger downstream reach near Perkiomen Creek in both periods. Stations in the middle reaches of the EBPC (from Sellersville to the vicinity of the Wawa Road crossing) consistently displayed the greatest amount of seasonal and annual variability in sample species composition. In part, this was due

to the occasionally capture of displaced headwater species. Also, several seining stations fell within this relatively long reach, so the large amount of effort expended resulted in the more frequent capture of lesser abundant species. Species that are abundant in the small impoundments scattered along the EBPC (carp, goldfish, largemouth bass and pumpkinseed) were also taken occasionally which added to the variability in sample species composition observed in the middle reaches of the EBPC.

Nevertheless, a pronounced shift in the abundance of several species has occurred in the middle EBPC. Redbreast sunfish and smallmouth bass were far more numerous from stations as far upstream as E22240 (electrofishing) and E22980 (seining) in 1981-1985 than in 1975-1976. Collection of large numbers of YOY of these species by seine indicated that suitable spawning habitat was available. Rock bass were found only from extreme downstream stations in 1975-1976 but are now abundant in the Moyer Road vicinity (E12440) and were taken in low numbers by electrofishing as far upstream as E22240 near Sellersville. At the same time, the green sunfish and white sucker (species that are tolerant of degraded stream conditions) no longer dominate the middle EBPC fish community to the extent that they did in 1975-1976. These shifts in relative species abundance imply a long-term reduction in pollution stress that strongly influenced EBPC fish populations in the past (EROL).

Table 4.3-1. Total catch and relative abundance of fishes collected by seine from the East Branch Perkiomen Creek, Morris Run, and Perkiomen Creek during 1985.

Species	East Branch Catch	%	Morris Run Catch	%	Perkiomen Cr Catch	%
Redfin pickerel	4	+	-	-	-	-
Goldfish	2	+	-	-	-	-
Carp	2	+	-	-	-	-
Cutlips minnow	44	0.3	-	-	8	0.5
Golden shiner	524	3.7	1	0.1	3	0.2
Comely shiner	874	6.2	4	0.4	40	2.6
Satinfin shiner	1019	7.2	-	-	11	0.7
Bridle shiner	2	+	-	-	-	-
Common shiner	996	7.1	214	20.7	10	0.7
Spottail shiner	75	0.5	-	-	18	1.2
Swallowtail shiner	342	2.4	43	4.2	49	3.2
Spotfin shiner	7231	51.4	252	24.4	1031	67.8
Bluntnose minnow	396	2.8	64	6.2	6	0.4
Blacknose dace	157	1.1	64	6.2	62	4.1
Longnose dace	35	0.2	-	-	26	1.7
Creek chub	3	+	-	-	1	0.1
Fallfish	11	0.1	-	-	95	6.2
White sucker	482	3.4	1	0.1	32	2.1
Creek chubsucker	33	0.2	1	0.1	-	-
Yellow bullhead	5	+	-	-	-	-
Banded killifish	875	6.2	326	31.5	7	0.5
Rock bass	3	+	-	-	-	-
Redbreast sunfish	163	1.2	49	4.7	9	0.6
Green sunfish	118	0.8	4	0.4	-	-
Pumpkinseed	85	0.6	-	-	5	0.3
Bluegill	51	0.4	1	0.1	7	0.5
Lepomis hybrid	21	0.1	-	-	-	-
Smallmouth bass	215	1.5	6	0.6	62	4.1
Largemouth bass	35	0.2	-	-	1	0.1
Tessellated darter	263	1.9	4	0.4	27	1.8
Shield darter	-	-	-	-	11	0.7
Total Catch	14066		1034		1521	
Number of Species	29		15		22	
Number of Stations	7		1		1	

+ = Less than 0.1%

Table 4.3-2. Total catch and relative abundance of fishes collected by seine from the East Branch Perkiomen Creek by station during 1985.

Species	E 1890 Catch	%	E 5475 Catch	%	E12440 Catch	%	E22980 Catch	%	E26630 Catch	%	E29810 Catch	%	E36690 Catch	%
Redfin pickerel	-	-	-	-	-	-	-	-	1	+	-	-	3	0.4
Goldfish	-	-	-	-	-	-	-	-	2	0.1	-	-	-	-
Carp	-	-	-	-	-	-	-	-	2	0.1	-	-	-	-
Cutlips minnow	-	-	7	0.3	10	0.3	15	1.5	12	0.3	-	-	-	-
Golden shiner	-	-	-	-	12	0.4	2	0.2	41	1.2	36	1.5	433	53.9
Comely shiner	11	2.9	103	3.9	404	12.2	70	6.9	175	5.0	110	4.6	1	0.1
Satinfin shiner	61	16.4	460	17.3	379	11.5	36	3.5	83	2.4	-	-	-	-
Bridle shiner	-	-	-	-	-	-	-	-	-	-	-	-	2	0.2
Common shiner	10	2.7	174	6.5	133	4.0	241	23.7	144	4.1	292	12.2	2	0.2
Spottail shiner	-	-	20	0.8	4	0.1	3	0.3	29	0.8	19	0.8	-	-
Swallowtail shiner	2	0.5	17	0.6	52	1.6	20	2.0	148	4.2	101	4.2	2	0.2
Spotfin shiner	140	37.5	1573	59.2	2097	63.5	238	23.4	1872	53.3	1289	53.8	22	2.7
Bluntnose minnow	-	-	6	0.2	12	0.4	38	3.7	197	5.6	109	4.5	34	4.2
Blacknose dace	10	2.7	23	0.9	10	0.3	63	6.2	46	1.3	5	0.2	-	-
Longnose dace	11	2.9	17	0.6	2	0.1	5	0.5	-	-	-	-	-	-
Creek chub	-	-	-	-	1	+	-	-	2	0.1	-	-	-	-
Fallfish	2	0.5	9	0.3	-	-	-	-	-	-	-	-	-	-
White sucker	7	1.9	80	3.0	58	1.8	172	16.9	62	1.8	86	3.6	17	2.1
Creek chubsucker	-	-	-	-	-	-	-	-	-	-	1	+	32	4.0
Yellow bullhead	-	-	1	+	-	-	1	0.1	3	0.1	-	-	-	-
Banded killifish	18	4.8	103	3.9	51	1.5	34	3.3	462	13.2	190	7.9	17	2.1
Rock bass	2	0.5	1	+	-	-	-	-	-	-	-	-	-	-
Redbreast sunfish	16	4.3	17	0.6	40	1.2	7	0.7	12	0.3	68	2.8	3	0.4
Green sunfish	1	0.3	-	-	4	0.1	7	0.7	2	0.1	10	0.4	94	11.7
Pumpkinseed	-	-	2	0.1	-	-	-	-	11	0.3	3	0.1	69	8.6
Bluegill	-	-	-	-	3	0.1	-	-	11	0.3	6	0.3	31	3.9
Lepomis hybrid	-	-	-	-	2	0.1	-	-	6	0.2	9	0.4	4	0.5
Smallmouth bass	81	21.7	45	1.7	23	0.7	59	5.8	4	0.1	3	0.1	-	-
Largemouth bass	-	-	-	-	-	-	-	-	33	0.9	-	-	2	0.2
Tessellated darter	1	0.3	1	+	5	0.2	7	0.7	153	4.4	60	2.5	36	4.5
Total Catch	373		2659		3302		1018		3513		2397		804	
Number of Species	15		19		19		18		24		17		17	
Number of Stations	1		1		1		1		1		1		1	

+ = Less than 0.1%

Table 4.3-3. Total catch and relative abundance of fishes collected by seine from the East Branch Perkiomen Creek by date during 1985.

Species	1/7 Catch	%	2/20 Catch	%	3/14 Catch	%	4/11 Catch	%	5/10 Catch	%	6/6 Catch	%
Redfin pickerel	-	-	-	-	1	0.1	-	-	-	-	2	0.1
Goldfish	-	-	-	-	-	-	-	-	-	-	-	-
Carp	-	-	-	-	-	-	-	-	-	-	2	0.1
Cutlips minnow	-	-	-	-	-	-	-	-	-	-	6	0.4
Golden shiner	6	0.3	-	-	7	0.9	4	0.2	19	1.3	12	0.9
Comely shiner	220	12.1	61	6.0	67	8.3	150	8.2	156	10.4	30	2.1
Satinfin shiner	280	15.4	156	15.2	91	11.2	260	14.3	67	4.5	28	2.0
Bridle shiner	-	-	-	-	-	-	-	-	1	0.1	-	-
Common shiner	10	0.6	34	3.3	5	0.6	13	0.7	66	4.4	91	6.5
Spottail shiner	-	-	9	0.9	-	-	4	0.2	1	0.1	5	0.4
Swallowtail shiner	5	0.3	3	0.3	5	0.6	72	4.0	37	2.5	17	1.2
Spotfin shiner	1243	68.6	725	70.7	559	68.9	1004	55.1	869	58.1	668	47.7
Bluntnose minnow	1	0.1	11	1.1	9	1.1	143	7.8	28	1.9	23	1.6
Blacknose dace	1	0.1	1	0.1	2	0.2	1	0.1	45	3.0	8	0.6
Longnose dace	2	0.1	-	-	-	-	-	-	1	0.1	10	0.7
Creek chub	-	-	-	-	-	-	-	-	1	0.1	1	0.1
Fallfish	-	-	-	-	-	-	-	-	-	-	-	-
White sucker	-	-	-	-	1	0.1	4	0.2	77	5.2	219	15.7
Creek chubsucker	-	-	-	-	-	-	-	-	4	0.3	2	0.1
Yellow bullhead	-	-	-	-	-	-	-	-	-	-	-	-
Banded killifish	38	2.1	21	2.0	41	5.1	149	8.2	74	4.9	36	2.6
Rock bass	-	-	-	-	-	-	-	-	-	-	1	0.1
Redbreast sunfish	-	-	1	0.1	1	0.1	2	0.1	11	0.7	35	2.5
Green sunfish	2	0.1	2	0.2	3	0.4	2	0.1	11	0.7	9	0.6
Pumpkinseed	-	-	-	-	3	0.4	4	0.2	8	0.5	8	0.6
Bluegill	1	0.1	-	-	5	0.6	3	0.2	4	0.3	-	-
Lepomis hybrid	-	-	-	-	7	0.9	2	0.1	2	0.1	-	-
Smallmouth bass	-	-	1	0.1	-	-	-	-	1	0.1	107	7.6
Largemouth bass	-	-	-	-	-	-	-	-	1	0.1	1	0.1
Tessellated darter	4	0.2	-	-	4	0.5	5	0.3	11	0.7	78	5.6
Total Catch	1813		1025		811		1822		1495		1399	
Number of Species	13		12		16		16		22		24	
Number of Stations	1		1		1		1		1		1	

+ = Less than 0.1%

Table 4.3-3. Total catch and relative abundance of fishes collected by seine from the East Branch Perkiomen Creek by date during 1985.

Species	7/12 Catch	%	8/22 Catch	%	9/24 Catch	%	10/21 Catch	%	11/20 Catch	%	12/17 Catch	%
Redfin pickerel	-	-	-	-	1	0.1	-	-	-	-	-	-
Goldfish	2	0.1	-	-	-	-	-	-	-	-	-	-
Carp	-	-	-	-	-	-	-	-	-	-	-	-
Cutlips minnow	4	0.3	17	1.4	10	0.8	7	1.1	-	-	-	-
Golden shiner	24	1.6	136	10.8	235	18.8	24	3.8	36	4.3	21	9.6
Comely shiner	34	2.3	16	1.3	57	4.6	42	6.6	38	4.5	3	1.4
Satinfin shiner	34	2.3	26	2.1	53	4.2	11	1.7	6	0.7	7	3.2
Bridle shiner	-	-	1	0.1	-	-	-	-	-	-	-	-
Common shiner	178	11.9	236	18.8	162	13.0	125	19.6	60	7.2	16	7.3
Spottail shiner	21	1.4	1	0.1	4	0.3	10	1.6	6	0.7	14	6.4
Swallowtail shiner	55	3.7	62	4.9	44	3.5	13	2.0	24	2.9	5	2.3
Spotfin shiner	587	39.1	360	28.7	376	30.1	230	36.0	500	59.8	110	50.2
Bluntnose minnow	29	1.9	34	2.7	43	3.4	21	3.3	49	5.9	5	2.3
Blacknose dace	69	4.6	14	1.1	8	0.6	7	1.1	1	0.1	-	-
Longnose dace	13	0.9	3	0.2	3	0.2	3	0.5	-	-	-	-
Creek chub	-	-	-	-	1	0.1	-	-	-	-	-	-
Fallfish	2	0.1	1	0.1	8	0.6	-	-	-	-	-	-
White sucker	160	10.7	10	0.8	3	0.2	4	0.6	2	0.2	2	0.9
Creek chubsucker	3	0.2	8	0.6	14	1.1	-	-	2	0.2	-	-
Yellow bullhead	-	-	1	0.1	3	0.2	-	-	1	0.1	-	-
Banded killifish	68	4.5	160	12.7	111	8.9	81	12.7	62	7.4	34	15.5
Rock bass	-	-	2	0.2	-	-	-	-	-	-	-	-
Redbreast sunfish	26	1.7	32	2.5	28	2.2	9	1.4	18	2.2	-	-
Green sunfish	17	1.1	41	3.3	25	2.0	1	0.2	4	0.5	1	0.5
Pumpkinseed	25	1.7	5	0.4	23	1.8	3	0.5	6	0.7	-	-
Bluegill	5	0.3	20	1.6	2	0.2	7	1.1	4	0.5	-	-
Lepomis hybrid	-	-	1	0.1	-	-	9	1.4	-	-	-	-
Smallmouth bass	41	2.7	44	3.5	15	1.2	1	0.2	5	0.6	-	-
Largemouth bass	7	0.5	18	1.4	5	0.4	2	0.3	1	0.1	-	-
Tessellated darter	98	6.5	6	0.5	16	1.3	29	4.5	11	1.3	1	0.5
Total Catch	1502		1255		1250		639		836		219	
Number of Species	23		25		25		20		20		12	
Number of Stations	1		1		1		1		1		1	

+ = Less than 0.1%

Table 4.3-4. Total catch and relative abundance of fishes collected by seine from the East Branch Perkiomen Creek, during 1977.

Species	East Branch Catch	%
Redfin pickerel	23	0.1
Goldfish	2	+
Carp	2	+
Cutlips minnow	205	1.1
Golden shiner	624	3.3
Cowely shiner	420	2.2
Satinfin shiner	299	1.6
Bridle shiner	6	+
Common shiner	3215	17.1
Spottail shiner	270	1.4
Swallowtail shiner	761	4.0
Spotfin shiner	5586	29.7
Bluntnose minnow	877	4.7
Blacknose dace	630	3.4
Longnose dace	200	1.1
Creek chub	43	0.2
Fallfish	34	0.2
Minnow hybrid	1	+
White sucker	1670	8.9
Creek chubsucker	70	0.4
Yellow bullhead	41	0.2
Brown bullhead	8	+
Margined madtom	1	+
Banded killifish	1650	8.8
Rock bass	2	+
Redbreast sunfish	322	1.7
Green sunfish	422	2.2
Pumpkinseed	58	0.3
Bluegill	90	0.5
Lepomis hybrid	23	0.1
Smallmouth bass	255	1.4
Largemouth bass	47	0.3
Tessellated darter	935	5.0
Total Catch	18792	
Number of Species	32	
Number of Stations	8	

+ = Less than 0.1%

4.4 Fishes Collected by Electrofishing

Summary

1. An electrofishing survey of a target portion of the fish community present at six EBPC stations was conducted at monthly intervals from April through October 1985.

2. A total of 9,362 fish of 19 species and 1 hybrid was caught in 35.2 hours of electrofishing at an overall rate of 266 fish/hour.

3. Redbreast sunfish, green sunfish, and white sucker were the only species to comprise more than 10% of the stream-wide electrofishing catch and ranked first through third in relative abundance, respectively.

4. Compared to 1984, relative abundance of rock bass, creek chubsucker, and goldfish increased while that of bluegill and golden shiner declined. Other common species were present in nearly the same proportions seen in earlier surveys.

5. Fish community differences between headwater stations and those downstream were similar to past observations, and reflected known or hypothesized species-habitat relationships. Differences in fish community composition in the middle EBPC from EROL information infers a long-

term improvement in stream habitat quality, which may include a reduction in pollution stress.

Introduction and Methods

An electrofishing survey of the EBPC large fish community continued in 1985 for the fifth consecutive year. The primary objective of the survey was to provide species composition and relative abundance data for a target portion of the stream fish community (RMC 1984).

Electrofishing methods used to collect fish were described in RMC (1984). After collection, individual fish were identified, measured to the nearest mm fork length (FL), weighed to the nearest g, and examined for the presence of disease, broadly defined herein to include presence of parasites and anomalies. Fish less than 50 mm FL were excluded from analysis to avoid possible gear bias against small fish. Electrofishing efforts were timed to the nearest minute to permit calculation of catch-per-unit-effort (CPUE), expressed in terms of fish/hour-of-electrofishing, or simply fish/hour. CPUE was used as an index of relative fish density to facilitate comparison between fish catches made at different places and times.

Spatial and temporal variation in these aspects of fish ecology were addressed by sampling several stations at monthly

intervals between April and October (Table 4.4-1). Sample stations were described in an earlier progress report (RMC 1984).

Results and Discussion

Species Composition and Relative Abundance

A total of 9,362 fish of 19 species and 1 hybrid was caught in 35.2 hours of electrofishing from six EBPC stations in 1985 (Table 4.4-2). Annual electrofishing catch rates from 1981 through 1984 ranged between 249 fish/hour and 347 fish/hour, thus the annual catch rate in 1985, 266 fish/hour, was not unusually high or low.

Redbreast sunfish, green sunfish, and white sucker were the only species to comprise more than 10% of the streamwide electrofishing catch and ranked first through third in relative abundance, respectively. Compared to 1984, many young-of-year (YOY) rock bass, creek chubsucker, and goldfish were caught, which approximately doubled catch rate and percent composition for these species. Relative abundance indices were approximately halved for bluegill and golden shiner compared to 1984. Other common species were present in about the same proportions observed in earlier surveys (RMC 1984, 1985).

No species or hybrid was collected in 1985 that was not reported in earlier progress reports or the EROL. Muskellunge x

northern pike hybrid, carp x goldfish hybrid, white catfish, white crappie, black crappie, and walleye were collected from EBPC in one or more past years but not in 1985.

Community Relationships

Changes in habitat, energy flow, and competitive interactions that occur as a stream increases in size are reflected in the composition of the fish community present at different locations along the EBPC. Past studies (EROL, RMC 1984, 1985) showed that certain fishes are abundant only in the EBPC headwaters (e.g., redfin pickerel, creek chubsucker) and others normally occur only in the lower reaches of the stream (e.g., fallfish, American eel). Some, such as margined madtom and chain pickerel, were collected only from specific areas with appropriate habitat. The relative abundance and distribution of more ubiquitous species are probably determined by many factors, including but not limited to local habitat and water quality characteristics, and complex biological interactions. This latter group of fishes includes white sucker, carp, goldfish, yellow bullhead, Lepomis sunfishes, rock bass, largemouth bass, and smallmouth bass. In order to better comprehend these naturally occurring changes in the stream fish community, results from each of the EBPC electrofishing stations were examined individually.

E36235

Samples from this headwater station in 1985 contained 13 species plus sunfish hybrids (Table 4.4-3). A total of 808 fish was caught in 2.32 hours of electrofishing at an overall rate of 348 fish/hour, compared to between 206 fish/hour in 1982 to 406 fish/hour in 1981 and 1984.

Green sunfish, white sucker, and bluegill were the only species to comprise more than 10% of the annual catch from E36235, and ranked first through third in relative abundance, respectively. Most of these fish were juveniles. As in 1984, relative abundance of redfin pickerel remained relatively low, compared to a peak in population abundance of this headwater species observed in 1983. Relative abundance of another headwater species, creek chubsucker, also was lower than during 1981-1983, but was higher than that seen in 1984. Much of the increase could be attributed to recruitment of young creek chubsuckers.

A single chain pickerel, 458 mm FL that weighed 796 g, was taken in April 1985 and was only the second chain pickerel collected since 1981. Other species that were relatively more abundant at E36235 than at other lotic stations included golden shiner, brown bullhead, and largemouth bass.

E30614

Although situated in the headwaters of the EBPC above Sellersville, Pennsylvania, E30614 is located downstream of the confluence with Morris Run, below which the EBPC approximately doubles in size. Adult white sucker, redbreast sunfish and smallmouth bass are locally abundant in several 1-m deep, slow pools that are separated by short riffles and chutes. In the summer of 1985 this station was disturbed by construction of a rock dam a short distance downstream. Stream surface elevation within the station was raised approximately 0.5 m, which prevented sampling after July. Exploratory collections in pools upstream of the newly impounded channel section revealed the presence of a fish community similar to that at E30614, but these data are not reported herein.

Between April and July 1985, a total of 796 fish was collected in 2.15 hours of electrofishing at an overall rate of 370 fish/hour (Table 4.4-4). Catch rates in previous years ranged between 246 fish/hour in 1982 and 426 fish/hour in 1981, thus relative total fish density was not particularly high or low in 1985.

Redbreast sunfish was the dominant target species at E30614 and comprised nearly one-half of the annual electrofishing catch. Green sunfish and yellow bullhead were the only other species to

comprise more than 10% of the sample. Catch rate of white sucker declined markedly in 1985 relative to earlier surveys, in which this species ranked first or second in relative abundance at E30614. This decline may be an artifact of not having sampled in late summer and autumn when YOY white suckers would normally contribute to the catch. Most other species were present in the same proportions seen in past samples.

No new species for this station was collected in 1985. Species collected at E30614 in at least one year between 1981 and 1984 but not collected in 1985 include American eel, golden shiner, white catfish, and walleye. The latter two species were presumably introduced by anglers and were represented by single captures.

E22240

This station was the first one downstream of effluent discharge from a wastewater treatment plant in Sellersville. In 1985, a total of 2,594 fish was taken in 8.0 hours of electrofishing at an overall rate of 324 fish/hour (Table 4.4-5). Most species were present in the same proportions and relative densities observed in 1984. Exceptions among the more common species were yellow bullhead and redbreast sunfish. Both percent composition and CPUE of yellow bullhead were approximately one-half of 1984 values. Sample abundance of redbreast sunfish at

E22240 has risen steadily in recent years, ranking fifth in 1981, third in 1982-1983, and second in 1984. In 1985, redbreast sunfish attained the position of greatest relative abundance at this station for the first time. In the 1970's, when the middle reach of the EBPC was more severely polluted than it is now, redbreast sunfish was dominant in the lower EBPC but much less abundant nearer Sellersville, where green sunfish was the dominant sunfish species. Green sunfish is more tolerant of poor water quality than redbreast sunfish, and presumably possessed a competitive advantage at E22240 for this reason (EROL). Possibly, recent reductions in phosphorous loading and median concentrations for some conservative parameters in summer (RMC 1985) have improved water quality enough to have negated the advantage that green sunfish once held. A marked and sustained increase in smallmouth bass abundance in the reach is another biological indicator of improved stream conditons.

E12111

A total of 1,786 fish of 14 species plus sunfish hybrids was caught in 6.12 hours of electrofishing in 1985 (Table 4.4-6). The overall catch rate, 292 fish/hour, was similar to that of 1984 (306 fish/hour) and was within the range of CPUE values observed each year since 1981, 201 to 450 fish/hour.

Redbreast sunfish was the dominant large fish species at E12111 as it has been in every yearly electrofishing sample. Compared to 1984, goldfish, white sucker, creek chubsucker, and rock bass increased in relative abundance, due mostly to large catches of young fish in late summer. Sample abundance of green sunfish and smallmouth bass decreased relative to the 1984 collection; smallmouth bass CPUE was within the range of 1981-1984 values but green sunfish CPUE reached a new minimum for that time period. However, sample abundance of many species has tended to fluctuate more at E12111 than at other EBPC electrofishing stations. Differences in habitat between E12111 and other EBPC lotic stations may be responsible for the greater variability in local fish density. Most EBPC stations consist of relatively deep, distinct pools bounded by riffles, but much of E12111 consists of wide, shallow run habitat with little canopy coverage. Larger fish especially tend to congregate in the deeper, shaded pools in summer. Thus, fluctuations in catches at E12111 may be more a function of fish location than of changes in population abundance in the vicinity.

E5650

This location differs from other EBPC stations in being a slow, deep pool impounded by a low-head dam. Fourteen species plus sunfish hybrids were collected in 1985. In all, 8.37 hours

of electrofishing yielded a total catch of 1,351 fish at an overall CPUE of 161 fish/hour, up from the 1984 value (127 fish/hour) but somewhat below the CPUE values determined in 1981-1983 (204-244 fish/hour).

Green sunfish ranked first in relative abundance, while equal numbers of white sucker and redbreast sunfish were caught. No other species individually comprised more than 10% of the sample. Several species that prefer slower, weedier habitat were relatively more abundant at E5650 than at most other EBPC stations. This group included goldfish, carp, carp x goldfish hybrid (collected in previous years but not in 1985), brown bullhead, green sunfish, pumpkinseed, and sunfish hybrids. Abundance of several of these species was also relatively high at E36235 and E22240, two other stations that consist of more sluggish habitat (Table 4.4-7).

E1637

The large fish community in this downstream EBPC station was dominated by redbreast sunfish (which comprised 46% of the total sample), smallmouth bass (19%) and rock bass (16%). No other species comprised more than 10% of the annual sample. In all, 2,027 fish of 15 species plus sunfish hybrids were captured in 8.25 hours of electrofishing (Table 4.4-8). Annual CPUE, 246

fish/hour, was not particularly high or low compared to previous annual CPUE values.

Many YOY white sucker, rock bass, and smallmouth bass contributed to an increase in relative population density of these species compared to 1984, while CPUE of pumpkinseed and bluegill declined. Relative abundance of other common species did not change appreciably.

Several species were generally more abundant at E1637 than at stations upstream, which contributed to the pattern of longitudinal zonation in fish community composition observed along the stream. With the percentage of each species' total EBPC catch from 1981-1985 taken at this station given in parentheses, this group of species included American eel (64%), fallfish (100%), rock bass (66%), redbreast sunfish (31%), and smallmouth bass (45%). The larger habitat, improved water quality relative to some upstream stations, and proximity to the bigger Perkiomen Creek just downstream may all contribute to fish community differences between E1637 and stations upstream.

Important Species

Certain species were selected as important according to Nuclear Regulatory Commission guidelines that consider a species' functional role in the community, importance to man, and sen-

sitivity to environmental change. Selected EBPC species include redfin pickerel, white sucker, yellow bullhead, redbreast sunfish, green sunfish, pumpkinseed, and smallmouth bass (EROL).

Redfin pickerel

The redfin pickerel is locally abundant only in the EBPC headwaters. For the period 1981-1985, 93% of redfin pickerel collected from the EBPC came from the uppermost station, E36235.

A total of 37 redfin pickerel was collected in 1985. One exhibited scoliosis (crooked spine) and one was parasitized by anchor-worm, a parasitic copepod. No other redfin pickerel examined was diseased. The largest redfin pickerel captured in 1985 was only 200 mm FL. Although occasionally regarded as a sport fish in some areas, redfin pickerel are not recreationally important in the EBPC due to small adult size and absence of fishing pressure in the headwaters. Relative abundance of redfin pickerel was low in both 1984 and 1985 compared to 1983, when it was the most abundant species in the electrofishing sample that year.

White sucker

White sucker ranked third in streamwide relative abundance in 1985, the same as its ranking the previous two years. Adults

tended to congregate in the larger, deeper pools in the middle and lower EBPC, as indicated by higher catches of adult white suckers at E22240 and E5650. Ten percent of white sucker examined were diseased, with body wounds and parasitic copepods being the commonest afflictions.

Yellow bullhead

Yellow bullhead comprised just over 5% of the 1985 sample and were taken at an overall rate of 13.6 fish/hour. Both indices of relative abundance were somewhat lower than values from 1981-1984 surveys, when yellow bullhead comprised an average of 7.9% of annual electrofishing catches and was taken at an average rate of 23 fish/hour. Distribution along the length of the EBPC was similar to that seen in past years, as was the rate of disease, about 7%. Body wounds and fin damage were common maladies.

Redbreast sunfish

Redbreast sunfish retained the position of greatest relative abundance among target species, comprising 37% of the 1985 electrofishing sample. Relative density, as measured by CPUE, was high everywhere except the impounded station at E5650 and the headwater station, E36235. In fact, these two were the only stations where redbreast sunfish was not the most abundant species in the electrofishing catch. The increase in population

density at E22240, which began in the early 1980's and has continued through the present, is especially noteworthy and suggests that a general improvement in overall water and stream quality has occurred since the 1970's.

Disease rates were similar to those observed in past surveys. In all, 9% of redbreast sunfish examined were diseased. Leech and copepod parasitism were common maladies, but the incidence of eye fluke, a parasite that causes a "pop-eye" condition, was greatly reduced.

Green sunfish

Green sunfish was the second-most abundant sunfish and the second-most abundant species overall in the 1985 electrofishing sample. It was the most abundant target species at E36235 and E5650, two stations that offer the sluggish conditions preferred by green sunfish. Although it remained abundant at E22240, green sunfish was replaced by redbreast sunfish in terms of numerical dominance at this middle EBPC station.

Green sunfish hybridizes readily with other sunfishes, especially pumpkinseed, judging from the appearance of most crosses. Hybrid sunfish were more abundant at those stations (E36235, E22240, and E5650) where densities of green sunfish and pumpkinseed were also high.

Approximately one-fourth of green sunfish examined in 1985 were diseased; parasitism by black spot was by far the most common affliction although individual infestations were seldom severe.

Pumpkinseed

This sunfish species was not as abundant in the EBPC as the redbreast sunfish and green sunfish, but in most years was more abundant than bluegill, the only other species of Lepomis sunfish that occurs in this stream. In 1985, pumpkinseed comprised 4% of the annual electrofishing catch and was captured at a rate of nearly 11 fish/hour. These indices of relative abundance were similar to 1984 values but somewhat below values obtained in 1981-1983 surveys. Pumpkinseed were most often collected from the same stations where green sunfish was abundant, as were hybrids between these two sunfishes. Blackspot, the most common disease of pumpkinseed, occurred on 20% of those examined in 1985, but individual fish were seldom heavily parasitized.

Smallmouth bass

Smallmouth bass ranked fourth in streamwide relative abundance in 1985, comprised 6.4% of the total electrofishing catch, and were caught at an average rate of 17 fish/hour. Although this recreationally and ecologically important predatory species

is most abundant in the lower EBPC, density remained higher in the middle reaches of the stream compared to observations made in the 1970's (EROL). Similar to other centrarchids (sunfish family) in the EBPC, nearly one-fourth of the smallmouth bass examined in 1985 were in some way diseased. Minor occurrence of blackspot was frequently observed, while smallmouth bass at E1637 were more often parasitized by leeches than blackspot. Production of a relatively strong year-class was evidenced by the capture of many YOY in late summer. Growth of these young fish appeared to be excellent. Many YOY smallmouth bass exceeded 100 mm FL by the end of their first summer of life.

Table 4.4-1. Summary of the East Branch Perkiomen Creek electrofishing sample sites and dates.

Name	Station	Type		A	M	J	J	A	S	O	Total
Elephant	E36235	Lotic	1981	X		X		X		X	4
			1982		X	X		X		X	4
			1983	X	X	X	X	X	X	X	7
			1984	X	X	X	X	X	X	X	7
			1985	X	X	X	X	X		X	6
		*									28
Covered Br.	E30614	Lotic	1981	X		X		X		X	4
			1982		X	X		X		X	4
			1983	X	X	X	X	X	X	X	7
			1984	X	X	X	X	X	X	X	7
			1985	X	X	X	X				4
		*									26
Cathill	E22240	Lotic	1981	X		X		X		X	4
			1982		X		X	X		X	4
			1983	X	X	X		X		X	5
			1984	X		X	X	X	X	X	6
			1985	X	X	X	X	X		X	6
		*									25
Moyer	E12111	Lotic	1981		X	X		X		X	4
			1982		X	X		X		X	4
			1983	X	X	X	X	X	X	X	7
			1984	X		X	X	X	X	X	6
			1985	X	X	X	X	X		X	6
		*									27
Hawa	E 5650	Lentic	1981		X	X		X		X	4
			1982		X		X	X		X	4
			1983	X	X	X	X	X	X	X	7
			1984	X		X	X	X	X	X	6
			1985	X	X	X	X	X		X	6
		*									27
Garges	E 1637	Lotic	1982		X		X	X		X	4
			1983	X	X	X	X	X	X	X	7
			1984	X	X	X	X	X	X	X	7
			1985	X	X	X	X	X		X	6
		*									24
											157

Table 4.4-2. Annual relative abundance of target fishes from the East Branch Perkiomen Creek electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		E 1637 8.25 Hr	E 5650 8.37 Hr	E12111 6.12 Hr	E22240 8.00 Hr	E30614 2.15 Hr	E36235 2.32 Hr	Total 35.20 Hr
American eel	Catch	10	-	1	2	-	-	13
	%	0.5	-	0.1	0.1	-	-	0.1
	CPUE	1.21	-	0.16	0.25	-	-	0.37
Redfin pickerel	Catch	-	-	-	5	1	31	37
	%	-	-	-	0.2	0.1	3.8	0.4
	CPUE	-	-	-	0.63	0.47	13.36	1.05
Chain pickerel	Catch	-	-	-	-	-	1	1
	%	-	-	-	-	-	0.1	+
	CPUE	-	-	-	-	-	0.43	0.03
Goldfish	Catch	3	16	55	-	-	-	74
	%	0.2	1.2	3.1	-	-	-	0.8
	CPUE	0.36	1.91	8.99	-	-	-	2.10
Carp	Catch	30	35	3	20	-	-	88
	%	1.5	2.6	0.2	0.8	-	-	0.9
	CPUE	3.64	4.18	0.49	2.50	-	-	2.50
Golden shiner	Catch	-	11	-	-	-	16	27
	%	-	0.8	-	-	-	2.0	0.3
	CPUE	-	1.31	-	-	-	6.90	0.77
Fallfish	Catch	8	-	-	-	-	-	8
	%	0.4	-	-	-	-	-	0.1
	CPUE	0.97	-	-	-	-	-	0.23
White sucker	Catch	50	319	124	535	53	161	1242
	%	2.5	23.6	6.9	20.6	6.7	19.9	13.3
	CPUE	6.06	38.11	20.26	66.88	24.65	69.40	35.28
Creek chubsucker	Catch	2	6	100	4	9	68	189
	%	0.1	0.4	5.6	0.2	1.1	8.4	2.0
	CPUE	0.24	0.72	16.34	0.50	4.19	29.31	5.37
Yellow bullhead	Catch	116	48	102	124	80	9	479
	%	5.7	3.6	5.7	4.8	10.1	1.1	5.1
	CPUE	14.06	5.73	16.67	15.50	37.21	3.88	13.61
Brown bullhead	Catch	6	24	1	6	2	14	53
	%	0.3	1.8	0.1	0.2	0.3	1.7	0.6
	CPUE	0.73	2.87	0.16	0.75	0.93	6.03	1.51
Margined madtom	Catch	-	-	10	-	-	-	10
	%	-	-	0.6	-	-	-	0.1
	CPUE	-	-	1.63	-	-	-	0.28
Rock bass	Catch	321	37	152	-	-	-	510
	%	15.8	2.7	8.5	-	-	-	5.5
	CPUE	38.91	4.42	24.84	-	-	-	14.49
Redbreast sunfish	Catch	936	319	996	788	380	39	3458
	%	46.2	23.6	55.8	30.4	47.7	4.8	36.9
	CPUE	113.45	38.11	162.75	98.50	176.74	16.81	98.24
Green sunfish	Catch	121	378	131	751	146	298	1825
	%	6.0	28.0	7.3	29.0	18.3	36.9	19.5
	CPUE	14.67	45.16	21.41	93.88	67.91	128.45	51.85
Pumpkinseed	Catch	15	80	10	186	28	55	374
	%	0.7	5.9	0.6	7.2	3.5	6.8	4.0
	CPUE	1.82	9.56	1.63	23.25	13.02	23.71	10.63
Bluegill	Catch	12	18	-	52	38	85	205
	%	0.6	1.3	-	2.0	4.8	10.5	2.2
	CPUE	1.45	2.15	-	6.50	17.67	36.64	5.82
Lepomis hybrid	Catch	16	35	5	51	10	16	133
	%	0.8	2.6	0.3	2.0	1.3	2.0	1.4
	CPUE	1.94	4.18	0.82	6.38	4.65	6.90	3.78

Table 4.4-2. Annual relative abundance of target fishes from the East Branch Perkiomen Creek electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		E 1637 8.25 Hr	E 5650 8.37 Hr	E12111 6.12 Hr	E22240 8.00 Hr	E30614 2.15 Hr	E36235 2.32 Hr	Total 35.20 Hr
Smallmouth bass	Catch	380	24	94	54	42	1	595
	%	18.8	1.8	5.3	2.1	5.3	0.1	6.4
	CPUE	46.06	2.87	15.36	6.75	19.53	0.43	16.90
Largemouth bass	Catch	1	1	2	16	7	14	41
	%	0.1	0.1	0.1	0.6	0.9	1.7	0.4
	CPUE	0.12	0.12	0.33	2.00	3.26	6.03	1.16
	Catch	2027	1351	1786	2594	796	808	9362

Table 4.4-3. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E36235 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 0.18 Hrs	May 0.45 Hrs	Jun 0.48 Hrs	Jul 0.38 Hrs	Aug 0.28 Hrs	Oct 0.53 Hrs
Redfin pickerel	Catch	-	5	8	7	6	5
	%	-	3.6	4.8	4.5	4.4	3.0
	CPUE	-	11.1	16.7	18.4	21.4	9.4
Chain pickerel	Catch	1	-	-	-	-	-
	%	2.2	-	-	-	-	-
	CPUE	5.6	-	-	-	-	-
Golden shiner	Catch	-	-	2	5	7	2
	%	-	-	1.2	3.2	5.1	1.2
	CPUE	-	-	4.2	13.2	25.0	3.8
White sucker	Catch	22	30	31	26	26	26
	%	48.9	21.9	18.5	16.6	19.0	15.9
	CPUE	122.2	66.7	64.6	68.4	92.9	49.1
Creek chubsucker	Catch	3	7	15	18	16	9
	%	6.7	5.1	8.9	11.5	11.7	5.5
	CPUE	16.7	15.6	31.3	47.4	57.1	17.0
Yellow bullhead	Catch	-	3	2	3	1	-
	%	-	2.2	1.2	1.9	0.7	-
	CPUE	-	6.7	4.2	7.9	3.6	-
Brown bullhead	Catch	1	4	2	5	2	-
	%	2.2	2.9	1.2	3.2	1.5	-
	CPUE	5.6	8.9	4.2	13.2	7.1	-
Redbreast sunfish	Catch	1	8	11	6	8	5
	%	2.2	5.8	6.5	3.8	5.8	3.0
	CPUE	5.6	17.8	22.9	15.8	28.6	9.4
Green sunfish	Catch	4	45	65	58	49	77
	%	8.9	32.8	38.7	36.9	35.8	47.0
	CPUE	22.2	100.0	135.4	152.6	175.0	145.3
Pumpkinseed	Catch	-	7	12	15	8	13
	%	-	5.1	7.1	9.6	5.8	7.9
	CPUE	-	15.6	25.0	39.5	28.6	24.5
Bluegill	Catch	11	22	14	10	8	20
	%	24.4	16.1	8.3	6.4	5.8	12.2
	CPUE	61.1	48.9	29.2	26.3	28.6	37.7
Lepomis hybrid	Catch	-	2	3	1	5	5
	%	-	1.5	1.8	0.6	3.6	3.0
	CPUE	-	4.4	6.3	2.6	17.9	9.4
Smallmouth bass	Catch	-	-	-	-	-	1
	%	-	-	-	-	-	0.6
	CPUE	-	-	-	-	-	1.9
Largemouth bass	Catch	2	4	3	3	1	1
	%	4.4	2.9	1.8	1.9	0.7	0.6
	CPUE	11.1	8.9	6.3	7.9	3.6	1.9

Table 4.4-4. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E30614 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 0.32 Hrs	May 0.52 Hrs	Jun 0.62 Hrs	Jul 0.70 Hrs
Redfin pickerel	Catch	-	-	-	1
	%	-	-	-	0.4
	CPUE	-	-	-	1.4
White sucker	Catch	21	15	10	7
	%	20.0	8.8	4.2	2.5
	CPUE	65.6	28.8	16.1	10.0
Creek chubsucker	Catch	3	2	2	2
	%	2.9	1.2	0.8	0.7
	CPUE	9.4	3.8	3.2	2.9
Yellow bullhead	Catch	16	15	24	25
	%	15.2	8.8	10.1	8.9
	CPUE	50.0	28.8	38.7	35.7
Brown bullhead	Catch	2	-	-	-
	%	1.9	-	-	-
	CPUE	6.3	-	-	-
Redbreast sunfish	Catch	14	69	132	165
	%	13.3	40.4	55.5	58.5
	CPUE	43.8	132.7	212.9	235.7
Green sunfish	Catch	32	42	33	39
	%	30.5	24.6	13.9	13.8
	CPUE	100.0	80.8	53.2	55.7
Pumpkinseed	Catch	5	7	6	10
	%	4.8	4.1	2.5	3.5
	CPUE	15.6	13.5	9.7	14.3
Bluegill	Catch	4	9	14	11
	%	3.8	5.3	5.9	3.9
	CPUE	12.5	17.3	22.6	15.7
Lepomis hybrid	Catch	2	1	3	4
	%	1.9	0.6	1.3	1.4
	CPUE	6.3	1.9	4.8	5.7
Smallmouth bass	Catch	4	9	13	16
	%	3.8	5.3	5.5	5.7
	CPUE	12.5	17.3	21.0	22.9
Largemouth bass	Catch	2	2	1	2
	%	1.9	1.2	0.4	0.7
	CPUE	6.3	3.8	1.6	2.9

Table 4.4-5. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E22240 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 1.25 Hrs	May 1.22 Hrs	Jun 1.37 Hrs	Jul 1.28 Hrs	Aug 1.47 Hrs	Oct 1.42 Hrs
American eel	Catch	-	2	-	-	-	-
	%	-	0.5	-	-	-	-
	CPUE	-	1.6	-	-	-	-
Redfin pickerel	Catch	-	-	1	2	1	1
	%	-	-	0.2	0.4	0.2	0.2
	CPUE	-	-	0.7	1.6	0.7	0.7
Carp	Catch	1	4	5	3	6	1
	%	0.3	1.0	1.1	0.6	1.4	0.2
	CPUE	0.8	3.3	3.6	2.3	4.1	0.7
White sucker	Catch	169	60	75	88	75	68
	%	43.4	14.9	16.9	17.8	16.9	16.3
	CPUE	135.2	49.2	54.7	68.8	51.0	47.9
Creek chubsucker	Catch	-	-	1	1	1	1
	%	-	-	0.2	0.2	0.2	0.2
	CPUE	-	-	0.7	0.8	0.7	0.7
Yellow bullhead	Catch	26	22	20	22	22	12
	%	6.7	5.4	4.5	4.4	5.0	2.9
	CPUE	20.8	18.0	14.6	17.2	15.0	8.5
Brown bullhead	Catch	2	3	-	1	-	-
	%	0.5	0.7	-	0.2	-	-
	CPUE	1.6	2.5	-	0.8	-	-
Redbreast sunfish	Catch	58	128	140	144	170	148
	%	14.9	31.7	31.5	29.1	38.3	35.5
	CPUE	46.4	104.9	102.2	112.5	115.6	104.2
Green sunfish	Catch	70	127	143	168	115	128
	%	18.0	31.4	32.1	33.9	25.9	30.7
	CPUE	56.0	104.1	104.4	131.3	78.2	90.1
Pumpkinseed	Catch	36	32	36	31	17	34
	%	9.3	7.9	8.1	6.3	3.8	8.2
	CPUE	28.8	26.2	26.3	24.2	11.6	23.9
Bluegill	Catch	15	11	3	9	11	3
	%	3.9	2.7	0.7	1.8	2.5	0.7
	CPUE	12.0	9.0	2.2	7.0	7.5	2.1
Lepomis hybrid	Catch	6	10	10	10	9	6
	%	1.5	2.5	2.2	2.0	2.0	1.4
	CPUE	4.8	8.2	7.3	7.8	6.1	4.2
Smallmouth bass	Catch	6	5	10	11	10	12
	%	1.5	1.2	2.2	2.2	2.3	2.9
	CPUE	4.8	4.1	7.3	8.6	6.8	8.5
Largemouth bass	Catch	-	-	1	5	7	3
	%	-	-	0.2	1.0	1.6	0.7
	CPUE	-	-	0.7	3.9	4.8	2.1

Table 4.4-6. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E12111 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 0.35 Hrs	May 1.05 Hrs	Jun 1.08 Hrs	Jul 0.87 Hrs	Aug 1.78 Hrs	Oct 0.98 Hrs
American eel	Catch	-	-	-	-	1	-
	%	-	-	-	-	0.1	-
	CPUE	-	-	-	-	0.6	-
Goldfish	Catch	-	2	1	5	45	2
	%	-	0.6	0.6	1.3	6.3	1.4
	CPUE	-	1.9	0.9	5.7	25.3	2.0
Carp	Catch	-	2	-	-	1	-
	%	-	0.6	-	-	0.1	-
	CPUE	-	1.9	-	-	0.6	-
White sucker	Catch	14	2	-	2	97	9
	%	33.3	0.6	-	0.5	13.6	6.1
	CPUE	40.0	1.9	-	2.3	54.5	9.2
Creek chubsucker	Catch	-	1	-	-	96	3
	%	-	0.3	-	-	13.4	2.0
	CPUE	-	1.0	-	-	53.9	3.1
Yellow bullhead	Catch	3	9	2	6	78	4
	%	7.1	2.9	1.1	1.6	10.9	2.7
	CPUE	8.6	8.6	1.9	6.9	43.8	4.1
Brown bullhead	Catch	-	-	-	1	-	-
	%	-	-	-	0.3	-	-
	CPUE	-	-	-	1.1	-	-
Margined madtom	Catch	1	1	-	2	6	-
	%	2.4	0.3	-	0.5	0.8	-
	CPUE	2.9	1.0	-	2.3	3.4	-
Rock bass	Catch	-	35	15	21	66	15
	%	-	11.1	8.3	5.4	9.2	10.1
	CPUE	-	33.3	13.9	24.1	37.1	15.3
Redbreast sunfish	Catch	15	214	134	319	257	57
	%	35.7	68.2	74.0	82.4	36.0	38.5
	CPUE	42.9	203.8	124.1	366.7	144.4	58.2
Green sunfish	Catch	7	33	25	16	31	19
	%	16.7	10.5	13.8	4.1	4.3	12.8
	CPUE	20.0	31.4	23.1	18.4	17.4	19.4
Pumpkinseed	Catch	-	-	2	2	2	4
	%	-	-	1.1	0.5	0.3	2.7
	CPUE	-	-	1.9	2.3	1.1	4.1
Lepomis hybrid	Catch	1	-	-	-	2	2
	%	2.4	-	-	-	0.3	1.4
	CPUE	2.9	-	-	-	1.1	2.0
Smallmouth bass	Catch	1	15	2	13	30	33
	%	2.4	4.8	1.1	3.4	4.2	22.3
	CPUE	2.9	14.3	1.9	14.9	16.9	33.7
Largemouth bass	Catch	-	-	-	-	2	-
	%	-	-	-	-	0.3	-
	CPUE	-	-	-	-	1.1	-

Table 4.4-7. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E 5650 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 1.07 Hrs	May 1.10 Hrs	Jun 1.27 Hrs	Jul 1.30 Hrs	Aug 1.62 Hrs	Oct 2.02 Hrs
Goldfish	Catch	4	1	2	-	6	3
	%	2.6	0.4	0.6	-	2.7	1.0
	CPUE	3.7	0.9	1.6	-	3.7	1.5
Carp	Catch	6	7	6	1	14	1
	%	3.9	2.8	1.9	1.0	6.4	0.3
	CPUE	5.6	6.4	4.7	0.8	8.6	0.5
Golden shiner	Catch	-	2	-	-	2	7
	%	-	0.8	-	-	0.9	2.2
	CPUE	-	1.8	-	-	1.2	3.5
White sucker	Catch	1	35	132	70	69	12
	%	0.6	13.8	42.4	70.0	31.4	3.8
	CPUE	0.9	31.8	103.9	53.8	42.6	5.9
Creek chubsucker	Catch	-	-	-	-	5	1
	%	-	-	-	-	2.3	0.3
	CPUE	-	-	-	-	3.1	0.5
Yellow bullhead	Catch	14	6	12	1	5	10
	%	9.0	2.4	3.9	1.0	2.3	3.2
	CPUE	13.1	5.5	9.4	0.8	3.1	5.0
Brown bullhead	Catch	3	3	7	5	2	4
	%	1.9	1.2	2.3	5.0	0.9	1.3
	CPUE	2.8	2.7	5.5	3.8	1.2	2.0
Rock bass	Catch	3	5	-	1	18	10
	%	1.9	2.0	-	1.0	8.2	3.2
	CPUE	2.8	4.5	-	0.8	11.1	5.0
Redbreast sunfish	Catch	38	66	39	7	23	146
	%	24.5	26.1	12.5	7.0	10.5	46.8
	CPUE	35.5	60.0	30.7	5.4	14.2	72.3
Green sunfish	Catch	46	89	98	11	54	80
	%	29.7	35.2	31.5	11.0	24.5	25.6
	CPUE	43.0	80.9	77.2	8.5	33.3	39.6
Pumpkinseed	Catch	20	25	10	2	9	14
	%	12.9	9.9	3.2	2.0	4.1	4.5
	CPUE	18.7	22.7	7.9	1.5	5.6	6.9
Bluegill	Catch	7	3	3	1	3	1
	%	4.5	1.2	1.0	1.0	1.4	0.3
	CPUE	6.5	2.7	2.4	0.8	1.9	0.5
Lepomis hybrid	Catch	11	9	2	-	5	8
	%	7.1	3.6	0.6	-	2.3	2.6
	CPUE	10.3	8.2	1.6	-	3.1	4.0
Smallmouth bass	Catch	2	2	-	1	4	15
	%	1.3	0.8	-	1.0	1.8	4.8
	CPUE	1.9	1.8	-	0.8	2.5	7.4
Largemouth bass	Catch	-	-	-	-	1	-
	%	-	-	-	-	0.5	-
	CPUE	-	-	-	-	0.6	-

Table 4.4-8. Monthly relative abundance of target fishes from the East Branch Perkiomen Creek electrofished at E 1637 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 0.83 Hrs	May 1.47 Hrs	Jun 1.17 Hrs	Jul 1.83 Hrs	Aug 1.58 Hrs	Oct 1.37 Hrs
American eel	Catch	2	2	2	-	4	-
	%	1.7	0.9	0.7	-	0.8	-
	CPUE	2.4	1.4	1.7	-	2.5	-
Goldfish	Catch	1	-	-	-	1	1
	%	0.8	-	-	-	0.2	0.2
	CPUE	1.2	-	-	-	0.6	0.7
Carp	Catch	3	3	-	10	4	10
	%	2.5	1.4	-	2.5	0.8	2.1
	CPUE	3.6	2.0	-	5.5	2.5	7.3
Fallfish	Catch	1	1	2	4	-	-
	%	0.8	0.5	0.7	1.0	-	-
	CPUE	1.2	0.7	1.7	2.2	-	-
White sucker	Catch	13	-	1	7	11	18
	%	10.9	-	0.3	1.8	2.1	3.8
	CPUE	15.7	-	0.9	3.8	7.0	13.1
Creek chubsucker	Catch	-	-	-	1	-	1
	%	-	-	-	0.3	-	0.2
	CPUE	-	-	-	0.5	-	0.7
Yellow bullhead	Catch	16	15	13	14	37	21
	%	13.4	6.8	4.2	3.5	7.2	4.5
	CPUE	19.3	10.2	11.1	7.7	23.4	15.3
Brown bullhead	Catch	3	2	1	-	-	-
	%	2.5	0.9	0.3	-	-	-
	CPUE	3.6	1.4	0.9	-	-	-
Rock bass	Catch	6	31	40	53	130	61
	%	5.0	14.2	13.0	13.4	25.1	13.0
	CPUE	7.2	21.1	34.2	29.0	82.3	44.5
Redbreast sunfish	Catch	22	118	195	211	206	184
	%	18.5	53.9	63.5	53.1	39.8	39.3
	CPUE	26.5	80.3	166.7	115.3	130.4	134.3
Green sunfish	Catch	21	20	13	19	30	18
	%	17.6	9.1	4.2	4.8	5.8	3.8
	CPUE	25.3	13.6	11.1	10.4	19.0	13.1
Pumpkinseed	Catch	8	1	-	-	-	6
	%	6.7	0.5	-	-	-	1.3
	CPUE	9.6	0.7	-	-	-	4.4
Bluegill	Catch	-	1	2	1	2	6
	%	-	0.5	0.7	0.3	0.4	1.3
	CPUE	-	0.7	1.7	0.5	1.3	4.4
Lepomis hybrid	Catch	6	1	3	2	-	4
	%	5.0	0.5	1.0	0.5	-	0.9
	CPUE	7.2	0.7	2.6	1.1	-	2.9
Smallmouth bass	Catch	17	24	35	75	92	137
	%	14.3	11.0	11.4	18.9	17.8	29.3
	CPUE	20.5	16.3	29.9	41.0	58.2	100.0
Largemouth bass	Catch	-	-	-	-	-	1
	%	-	-	-	-	-	0.2
	CPUE	-	-	-	-	-	0.7

4.5 Age and Growth of Selected Fishes

Summary

1. Age and growth characteristics and year-class strength of four species of fish from the East Branch Perkiomen Creek were evaluated using data collected in 1985. These species were redbreast sunfish, green sunfish, white sucker, and smallmouth bass.

2. Growth characteristics of all species of fish remained similar to findings in previous years. Redbreast sunfish, and to a lesser degree white sucker, exhibited an upstream to downstream increase in length at annulus. Length at annulus for green sunfish was similar for all sites.

3. No significant variation in annual growth rates was evident for any species studied.

4. Year-class analysis reiterated most previous findings. The 1985 year-class of smallmouth bass was very strong, and individuals of this age-group grew rapidly.

Introduction and Methods

The age and growth program is part of a study designed to detect diversion-induced changes in the growth and year-class

strength of representative and important species of fish. Fish were aged by reading scale samples taken from specimens collected by electrofishing in the fall of the year, after most annual growth had been completed. Redbreast sunfish, green sunfish, and white sucker have been studied since 1973; smallmouth bass have been studied since 1983.

Five sample stations were E36020, E30540, E22240, E12040, and E1550. These stations were essentially the same as those for the EBPC electrofishing program, but to ensure sufficient numbers of fish for age and growth analysis, fish from above and below the designated site were sometimes collected. Goals were set for sample size for each species at each station. It was known in advance, however, that these goals would probably not be met at some stations for some species.

Results and Discussion

Age Determination and Growth History

Redbreast sunfish collected in 1985 were assigned to age-groups I-IV on the basis of scale reading. Mean lengths at annulus were back-calulated for 309 fish (Table 4.5-1). The previously established upstream to downstream increase in growth rate was once again evident. With the exception of length at annulus II for fish at upstream sites E36020 and E30540, back-

calulated length at annulus was greater for a given annulus at each station when viewed from upstream to downstream.

Validation of the methodology for aging and back-calculation was accomplished by comparison of observed mean lengths at capture with the back-calculated mean lengths (Table 4.5-2). Good agreement was observed.

Green sunfish collected in 1985 were assigned to age-groups I-IV on the basis of scale reading. Mean lengths at annulus were back-calculated for 346 fish (Table 4.5-3). Lengths at annulus for all sites were quite similar, except when sample size for an annulus was very small. Greatest growth occurred in the second year of life.

White sucker collected in 1985 were also assigned to age-groups I-IV on the basis of scale reading. Mean lengths at annulus were calculated for 225 fish (Table 4.5-4). Back-calculated lengths at annulus exhibited a strong upstream to downstream increase in growth. Comparison of back-calculated mean lengths at annulus with observed mean length at capture (Table 4.5-5) supports the validity of age determination by scale reading, even though growth of individual white suckers tends to be quite variable compared to other species being studied.

Seventy-seven smallmouth bass collected in 1985 were assigned to age groups I-V. Back-calculated mean lengths at annulus are

presented in Table 4.5-6. Back-calculated lengths were validated by comparison with observed lengths at capture (Table 4.5-7). Excellent agreement was observed except for Age 0 fish which were larger at capture (121 mm) than back-calculated length at Annulus I (91 mm). This discrepancy may be due simply to the likelihood that YOY smallmouth bass grew faster in 1985 than in previous years, or to greater gear efficiency for larger YOY smallmouth bass.

Greatest growth of smallmouth bass occurred in the first year of life. Differences in growth between stations were not clear due to small sample sizes at some sites. Greatest growth appeared to occur at station E22240, with growth at station E30540 being nearly as great. Sample size, however, was very small (5 fish) at station E22240.

Year-Class Strength

Year-class analysis of fish collected in 1985 confirmed some previous conclusions about relative year-class strengths, but also produced some unexpected results. Some of the inconsistencies noted may have been related to the low flow conditions that existed throughout 1985. These low flows tended to dewater areas that in the past held fish and also to cause some areas to be so shallow that only smaller individuals of a species would occupy them. Redistribution of this type could change the age com-

position of a group of samples without any major changes in the actual age composition in the stream.

Redbreast sunfish displayed an age composition approximating a normal catch curve that reflects a healthy population (Table 4.5-8). Nine individuals (Age 5) of the abundant 1980 year-class were collected. This is an unusually large number of such old fish. The abundant 1983 year-class (Age II) remained very strong, comprising 35.9% (111 of 309) of fish collected. Age I redbreast comprised 29.1% (90 of 309) of the catch, demonstrating adequate but not good reproduction. This result is in contrast to the great scarcity of Age I redbreast sunfish that occurred in the Schuylkill River. Possibly the adverse affects of high flows during the spawning season were less intense on the EBPC. Station E30540 continued to support a large number of older and larger redbreast sunfish (21 individuals of Age IV or older).

A length-frequency histogram for redbreast collected in October (Figure 4.5-1) suggests that most year-classes are adequately represented. However, peaks representing year-classes in stream-wide length-frequency histograms can be obscured by overlap caused by differential growth at various stations, which is a characteristic of East Branch redbreast sunfish.

Green sunfish displayed an age composition that confirmed adequate reproduction in each of the three years, 1982-1984

(Table 4.5-9). In fact, the 1984 year-class (Age I) comprised 63.6% (220 of 346) of fish collected, indicating much greater than average reproduction. The development of this large year-class is further evidence that the adverse environmental factors that negatively impacted strength of the 1984 year-class of Schuylkill River redbreast did not exert a similar effect on the EBPC sunfish populations.

The overall age composition demonstrates the high natural mortality to which EBPC green sunfish are subjected. Age III green sunfish had declined to 7.8% (27 of 346) of collected fish. Only 9 of 346 (2.6%) green sunfish were Age IV or older.

Observed mean length at capture of Age I, II, and III green sunfish aged by reading of scales (Table 4.5-10) corresponded roughly to local maxima in the October length-frequency histogram (Figure 4.5-2). The histogram reiterated the apparent intense mortality.

Age composition of white sucker collected from EBPC in 1985 (Table 4.5-11) showed that most year-classes of white sucker were well-represented, with the 1983 year class (Age II) being the exception. This age-group had appeared as the relatively weak Age I year-class in the 1984 collection, and appears weaker still as the Age II year-class in 1985. The stream-wide length-frequency histogram for white sucker collected during the October

1985 electrofishing sample showed the abundance of Age 0 (1985 year-class) fish (Figure 4.5-3).

Comparison with Earlier Findings

Length at annulus of redbreast sunfish continued to be similar when compared with results from earlier years; greatest growth again occurred in the second year of life. The upstream to downstream increase in growth first reported in the EROL and demonstrated in each collection thereafter, was once again seen in the 1985 collection.

Redbreast sunfish continued to display a healthy age distribution with the 1983 year-class (Age II), previously identified as very abundant, continuing to be strong. The 1984 year-class had been labeled relatively weak in the 1984 Progress Report as a result of seine and electrofishing collections. This finding was confirmed by the age composition of the 1985 age and growth collection; however, the 90 Age I redbreast collected in 1985 did represent 29.1% of the sample, which indicates an adequate, but low, level of reproduction in 1984. The EBPC redbreast sunfish population continued to be a relatively long-lived one, with 42 of 309 (13.6%) fish Age IV or older.

Green sunfish, however, showed no consistent upstream to downstream growth rate differences; this was in agreement with

previous findings. Greatest growth continued to occur in the second year of life. Only eighteen green sunfish could be collected from site E1550. Low flows had eliminated much of the preferred back-water habitat of this species.

The 1984 year-class (Age I) of green sunfish was surprisingly strong. Green sunfish did not seem to be adversely affected by high flows and low temperatures during 1984 as had redbreast sunfish in both the EBPC and Schuylkill River. The previously established high natural mortality rate of green sunfish was reiterated by the 1985 collection.

The upstream versus downstream difference in growth of white sucker (faster growth downstream), first reported in the EROL and then appearing in subsequent data, continued to be manifested in the 1985 data. Lengths at annulus were quite similar to those calculated for data collected in 1981, 1983, and 1984. Age composition of the 1985 age and growth sample suggests that the 1983 year-class is extremely weak, a characteristic of the population not detected in the 1984 sample. However, conclusions about year-class strength are somewhat speculative due to sample biases inherent with this species, which were discussed in detail in the 1979-1983 Progress Report. Once again, the average age of white suckers tended to increase as sampling proceded downstream.

Back-calculated mean lengths at annulus of smallmouth bass were similar to back-calculated lengths for data collected in 1983 and 1984. Observed length at capture as well as the length-frequency histogram (Figure 4.5-4) indicated that YOY smallmouth bass grew exceptionally well in 1985. YOY smallmouth bass were also abundant.

Table 4.5-1. Back-calculated mean lengths (mm) at annulus for Redbreast sunfish collected from the East Branch Perkiomen Creek, 1985.

Station	Annulus	No.	Mean Length	Standard Deviation
E36020	I	17	30.8	4.1
	II	16	65.3	5.2
	III	2	86.1	13.0
	IV	2	106.3	2.0
E30540	I	78	32.0	7.0
	II	56	65.2	10.2
	III	38	94.7	9.2
	IV	21	115.9	8.9
E22240	I	84	33.4	6.0
	II	63	74.9	10.1
	III	20	104.8	11.7
	IV	4	121.3	10.5
E12040	I	58	34.8	9.7
	II	29	93.0	11.6
	III	15	133.3	10.0
	IV	4	151.6	6.1
E 1550	I	72	40.3	9.9
	II	55	96.7	16.4
	III	33	134.1	13.8
	IV	11	154.2	11.7
Combined	I	309	34.8	8.6
	II	219	79.6	17.7
	III	108	113.8	21.6
	IV	42	129.4	20.6

Table 4.5-2. Comparison of back-calculated mean lengths (mm) at annulus with observed mean lengths (mm) at capture of Redbreast sunfish collected from the East Branch Perkiomen Creek, October 1985.

Annulus	No.	Back-calculated mean length	Observed mean length at capture	No.	Age
I	309	35	56	26	0
II	219	80	79	90	I
III	108	114	114	111	II
IV	42	129	137	66	III
			144	32	IV

Table 4.5-3. Back-calculated mean lengths (mm) at annulus for Green sunfish collected from the East Branch Perkiomen Creek, 1985.

Station	Annulus	No.	Mean Length	Standard Deviation
E36020	I	87	37.0	7.9
	II	11	72.9	17.0
	III	4	102.3	14.6
	IV	3	126.1	13.1
E30540	I	69	38.2	7.9
	II	40	77.2	10.9
	III	11	117.0	10.5
	IV	1	134.6	-
E22240	I	97	32.9	6.4
	II	51	66.2	9.5
	III	18	100.7	12.0
	IV	4	115.9	14.7
E12040	I	78	35.8	8.1
	II	21	82.9	12.5
	III	3	108.0	17.5
	IV	1	131.4	-
E 1550	I	15	38.0	11.7
	II	3	93.8	26.4
	III	-	-	-
	IV	-	-	-
Combined	I	346	35.9	8.0
	II	126	73.7	13.5
	III	36	106.4	13.9
	IV	9	123.1	13.3

Table 4.5-4. Back-calculated mean lengths (mm) at annulus for White sucker collected from the East Branch Perkiomen Creek, 1985.

Station	Annulus	No.	Mean Length	Standard Deviation
E36020	I	65	74.3	7.9
	II	21	132.9	23.2
	III	7	186.3	22.6
	IV	1	228.3	-
E30540	I	68	82.3	10.3
	II	25	150.4	24.3
	III	17	218.7	29.7
	IV	3	252.4	27.7
E22240	I	42	91.6	13.9
	II	35	157.5	18.1
	III	32	221.8	20.5
	IV	14	254.4	16.8
E12040	I	37	93.3	15.2
	II	37	177.9	23.0
	III	37	253.4	27.5
	IV	18	287.0	25.5
E 1550	I	13	90.4	20.0
	II	5	216.6	14.1
	III	4	307.4	28.5
	IV	1	367.1	-
Combined	I	225	84.0	14.1
	II	123	160.4	28.9
	III	97	234.3	35.4
	IV	37	272.4	32.0

Table 4.5-5. Comparison of back-calculated mean lengths (mm) at annulus with observed mean lengths (mm) at capture of White sucker collected from the East Branch Perkiomen Creek, October 1985.

Annulus	No.	Back-calculated mean length	Observed mean length at capture	No.	Age
I	225	84	124	55	0
II	123	160	151	102	I
III	97	234	212	26	II
IV	37	272	289	60	III
			308	29	IV

Table 4.5-6. Back-calculated mean lengths (mm) at annulus for Smallmouth bass collected from the East Branch Perkiomen Creek, 1985.

Station	Annulus	No.	Mean Length	Standard Deviation
E36020	I	1	82.8	-
	II	-	-	-
	III	-	-	-
	IV	-	-	-
E30540	I	13	92.1	12.5
	II	11	172.9	17.8
	III	5	215.3	8.3
	IV	2	237.7	10.2
E22240	I	5	97.4	12.9
	II	4	175.7	26.6
	III	1	224.0	-
	IV	1	257.8	-
E12040	I	20	90.0	10.6
	II	13	156.8	15.0
	III	1	209.4	-
	IV	-	-	-
E 1550	I	38	90.2	9.9
	II	31	151.1	12.0
	III	13	194.0	15.0
	IV	4	241.8	18.4
Combined	I	77	90.8	10.6
	II	59	158.1	17.4
	III	20	201.6	16.6
	IV	7	242.9	15.3

Table 4.5-7. Comparison of back-calculated mean lengths (mm) at annulus with observed mean lengths (mm) at capture of Smallmouth bass collect from the East Branch Perkiomen Creek, October 1985.

		Back-calculated	Observed mean		
Annulus	No.	mean length	length at capture	No.	Age
I	77	91	121	28	0
II	59	158	161	18	I
III	20	202	212	39	II
IV	7	243	238	13	III
			278	6	IV

Table 4.5-8. Age composition of Redbreast sunfish collected from the East Branch Perkiomen Creek during 1985.

Year	Location	Number of Specimens I	II	III	IV	V	VI	TOTAL
1985	E36020	1	14	-	2	-	-	17
	E30540	22	18	17	16	4	1	78
	E22240	21	43	16	3	1	-	84
	E12040	29	14	11	3	1	-	58
	E 1550	17	22	22	8	3	-	72
	Combined	90	111	66	32	9	1	309

Table 4.5-9. Age composition of Green sunfish collected from the East Branch Perkiomen Creek during 1985.

Year	Location	Number of Specimens I	II	III	IV	V	VI	TOTAL
1985	E36020	76	7	1	3	-	-	87
	E30540	29	29	10	1	-	-	69
	E22240	46	33	14	3	1	-	97
	E12040	57	18	2	1	-	-	78
	E 1550	12	3	-	-	-	-	15
	Combined	220	90	27	8	1	-	346

Table 4.5-10. Comparison of back-calculated mean lengths (mm) at annulus with observed mean lengths (mm) at capture of Green sunfish collected from the East Branch Perkiomen Creek, October 1985.

Annulus	No.	Back-calculated mean length	Observed mean length at capture	No.	Age
I	346	36	54	24	0
II	126	74	76	220	I
III	36	106	113	90	II
IV	9	123	133	27	III
			137	8	IV

Table 4.5-11. Age composition of White sucker collected from the East Branch Perkiomen Creek during 1985.

Year	Location	Number of Specimens I	II	III	IV	V	VI	TOTAL
1985	E36020	44	14	6	1	-	-	65
	E30540	43	8	14	3	-	-	68
	E22240	7	3	18	11	3	-	42
	E12040	-	-	19	14	4	-	37
	E 1550	8	1	3	-	1	-	13
	Combined	102	26	60	29	8	-	225

FIGURE 4.5-1. LENGTH FREQUENCY DISTRIBUTION OF REDBREAST SUNFISH COLLECTED FROM THE EAST BRANCH PERKIOMEN CREEK, OCTOBER 1985.

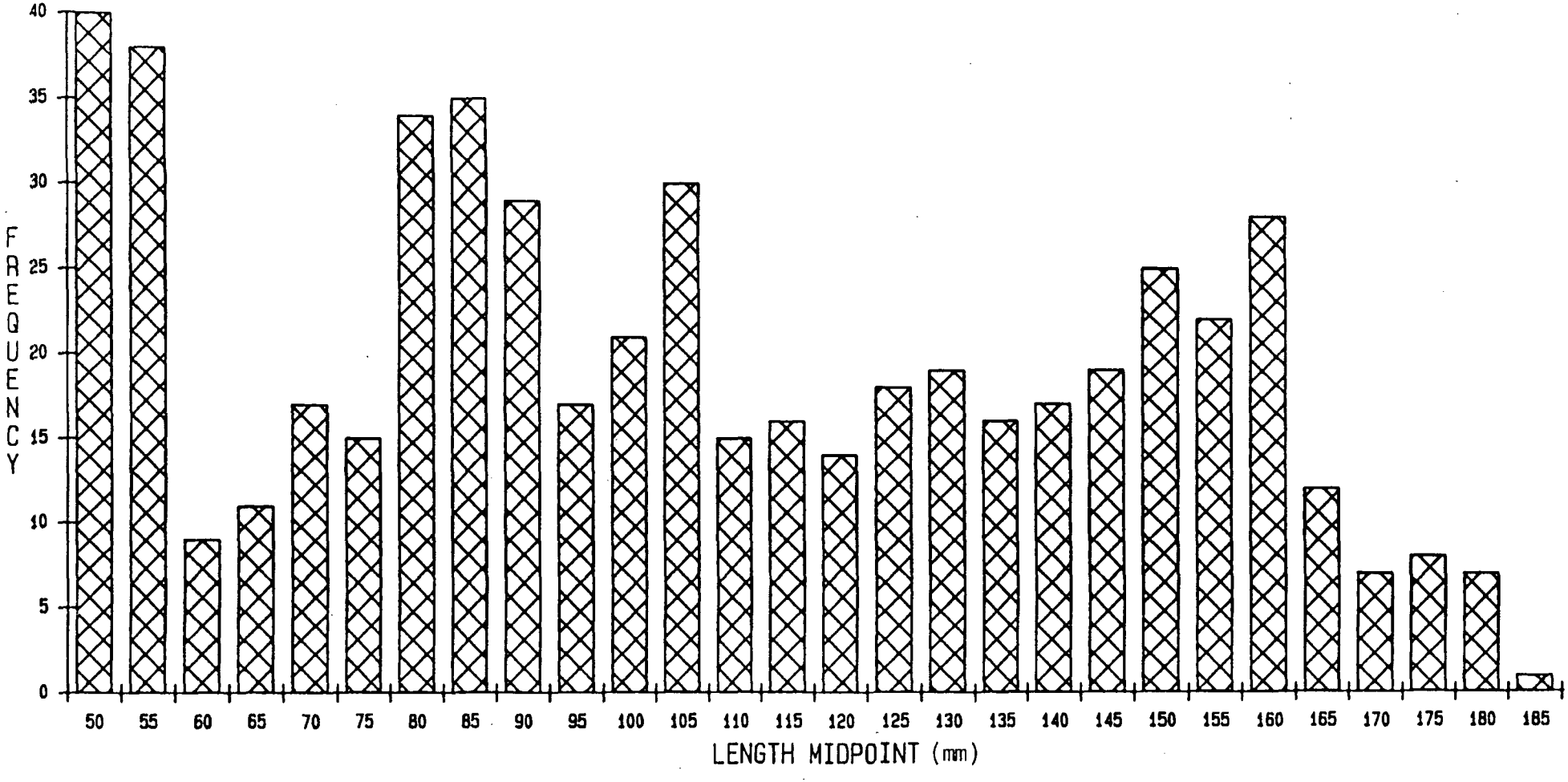


FIGURE 4.5-2. LENGTH FREQUENCY DISTRIBUTION OF GREEN SUNFISH COLLECTED FROM THE EAST BRANCH PERKIOMEN CREEK, OCTOBER 1985.

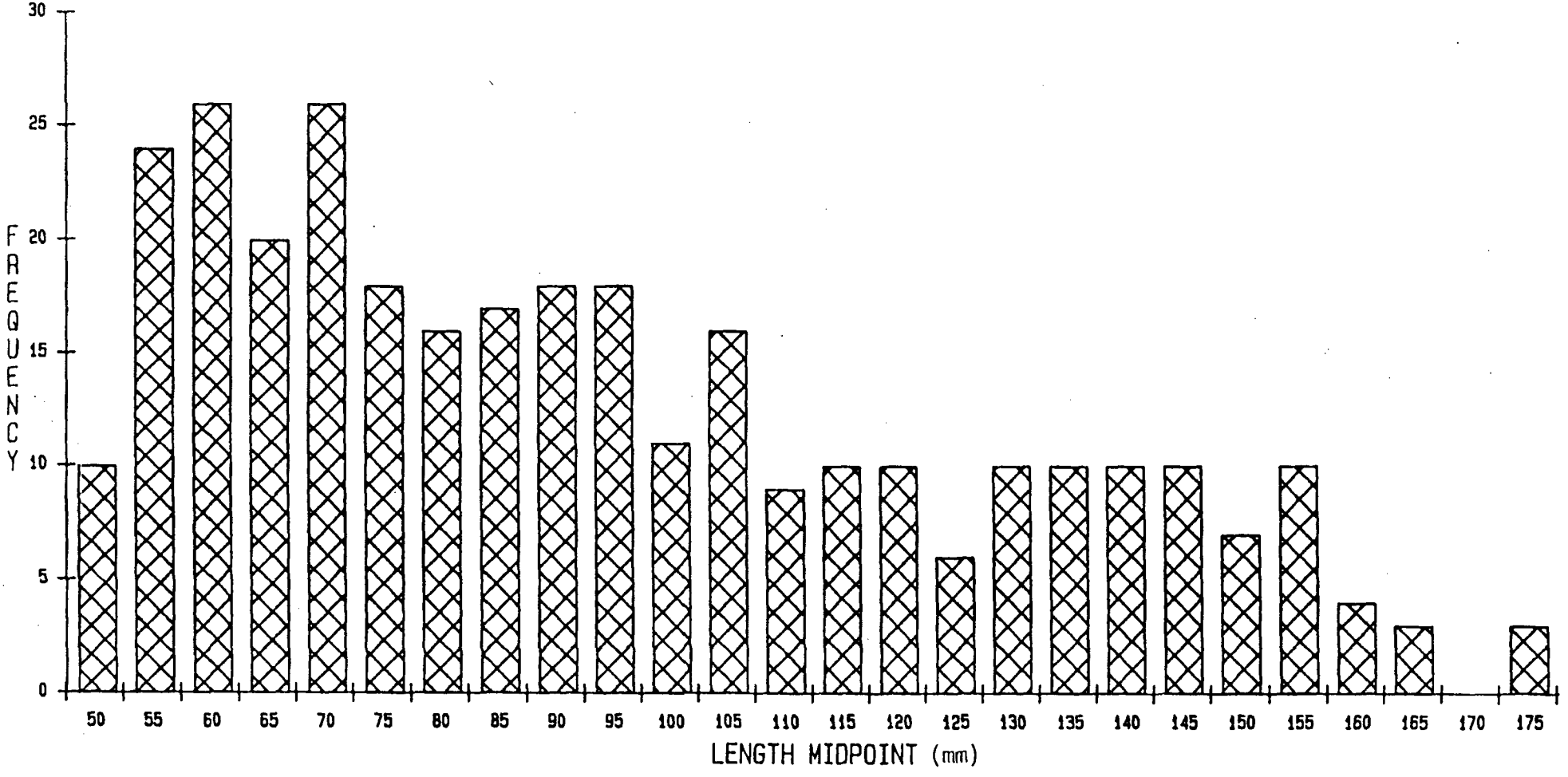


FIGURE 4.5-3. LENGTH FREQUENCY DISTRIBUTION OF WHITE SUCKER COLLECTED FROM THE EAST BRANCH PERKIOMEN CREEK, OCTOBER 1985.

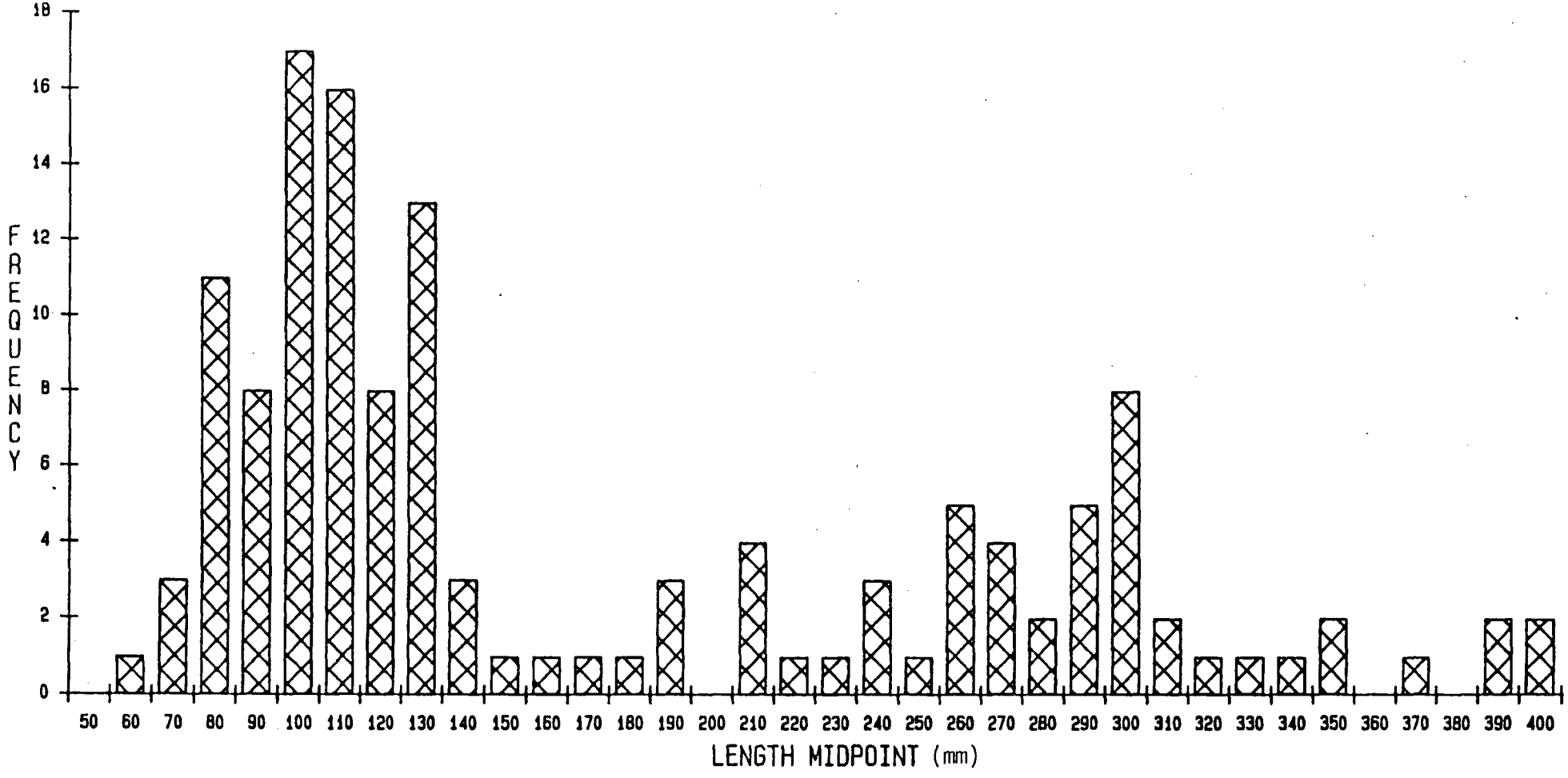
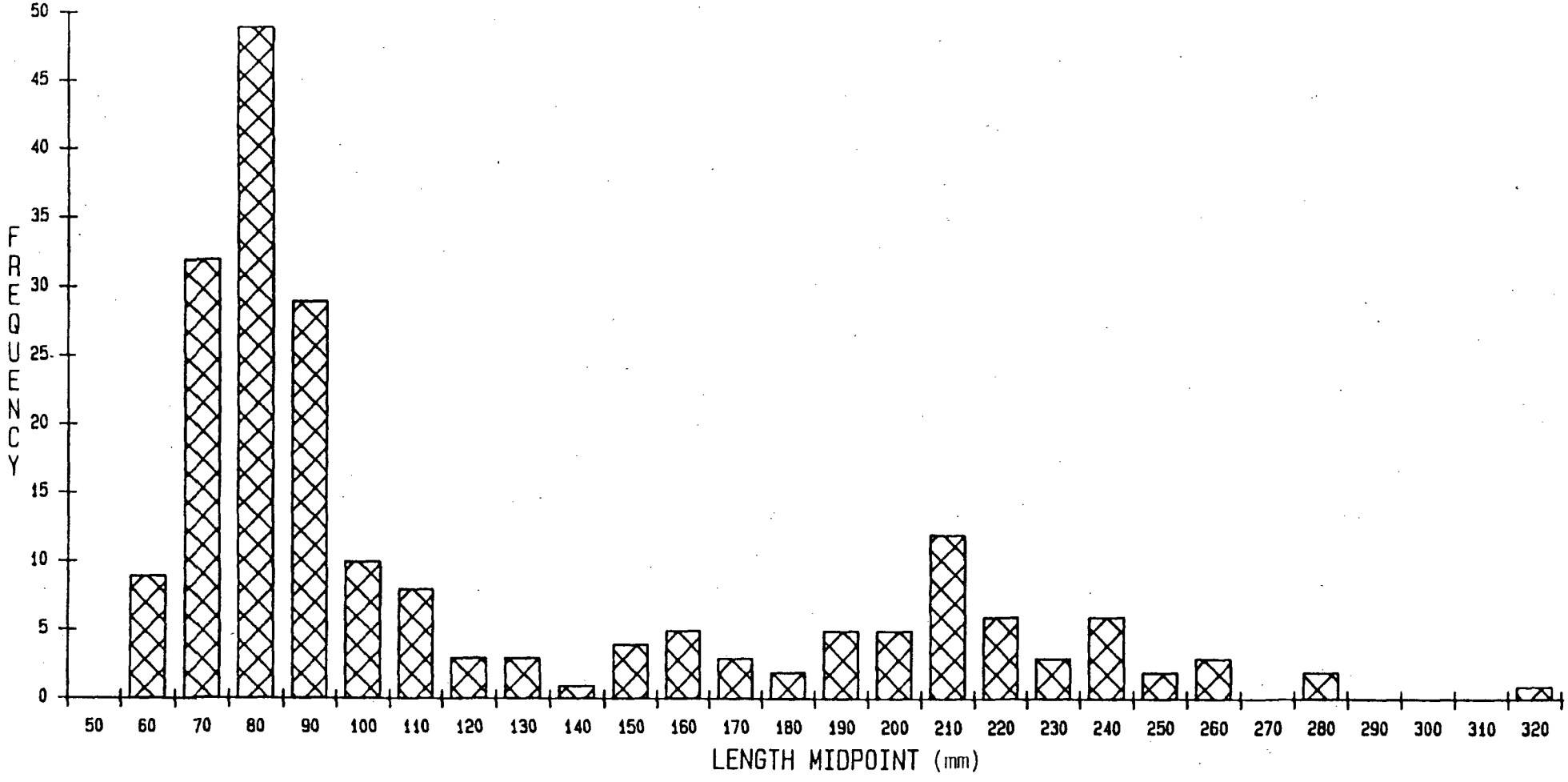


FIGURE 4.5-4. LENGTH FREQUENCY DISTRIBUTION OF SMALLMOUTH BASS COLLECTED FROM THE EAST BRANCH PERKIOMEN CREEK, OCTOBER 1985.



4.6 Creel Survey

Summary

1. A creel survey was conducted at EBPC access points from April through September in 1985.

2. Total fishing pressure estimated at bimonthly intervals summed to 8,940 angler-hours for the season. Fishing pressure peaked in June and July and declined sharply thereafter. Fishing was concentrated in public parks, especially at WaWa Dam and in the town of Sellersville.

3. Anglers caught fish at an overall rate of 1.73 fish/angler-hour. An estimated 15,866 fish, 80% of which were Lepomis sunfish, were caught along with an estimated 871 smallmouth bass. In all, 12 species or hybrids were taken by recreational anglers.

4. Nearly 90% of the estimated 3,653 fish harvested were Lepomis sunfish. A relatively high percentage (23%) of the total catch was harvested compared to past EBPC creel surveys, but over one-half of the estimated harvest occurred in late season when a small group of anglers harvested a disproportionaltely large percentage of their catch. Annual harvest by weight amounted to an estimated

292 kg, or about 6 kg per surface ha or 8 kg per km of stream.

5. Proportions of anglers fishing EBPC in 1985 classified by age, sex, and mode of access were similar to past determinations. "Bass" was the most popular kind of fish among anglers having a preference, although a majority fished for anything.

Introduction and Methods

A survey of recreational fishing at EBPC access points began in 1980 and was also conducted in 1981, 1983, and 1985. The level of survey effort in 1985 was reduced to one-half the level used in previous surveys. The original sampling design (RMC 1984) was modified to estimate fishing pressure for bimonthly instead of monthly intervals. Other field and computational procedures did not change.

Fishery characteristics that were investigated included 1) bimonthly fishing pressure at public access points along the entire length of the stream, 2) bimonthly catch and harvest by species, and 3) information about preferred fish species, access, and the age and sex composition of anglers. Creel survey data can augment studies of fish population dynamics and are useful in fisheries management. Baseline preoperational creel survey data

would be of potential use in evaluating postoperational changes in the large fish community following diversion of Delaware River water into EBPC.

Results and Discussion

Fishing Pressure

Total fishing pressure estimated at bimonthly intervals (Table 4.6-1) summed to 8,940 angler-hour for the season. This total was below the average seasonal fishing pressure of 10,128 angler-hour measured in 1980, 1981, and 1983 (RMC 1984). Fishing pressure peaked in June and July and then declined sharply during August and September. Late summer and early autumn declines in fishing pressure on EBPC were observed in previous survey years. Most fishing in 1985 took place at previously identified popular locations including WaWa Dam and Park and the town of Sellersville (Table 4.6-2). Three closely spaced access points between Moyer Road and Old Sumneytown Pike were also used frequently. Two angling parties, one containing eight anglers and another with three anglers, were sighted in the reach above Sellersville, however, none was in the immediate vicinity of the proposed outfall for the Point Pleasant Water Diversion Project.

Catch and Harvest

Averaged over the season, anglers caught fish at a rate of 1.73 fish per angler-hour (Table 4.6-1). An estimated 15,866 fish were caught between April and September (Table 4.6-3). One-half of the seasonal total was caught in the June-July sampling period when fishing pressure peaked. Although catch-per-unit-effort (CPUE) was greatest in the August-September period, CPUE was based on only a few anglers, and total catch for this period was greatly reduced due to the lack of fishing pressure. Unidentified (released) sunfish comprised 60% of the estimated catch, and one-half of the remainder was comprised of Lepomis sunfish, including (in order of decreasing abundance) - bluegill, pumpkinseed, redbreast sunfish, hybrid sunfish, and green sunfish (Table 4.6-3). Anglers caught an estimated 871 smallmouth bass. Peak catches of this recreationally important species occurred in June and July. In all, 12 species or hybrids appeared in the catch.

Compared to past creel surveys on EBPC, a relatively high proportion (23%) of the total catch was harvested (Table 4.6-3). Nearly 90% of the 3,653 fish harvested were Lepomis sunfish, principally bluegill and pumpkinseed. Over one-half of the estimated harvest occurred during August and September when a small group of anglers harvested a disproportionately large percentage of their catch. If the harvest rate by these individuals was not

representative of other anglers during this period, then the true harvest during August and September may have been considerably lower. The estimated harvest for April through July was only 11% of the total catch, which was more similar to previous creel survey information. The weight of seasonal harvest (Table 4.6-4) could not be estimated with precision because of the low number of fish actually observed in anglers' creels, but appeared to be comparable to previous estimates (RMC 1984). In all, an estimated 292 kg of fish were harvested in 1985, which amounts to about 6 kg per surface ha or 8 kg per km of stream.

Characteristics of Anglers

Proportions of anglers fishing EBPC in 1985 classified by age, sex, and mode of access (Table 4.6-5) were not much different from previous determinations (RMC-Environmental Services 1984). Fifteen percent of EBPC anglers were female, which was slightly higher than the percentage of female anglers on the Perkiomen Creek or Schuylkill River creel survey areas, but was lower than a recently determined national average of 30% (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census 1982).

"Bass" was the most popular kind of fish among anglers having a preference, although a majority fished for whatever they could

catch (Table 4.6-6). Most of the remaining effort was directed towards sunfish, carp, and catfish.

Table 4.6-1. Bimonthly estimates of fishing pressure with standard error and coefficient of variation (from angler counts), and catch-per-unit-effort (CPUE) based on observed effort, total catch (includes released fish), harvest (includes only fish kept) from angler interviews on East Branch Perkiomen Creek in 1985.

Fishing pressure

Bimonthly period	Number of survey trips	Fishing pressure (angler-hours)	Standard error	Coefficient of variation (%)
Apr-May	8	3159	782	25
Jun-Jul	8	4931	1504	30
Aug-Sep	8	850	428	50
Total	24	8940		Mean: 35

CPUE

Bimonthly period	Number of anglers interviewed	Observed effort (angler-hours)	Total catch	Total CPUE	Total harvest	Harvest CPUE
Apr-May	54	75.3	127	1.69	16	0.21
Jun-Jul	50	61.5	99	1.61	11	0.18
Aug-Sep	8	8.5	26	3.06	21	2.47
Total	112	145.3	252	1.73	48	0.33

Table 4.6-2. Number of anglers interviewed at East Branch Perkiomen Creek access points during 1985.

Access Point	Meter Number	1985
Garges Rd.	2100	4
Camp Wawa Rd. + Park	5550	16
Old Sumneytown Pike	11700	7
Pa. Route 63	11800	7
Moyer Rd.	12500	9
Morwood Rd. + Park	15900	3
Cowpath Rd.	20950	4
Cathill Rd.	23000	2
Sellersville Garge	26250	5
Pa. Route 152	26650	2
Sellersville Dam + Park	26720	30
Lenape Park	27080	14
Blooming Glenn Rd.	31380	8
Branch Rd.	32200	3

Table 4.6-3. Bimonthly species composition and estimated number of fish caught and number of fish harvested by anglers fishing the East Branch Perkiomen Creek in 1985.

Bimonthly period:	Apr-May		Jun-Jul		Aug-Sep		Total	
Species	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest
White sucker	168	-	-	-	-	-	168	-
Carp	42	-	80	-	-	-	122	-
Golden shiner	-	-	160	-	-	-	160	-
Brown bullhead	-	-	-	-	100	100	100	100
Unidentified catfish	252	-	-	-	-	-	252	-
Bluegill	126	-	561	401	500	500	1187	901
Green sunfish	252	252	160	160	100	100	512	512
Pumpkinseed	42	42	160	-	700	700	902	742
Redbreast sunfish	168	168	80	80	300	300	548	548
Hybrid sunfish	84	84	160	160	300	300	544	544
Unidentified sunfish	3524	-	5693	-	400	-	9617	-
Rock bass	294	42	241	-	-	-	535	42
Smallmouth bass	210	42	561	80	100	-	871	122
Largemouth bass	42	42	80	-	100	100	222	142
Unidentified bass	126	-	-	-	-	-	126	-
Total	5330	672	7936	881	2600	2100	15866	3653

Table 4.6-4. Estimated weight of angler harvest by species from East Branch Perkiomen Creek in 1985.

Species	Number in creel	Average weight per fish(g)	Estimated number harvested	Weight of harvest(kg)
Brown bullhead	1	278.0	100	27.8
Bluegill	10	55.1	901	49.6
Green sunfish	9	56.2	512	28.8
Pumpkinseed	8	60.2	742	44.7
Redbreast sunfish	8	54.0	548	29.6
Hybrid sunfish	7	51.6	544	28.1
Rock bass	1	157.0	42	6.6
Smallmouth bass	2	405.0	122	49.5
Largemouth bass	2	191.0	142	27.2

Table 4.6-5. Age and sex composition and mode of access for anglers interviewed on the East Branch Perkiomen Creek during 1985.

Sex	Number	%
Males	95	85
Females	17	15
	112	100
Age(Years)		
Child (<13)	38	34
Teen (13-19)	12	11
Adult (20-64)	62	55
	112	100
Mode of Access		
Boat	2	2
Shore	107	94
Wading	5	4
	114	100

Table 4.6-6. Preferred fishes of East Branch Perkiomen Creek anglers during 1985.

	Number of anglers identifying as:		
Category	1st Choice	2nd Choice	Total
Anything	44	-	44
Bass	31	6	37
Sunfish	15	10	25
Carp	10	2	12
Catfish	8	2	10
Sucker	2	2	4
Trout	2	-	2

5.0 Perkiomen Creek

Perkiomen Creek is located in the Triassic Lowland section of the Piedmont physiographic province, a rich farming area of rolling hills. It is a major Schuylkill River tributary and drains 938 km^2 of Lehigh, Berks, Bucks, and Montgomery Counties.

No major population centers occur within its relatively rural watershed which contains a number of small boroughs. Most surrounding land is residential or used for agriculature. Low base flows and frequent spates characterize an extremely variable flow regime. Spring flows are generally high due to snow melt and precipitation; late summer and early autumn flows are very low but subject to rapid fluctuation due to local thunderstorms.

The aquatic community of the Perkiomen Creek system has been influenced by man's long history of activities in the watershed. Water quality and flows have been altered, habitat changed or eliminated, and the species complex directly manipulated. Although these activities probably have reduced diversity somewhat, the community remains relatively stable and healthy.

The creek downstream of the East Branch confluence will be impacted by water diversion and water withdrawal will occur at Graterford. The Graterford intake design incorporates state-of-the-art technology, i.e., 2-mm slot width, wedge-wire screens located mid-channel and oriented parallel with the current.

Although Graterford intake construction is complete, little water was pumped from the Perkiomen Creek. Therefore, LGS operation had limited impact on the Perkiomen Creek.

The Perkiomen Creek study area included that stretch from Spring Mount Road bridge downstream to the Collegeville Dam. For a detailed description of this area, refer to the LGS EROL (PECo 1981 Section 6.1). Sample stations are designated by common name and by the letter 'P' followed by a number that indicates distance in meters from the mouth of the creek. Where sample stations include several meters of stream, the numbers designate the downstream end of the stations.

Aquatic biota of the Perkiomen Creek study area was studied extensively from 1970 through 1978 and is summarized in the LGS EROL (PECo 1981, Section 2.2.2.2). Additional studies of water quality (1979-1984) and fishes (1980-1984) were summarized in subsequent progress reports (RMC-Environmental Services 1984 and 1985). The results of these studies conducted in 1985 are summarized below.

5.1 Water Quality

Summary

1. Perkiomen Creek water quality continued to be monitored in 1985. Grab samples were obtained biweekly at one control station and one station on the future diversion-affected reach of the stream.

2. Low flows characterized most of 1985, but high flow events were also observed. Most of the new minimum and maximum water quality constituent values observed in 1985 were directly related to the low flow conditions, but many of the new extreme values were just slightly outside the previously established post-EROL period ranges.

3. The 1985 data show that Perkiomen Creek water quality was quite similar to that reported in the EROL and post-EROL progress reports.

Introduction and Methods

Investigation of Perkiomen Creek water quality in relation to LGS began in May 1974 and continued through 1985. The objectives of this program are to assess impacts of future diversion operation on water quality of the creek, provide water quality information regarding the consequences to LGS operations of

Perkiomen Creek use as a cooling water source, and to complement concurrent aquatic ecological programs.

As in previous years, sampling was conducted at two stations on the mainstem Perkiomen Creek (Fig. 5.1-1). Station P18700 is located just upstream of the Route 73 bridge and above the East Branch confluence. This control station provides water quality information on the diversion-unaffected portion of the Perkiomen Creek. Station P14390 is situated downstream of the East Branch confluence and in the immediate vicinity of the Graterford Intake. Sampling was conducted once every 2 weeks at both sample stations. All samples were collected as mid-channel, subsurface grabs and were analyzed according to standard, widely accepted methods.

Results and Discussion

Overall, Perkiomen Creek flows were low and interrupted by few high flow events in 1985 (Table 5.1-1). Compared to flow data recorded over a 15 year period, 1970-1985, the mean monthly flows in 1985 were below average in all months except September and November (Table 5.1-2).

Many new maximum and minimum parameter values for the post-EROL period (1979-1985) were recorded in 1985. Most were associated with the extended low flows experienced in the current

reporting period, and the vast majority were only slightly outside the previously established ranges.

Perkiomen Creek is a moderately hard warmwater stream which receives moderate amounts of nonindustrial pollution inputs as indicated by elevated concentrations of nutrients. The stream appears to fluctuate between a sulfate and carbonate ionic base and often contains high concentrations of major cations (calcium, magnesium, potassium, and sodium).

P18700

Seasonal summaries of water quality data obtained at this location are provided for 1979-1985 in Table 5.1-3 and for 1985 alone in Table 5.1-4. Several new minimum and maximum values were recorded for 1985 when compared to the 1979-1984 period (Tables 5.1-5 and 5.1-6, respectively).

In winter the new zinc maximum was a significant extension of the quarterly range and was the highest concentration observed at either Perkiomen Creek station in 1985. New minima established for biochemical oxygen demand, total hardness, and calcium coincided with new minima established for these parameters at the downstream station. The new minimum dissolved oxygen value recorded in spring occurred during an extended low flow and high temperature period in late April. Of the four parameters for

which new maximum concentrations were recorded in the spring quarter, all parameters except nitrite nitrogen are conservative and vary inversely with flow. Thus, the new records established for the conservative parameters can be explained by the low flows which occurred in spring. The nitrite nitrogen maximum was a slight extension of the range and coincided with a new maxima established on the same date at the lower sample site. In summer, the only new maximum value observed was for sulfate, and it did not represent a major extension of the range established prior to 1985. The new minima for biochemical oxygen demand and fecal coliforms were minor exceedances of the previously established ranges. In the fall quarter, new maximum values were recorded for six parameters, and all represented minor range extensions.

P14390

Water quality data for this station are presented as seasonal summaries for 1979-1985 in Table 5.1-7 and for 1985 alone in Table 5.1-8. The new minimum and maximum values established in 1985 are shown in Tables 5.1-9 and 5.1-10, respectively.

In winter, only the new maximum total dissolved solids value was a major extension of the established range. Exceedances for the other parameters were minor. In spring a new dissolved oxygen value was recorded on 24 April and on this same date new maxima were established for five conservative parameters which

vary inversely with flow. In summer, new maxima were recorded for several conservative parameters as low flows persisted. The new iron and coliform minima extended the previously established ranges to minimum values found in other quarters. The exceedances observed in the fall quarter were unremarkable.

Table 5.1-1. Mean daily Perkiomen Creek discharge (cu ft/sec) measured at the Graterford US Geological Survey gage in 1985.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	353	229	387	300	96	125	68	414	72	221	113	2520
02	672	294	358	365	114	163	61	135	63	171	111	N/A
03	766	333	310	290	2850	124	59	82	52	1280	110	N/A
04	457	278	276	258	1420	107	55	70	55	912	111	653
05	440	256	342	249	628	109	52	64	56	603	317	512
06	374	286	401	243	401	191	55	63	58	430	339	474
07	359	283	317	264	340	155	76	61	57	277	195	458
08	372	261	321	239	262	127	80	133	60	215	153	421
09	257	244	334	214	195	141	112	101	68	172	130	389
10	266	235	280	195	172	123	87	68	82	156	119	N/A
11	247	234	253	187	162	109	69	56	70	138	120	327
12	272	3300	390	182	149	96	60	50	62	118	120	343
13	292	3150	543	172	156	89	55	49	54	110	128	375
14	235	1020	345	163	163	82	52	49	54	113	126	680
15	176	646	282	160	135	75	57	52	52	122	144	419
16	193	456	221	163	123	198	69	47	52	114	535	337
17	204	379	205	161	160	279	64	43	52	101	4820	319
18	180	331	198	149	572	181	56	45	52	87	1070	290
19	159	344	168	138	347	125	49	45	52	90	634	232
20	261	383	162	132	230	105	44	47	55	88	472	241
21	270	353	164	129	184	96	42	50	54	88	368	216
22	193	353	150	130	191	82	66	57	55	94	1230	N/A
23	225	621	174	125	192	76	60	56	55	76	1420	171
24	242	834	279	125	183	69	49	53	54	88	696	N/A
25	251	745	277	130	156	91	46	97	51	123	467	N/A
26	249	573	251	120	129	80	62	237	53	115	N/A	187
27	242	529	210	111	116	66	165	122	11900	102	1740	N/A
28	237	446	192	104	107	62	146	83	2130	104	3380	N/A
29	231		192	97	108	66	83	73	537	104	3020	N/A
30	218		187	98	98	69	66	71	313	102	1410	N/A
31	215		180		95		91	81		N/A		N/A
Minimum	159	229	150	97	95	62	42	43	51	76	110	171
Mean	294	621	269	180	330	115	70	86	546	217	814	478
Median	249	353	276	162	163	106	61	63	55	115	339	359
Maximum	766	3300	543	365	2850	279	165	414	11900	1280	4820	2520

Table 5.1-2. Mean monthly Perkiomen Creek discharge (cu ft/sec) measured at the Graterford US Geological Survey gage, 1970 - 1985.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	238	871	552	1123	167	240	83	89	64	183	727	395
1971	458	1241	770	467	361	162	116	493	1163	396	672	382
1972	468	691	984	482	601	1330	248	75	58	82	1182	1092
1973	719	731	521	1074	541	519	242	172	98	81	114	1311
1974	762	267	730	953	371	171	80	167	416	217	131	696
1975	895	903	836	471	466	790	1076	168	586	534	431	310
1976	1006	723	424	403	199	127	102	103	75	371	168	270
1977	134	710	1243	819	230	98	90	104	70	280	827	1307
1978	1344	278	1525	351	864	191	218	273	133	104	118	704
1979	2071	1186	752	527	733	298	186	143	648	657	661	398
1980	354	156	1043	816	379	112	93	74	80	99	137	83
1981	76	539	209	564	488	173	100	54	73	111	137	331
1982	542	973	387	933	290	946	143	84	58	54	128	217
1983	410	587	1112	1759	542	250	66	63	46	151	734	1491
1984	291	1106	946	1100	1259	557	1286	189	93	103	171	397
1985	296	621	272	180	330	115	70	86	546	217	814	478
Minimum	58	58	83	97	74	62	31	38	28	35	35	58
Mean	630	723	770	751	489	380	262	146	263	229	448	625
Median	280	350	424	396	262	162	90	78	70	99	162	311
Maximum	14602	10000	9440	11399	8350	13300	14800	9000	11900	4430	8080	14300

Table 5.1-3. Summary of Perkiomen Creek water quality at Station P18700, 20 March 1979 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	1.1	8.0	1.0	9.9	21.0	14.0	22.5	27.0	3.5	14.5	23.5	166
Dissolved Oxygen (mg/l)	8.7	12.5	15.8	6.8	11.1	14.1	5.8	8.0	12.7	6.8	10.1	14.4	174
Biochemical Oxygen Demand (mg/l)	0.1	1.7	4.7	0.0	2.0	3.5	0.4	1.6	3.7	0.2	1.5	7.0	176
Chemical Oxygen Demand (mg/l)	0.0	11.8	81.9	0.0	13.9	42.7	0.0	11.0	76.6	0.0	13.1	42.1	175
Total Organic Carbon (mg/l)	0.0	3.8	20.2	0.0	3.5	15.7	0.0	4.7	16.0	0.0	4.9	21.4	169
pH	7.04	7.60	8.82	7.33	7.86	8.79	7.28	7.92	9.19	7.41	8.03	9.09	176
Total Alkalinity (mg/l)	11.4	50.6	99.6	4.7	43.4	60.5	20.5	59.2	77.8	34.9	66.5	83.8	176
Total Hardness (mg/l)	40.3	80.3	147.2	40.9	70.8	112.5	54.4	82.7	123.6	53.4	92.7	179.1	175
Specific Conductance (usm/cm)	126	213	381	109	182	239	106	222	452	145	250	585	176
Total Suspended Solids (mg/l)	0	2	471	0	7	63	0	9	37	0	2	23	176
Total Dissolved Solids (mg/l)	85	167	275	99	148	244	70	178	325	100	180	397	176
Total Inorganic Carbon (mg/l)	12.6	54.7	102.2	10.8	45.1	57.7	20.9	61.7	79.3	50.8	68.7	85.1	98
Chloride (mg/l)	12.1	22.7	49.3	9.2	16.7	29.4	4.6	19.1	64.0	11.0	23.0	67.1	176
Sulfate (mg/l)	15.4	32.8	70.4	12.0	29.2	40.1	0.0	18.4	76.7	18.2	35.0	96.6	176
Sodium (mg/l)	6.03	13.32	26.60	6.09	9.75	17.20	4.11	11.99	32.22	7.53	14.90	50.70	176
Potassium (mg/l)	1.7	3.2	12.2	1.5	2.4	6.4	1.7	4.2	14.8	2.3	5.5	30.5	176
Calcium (mg/l)	10.1	17.6	43.3	6.1	16.9	32.9	8.4	18.0	43.8	12.6	21.0	36.7	176
Magnesium (mg/l)	5.33	8.80	14.70	4.80	7.86	10.80	4.92	8.98	11.90	6.43	10.10	22.73	176
Ammonia Nitrogen (mg/l)	0.000	0.113	0.940	0.000	0.053	0.380	0.000	0.030	0.150	0.000	0.020	0.570	176
Nitrite Nitrogen (mg/l)	0.008	0.020	0.049	0.010	0.022	0.092	0.000	0.019	0.060	0.000	0.018	0.200	176
Nitrate Nitrogen (mg/l)	0.92	2.12	4.84	0.42	1.46	6.94	0.00	1.02	2.09	0.00	1.15	4.17	176
Total Phosphate Phosphorus (mg/l)	0.00	0.08	0.38	0.00	0.06	0.18	0.00	0.08	1.16	0.00	0.09	0.37	166
Ortho Phosphate Phosphorus (mg/l)	0.00	0.05	0.16	0.00	0.04	0.17	0.00	0.05	0.18	0.00	0.04	0.41	174
Chromium (mg/l)	0.000	0.005	0.026	0.000	0.005	0.050	0.000	0.004	0.056	0.000	0.004	0.030	175
Copper (mg/l)	0.000	0.002	0.082	0.000	0.003	0.020	0.000	0.003	0.036	0.000	0.001	0.017	176
Iron (mg/l)	0.00	0.24	10.70	0.00	0.34	1.41	0.08	0.30	1.74	0.00	0.20	1.10	176
Lead (mg/l)	0.000	0.000	0.020	0.000	0.000	0.015	0.000	0.000	0.049	0.000	0.000	0.013	176
Manganese (mg/l)	0.00	0.00	0.42	0.00	0.04	0.15	0.00	0.05	0.16	0.00	0.00	0.07	176
Zinc (mg/l)	0.00	0.00	0.59	0.00	0.01	0.21	0.00	0.00	0.08	0.00	0.00	0.16	176
Cyanide (mg/l)	0.000	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.002	0.000	0.000	0.004	174
Phenols (mg/l)	0.000	0.000	0.030	0.000	0.000	0.013	0.000	0.000	0.019	0.000	0.000	0.044	175
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147
Total Coliforms (c/.1l)	13	400	18000	15	270	34000	120	600	37000	40	480	40000	171
Fecal Coliforms (c/.1l)	1	85	3400	0	85	8600	50	255	25000	23	124	4100	170

Table 5.1-4. Summary of Perkiomen Creek water quality at Station P18700, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	0.0	1.5	7.0	6.0	10.5	18.0	18.0	22.0	24.0	11.2	13.8	21.5	26
Dissolved Oxygen (mg/l)	8.8	11.4	14.2	6.8	11.0	11.0	6.7	8.5	9.8	6.8	9.3	9.7	25
Biochemical Oxygen Demand (mg/l)	0.1	1.3	4.4	0.5	1.8	2.2	0.4	0.9	1.3	0.3	0.7	3.0	26
Chemical Oxygen Demand (mg/l)	0.0	11.8	22.6	0.0	16.4	22.6	0.0	14.4	19.8	0.0	26.0	42.1	26
Total Organic Carbon (mg/l)	2.7	3.4	4.2	3.2	3.5	3.9	3.6	4.2	5.0	4.4	5.2	6.6	26
pH	7.26	7.68	7.91	7.63	8.04	8.39	7.79	8.08	8.26	7.63	7.92	8.00	26
Total Alkalinity (mg/l)	25.2	57.8	81.7	47.4	56.1	60.5	55.3	69.1	74.7	41.3	65.2	77.1	26
Total Hardness (mg/l)	40.3	72.0	104.9	68.2	74.8	91.7	65.3	77.4	92.4	56.1	70.4	104.0	26
Specific Conductance (usm/cm)	152	172	256	188	215	239	237	271	291	180	240	345	26
Total Suspended Solids (mg/l)	0	5	32	1	5	14	0	2	10	0	2	23	26
Total Dissolved Solids (mg/l)	92	138	174	114	165	244	148	180	238	150	169	242	26
Chloride (mg/l)	16.4	20.5	33.0	21.4	24.5	29.4	24.9	29.3	37.5	13.5	27.8	47.9	26
Sulfate (mg/l)	20.9	28.8	36.8	23.0	26.7	31.4	25.3	30.9	76.7	25.8	34.8	37.1	26
Sodium (mg/l)	7.60	10.14	17.31	11.65	13.64	14.57	14.96	16.42	17.86	9.44	13.61	22.90	26
Potassium (mg/l)	2.3	3.2	6.2	2.8	3.8	5.0	4.1	5.4	6.5	3.1	6.7	11.4	26
Calcium (mg/l)	10.1	17.6	20.6	23.0	24.1	26.3	23.7	27.4	31.8	21.0	23.8	33.2	26
Magnesium (mg/l)	6.40	7.88	10.94	8.71	9.38	10.13	8.34	10.03	11.11	6.98	9.91	22.73	26
Ammonia Nitrogen (mg/l)	0.048	0.096	0.282	0.000	0.054	0.073	0.024	0.047	0.096	0.000	0.048	0.075	26
Nitrite Nitrogen (mg/l)	0.008	0.019	0.043	0.012	0.028	0.092	0.000	0.017	0.025	0.010	0.030	0.031	26
Nitrate Nitrogen (mg/l)	1.33	1.54	2.38	0.76	1.13	1.37	0.58	0.70	1.26	0.76	1.22	1.76	26
Total Phosphate Phosphorus (mg/l)	0.01	0.08	0.11	0.02	0.07	0.11	0.09	0.12	0.15	0.08	0.11	0.22	25
Ortho Phosphate Phosphorus (mg/l)	0.00	0.04	0.07	0.00	0.01	0.08	0.07	0.08	0.12	0.00	0.07	0.13	24
Chromium (mg/l)	0.000	0.005	0.007	0.003	0.005	0.007	0.003	0.005	0.009	0.000	0.006	0.008	26
Copper (mg/l)	0.000	0.002	0.005	0.000	0.002	0.002	0.000	0.001	0.002	0.000	0.001	0.004	26
Iron (mg/l)	0.08	0.21	2.66	0.08	0.19	0.33	0.08	0.19	0.24	0.09	0.29	1.10	26
Lead (mg/l)	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.001	26
Manganese (mg/l)	0.00	0.00	0.11	0.00	0.03	0.09	0.00	0.00	0.05	0.00	0.03	0.07	26
Zinc (mg/l)	0.00	0.00	0.59	0.00	0.00	0.06	0.00	0.00	0.01	0.00	0.00	0.01	26
Cyanide (mg/l)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.002	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25
Total Coliforms (c/.1l)	170	350	3300	30	255	600	180	265	510	120	295	13500	25
Fecal Coliforms (c/.1l)	6	91	600	8	53	120	50	115	360	60	101	4100	25

Table 5.1-5. New minimum values observed for water quality parameters measured in 1985 at Station P18700 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Biochemical Oxygen Demand (mg/l)	0.1	01/16/85
	Total Hardness (mg/l)	40.3	12/04/85
	Calcium (mg/l)	10.1	02/13/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	6.8	04/24/85
Jun, Jul, Aug	Biochemical Oxygen Demand (mg/l)	0.4	08/28/85
	Fecal Coliforms (c/.1l)	50	06/19/85

Table 5.1-6. New maximum values observed for water quality parameters measured in 1985 at Station P18700 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Zinc (mg/l)	0.59	02/27/85
Mar, Apr, May	Total Alkalinity (mg/l)	60.5	04/11/85
	Total Dissolved Solids (mg/l)	244	03/27/85
	Chloride (mg/l)	29.4	03/27/85
	Nitrite Nitrogen (mg/l)	0.092	04/11/85
Jun, Jul, Aug	Sulfate (mg/l)	76.7	06/05/85
Sep, Oct, Nov	Total Suspended Solids (mg/l)	23	11/06/85
	Magnesium (mg/l)	22.73	09/25/85
	Iron (mg/l)	1.10	11/06/85
	Manganese (mg/l)	0.07	09/25/85
	Chemical Oxygen Demand (mg/l)	42.1	10/09/85
	Fecal Coliforms (c/.1l)	4100	11/06/85

Table 5.1-7. Summary of Perkiomen Creek water quality at Station P14390, 20 March 1979 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	2.0	8.0	1.0	10.9	24.0	14.0	23.0	28.0	3.0	14.5	24.0	167
Dissolved Oxygen (mg/l)	7.6	12.5	15.0	5.5	11.4	16.5	4.6	7.7	13.4	4.5	9.7	14.2	174
Biochemical Oxygen Demand (mg/l)	0.0	1.8	5.4	0.0	2.0	3.6	0.5	2.0	6.1	0.3	1.5	7.0	176
Chemical Oxygen Demand (mg/l)	0.0	12.4	50.0	0.0	12.5	42.6	0.0	12.3	135.8	0.0	14.0	164.7	174
Total Organic Carbon (mg/l)	0.0	4.3	36.2	0.0	2.6	12.1	0.0	4.4	19.2	0.0	4.8	25.8	169
pH	6.73	7.60	9.95	7.25	7.82	9.08	7.01	7.93	9.23	7.24	8.04	9.34	176
Total Alkalinity (mg/l)	16.5	52.4	104.2	9.3	45.0	66.2	17.8	63.5	79.3	32.6	71.0	89.4	176
Total Hardness (mg/l)	45.0	81.8	507.7	42.2	73.2	102.0	56.8	87.3	133.0	61.5	98.8	183.2	175
Specific Conductance (usm/cm)	127	221	411	116	195	279	123	252	333	163	280	523	176
Total Suspended Solids (mg/l)	0	4	676	0	6	101	0	9	383	0	2	29	176
Total Dissolved Solids (mg/l)	67	170	402	120	160	225	85	187	292	103	192	327	176
Total Inorganic Carbon (mg/l)	18.2	55.7	107.8	10.0	45.9	58.7	19.2	64.4	78.3	48.7	74.8	90.6	98
Chloride (mg/l)	11.4	23.6	56.1	9.2	17.7	38.7	5.8	24.1	52.2	11.9	30.4	102.4	176
Sulfate (mg/l)	10.5	35.7	72.6	16.6	30.6	44.3	0.0	31.1	101.0	19.9	36.9	76.3	176
Sodium (mg/l)	7.39	14.30	35.20	3.20	11.10	19.41	4.88	8.72	26.90	8.64	18.97	48.00	176
Potassium (mg/l)	1.9	3.6	7.6	1.0	2.8	5.9	1.7	3.8	11.0	2.5	5.0	15.5	176
Calcium (mg/l)	9.6	18.3	41.6	6.7	16.6	34.2	9.4	18.1	32.2	14.4	22.3	34.9	176
Magnesium (mg/l)	6.18	9.30	15.00	2.90	8.19	11.80	5.00	9.50	13.40	6.55	10.50	16.50	176
Ammonia Nitrogen (mg/l)	0.000	0.107	0.800	0.000	0.050	0.430	0.000	0.037	0.140	0.000	0.027	0.580	176
Nitrite Nitrogen (mg/l)	0.009	0.019	0.051	0.012	0.023	0.111	0.000	0.019	0.110	0.000	0.018	0.220	176
Nitrate Nitrogen (mg/l)	0.95	2.30	4.01	0.37	1.52	3.03	0.00	0.98	5.00	0.00	1.30	3.77	176
Total Phosphate Phosphorus (mg/l)	0.03	0.09	0.66	0.00	0.06	0.13	0.00	0.09	2.98	0.00	0.09	0.35	166
Ortho Phosphate Phosphorus (mg/l)	0.00	0.05	0.15	0.00	0.04	0.20	0.00	0.06	0.23	0.00	0.06	0.42	174
Chromium (mg/l)	0.000	0.005	0.032	0.000	0.004	0.020	0.000	0.003	2.523	0.000	0.004	0.029	175
Copper (mg/l)	0.000	0.002	0.053	0.000	0.002	0.031	0.000	0.002	0.053	0.000	0.001	0.015	176
Iron (mg/l)	0.00	0.22	16.49	0.04	0.25	2.43	0.00	0.28	3.88	0.00	0.25	1.59	176
Lead (mg/l)	0.000	0.000	0.034	0.000	0.000	0.027	0.000	0.000	5.368	0.000	0.000	0.013	176
Manganese (mg/l)	0.00	0.00	0.62	0.00	0.00	0.12	0.00	0.05	0.38	0.00	0.00	0.08	176
Zinc (mg/l)	0.00	0.01	0.34	0.00	0.01	0.13	0.00	0.01	0.53	0.00	0.00	0.23	176
Cyanide (mg/l)	0.000	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.002	0.000	0.000	0.003	174
Phenols (mg/l)	0.000	0.000	0.045	0.000	0.000	0.013	0.000	0.000	0.020	0.000	0.000	0.027	175
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	145
Total Coliforms (c/.1l)	8	440	15500	4	340	37000	50	950	43000	70	818	43000	170
Fecal Coliforms (c/.1l)	1	80	3100	0	66	12500	18	339	20000	13	152	4100	172

Table 5.1-8. Summary of Perkiomen Creek water quality at Station PI4390, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	1.5	7.5	6.0	10.5	17.5	19.0	22.0	26.0	11.5	13.4	22.0	26
Dissolved Oxygen (mg/l)	11.0	12.1	14.1	5.5	10.2	12.2	5.1	6.3	8.9	4.5	8.5	9.7	24
Biochemical Oxygen Demand (mg/l)	0.0	1.0	4.2	0.6	1.7	3.4	0.5	1.0	1.4	0.3	0.6	2.7	26
Chemical Oxygen Demand (mg/l)	0.0	10.8	22.3	7.5	15.3	20.8	0.0	12.3	35.3	0.0	23.0	37.7	26
Total Organic Carbon (mg/l)	2.6	3.3	4.1	3.0	3.4	4.4	3.7	4.5	5.0	3.9	5.1	6.6	26
pH	7.12	7.60	7.88	7.61	7.86	8.22	7.76	8.24	8.58	7.51	7.88	8.07	26
Total Alkalinity (mg/l)	31.6	59.3	72.6	50.9	58.2	66.2	65.6	73.4	77.5	40.3	68.8	83.0	26
Total Hardness (mg/l)	45.0	75.8	110.8	72.3	77.3	97.2	75.4	82.4	100.5	61.5	77.7	117.6	26
Specific Conductance (usm/cm)	137	200	270	207	237	279	280	306	333	191	281	377	26
Total Suspended Solids (mg/l)	2	6	28	0	5	12	0	4	12	0	2	20	26
Total Dissolved Solids (mg/l)	67	153	402	132	206	225	172	254	292	153	173	302	26
Chloride (mg/l)	13.0	22.8	39.3	22.2	28.6	38.7	35.2	38.1	52.2	15.7	31.8	54.9	26
Sulfate (mg/l)	21.7	31.2	51.4	24.5	28.4	34.7	29.5	31.6	78.1	23.5	35.3	40.3	26
Sodium (mg/l)	8.58	12.04	21.81	13.63	15.98	19.41	20.65	21.44	24.64	9.77	17.31	28.41	26
Potassium (mg/l)	2.6	3.6	6.0	2.8	3.8	5.9	4.7	5.6	7.6	3.4	7.4	10.7	26
Calcium (mg/l)	9.6	17.8	22.0	24.0	25.3	28.0	27.1	30.3	32.2	21.0	27.7	33.2	26
Magnesium (mg/l)	6.69	8.57	11.24	8.41	10.47	10.76	8.72	10.82	11.58	7.83	10.92	12.83	26
Ammonia Nitrogen (mg/l)	0.000	0.068	0.261	0.000	0.066	0.082	0.045	0.076	0.125	0.000	0.064	0.095	26
Nitrite Nitrogen (mg/l)	0.009	0.016	0.051	0.014	0.029	0.111	0.000	0.016	0.025	0.017	0.024	0.032	26
Nitrate Nitrogen (mg/l)	1.58	1.85	2.84	0.71	1.10	1.49	0.28	0.65	1.32	0.54	1.32	2.07	26
Total Phosphate Phosphorus (mg/l)	0.04	0.09	0.17	0.03	0.06	0.11	0.07	0.11	0.15	0.07	0.12	0.21	25
Ortho Phosphate Phosphorus (mg/l)	0.00	0.06	0.09	0.01	0.02	0.09	0.05	0.08	0.12	0.05	0.09	0.15	24
Chromium (mg/l)	0.000	0.006	0.015	0.003	0.005	0.007	0.003	0.005	0.008	0.000	0.006	0.009	26
Copper (mg/l)	0.000	0.002	0.004	0.002	0.003	0.004	0.000	0.001	0.007	0.000	0.002	0.005	26
Iron (mg/l)	0.10	0.21	1.42	0.08	0.12	0.28	0.00	0.13	0.16	0.00	0.24	1.12	26
Lead (mg/l)	0.000	0.000	0.002	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.001	26
Manganese (mg/l)	0.00	0.00	0.10	0.00	0.00	0.05	0.00	0.00	0.07	0.00	0.04	0.08	26
Zinc (mg/l)	0.00	0.00	0.25	0.00	0.01	0.06	0.00	0.01	0.02	0.00	0.00	0.01	26
Cyanide (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24
Total Coliforms (c/.1l)	130	400	4500	30	300	360	50	150	610	100	695	10000	25
Fecal Coliforms (c/.1l)	16	100	1100	14	53	260	18	57	380	23	110	4100	25

Table 5.1-9. New minimum values observed for water quality parameters measured in 1985 at Station P14390 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Biochemical Oxygen Demand (mg/l)	0.0	01/16/85
	Total Hardness (mg/l)	45.0	12/04/85
	Total Dissolved Solids (mg/l)	67	01/30/85
	Calcium (mg/l)	9.6	02/13/85
	Nitrite Nitrogen (mg/l)	0.009	01/16/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	5.5	04/24/85
Jun, Jul, Aug	Iron (mg/l)	0.00	07/02/85
	Fecal Coliforms (c/.1l)	18	07/31/85
	Total Coliforms (c/.1l)	50	07/17/85
Sep, Oct, Nov	Dissolved Oxygen (mg/l)	4.5	09/11/85
	Total Hardness (mg/l)	61.5	11/20/85

Table 5.1-10. New maximum values observed for water quality parameters measured in 1985 at Station P14390 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Total Dissolved Solids (mg/l)	402	02/27/85
	Nitrite Nitrogen (mg/l)	0.051	02/13/85
Mar, Apr, May	Total Alkalinity (mg/l)	66.2	04/24/85
	Specific Conductance (usm/cm)	279	04/24/85
	Total Dissolved Solids (mg/l)	225	05/22/85
	Chloride (mg/l)	38.7	04/24/85
	Sodium (mg/l)	19.41	04/24/85
	Potassium (mg/l)	5.9	04/24/85
	Nitrite Nitrogen (mg/l)	0.111	04/11/85
Jun, Jul, Aug	Specific Conductance (usm/cm)	333	07/17/85
	Total Dissolved Solids (mg/l)	292	07/17/85
	Chloride (mg/l)	52.2	07/17/85
	Calcium (mg/l)	32.2	07/17/85
Sep, Oct, Nov	Fecal Coliforms (c/.1l)	4100	11/06/85

5.2 Fishes Collected by Electrofishing

Summary

1. In 1985, a total of 4,468 fish of 20 species and three hybrids was collected in 19.88 hours of electrofishing in Perkiomen Creek at an overall rate of 226 fish/hour.

2. Redbreast sunfish (25.3% of the total sample), white sucker (19.1%), smallmouth bass (16.6%), and rock bass (15.9%) were the only species to comprise more than 10% of the 1985 electrofishing catch.

3. Exceptionally low catch rates of most species seen in 1984 at P14540 and P14030 were not evident in 1985 as catches rebounded to levels seen in 1981-1983.

4. Most species produced relatively strong year-classes in 1985, especially smallmouth bass. Differences between stations in the rank order of more common species were probably due to local habitat differences rather than large-scale effects of longitudinal zonation, due to the proximity of stations to each other.

Introduction and Methods

An electrofishing survey of the Perkiomen Creek large fish community continued in 1985 for the fifth consecutive year. The

primary objective of the survey was to provide species composition and relative abundance data for a target portion of the stream fish community (RMC 1984).

Electrofishing methods used to collect fish were described in RMC (1984). After collection, individual fish were identified, measured to the nearest mm fork length (FL), weighed to the nearest g, and examined for the presence of disease, broadly defined herein to include presence of parasites and anamolies. Fish less than 50 mm FL were excluded from analysis to avoid possible gear bias against small fish. Electrofishing efforts were timed to the nearest minute to permit calculation of catch-per-unit-effort (CPUE), expressed as fish/hour-of-electrofishing-effort, or simply fish/hour. CPUE was used as an index of relative fish density to facilitate comparisons between fish catches made at different places and times.

Spatial and temporal variation in these aspects of fish ecology were addressed by sampling several stations at bimonthly intervals, May through November (Table 5.2-1). Sample stations were described in an earlier progress report (RMC 1984).

Results and Discussion

Species Composition and Relative Abundance

In 1985, a total of 4,468 fish of 20 species and three hybrids was collected in 19.88 hours of electrofishing (Table 5.2-2). Annual CPUE, 226 fish/hour, was higher than any previous year since 1981, and was double the annual catch rate in 1984 (RMC 1985). Four species exceeded 10% of the annual catch; in decreasing order these were: redbreast sunfish (25.3%), white sucker (19.1%), smallmouth bass (16.6%), and rock bass (15.9%). Relative densities of these and most other common species were all increased compared to 1984, due in part to the catch of more young-of-year (YOY) fish in late summer 1985. Relative density of bluegill, white crappie, and black crappie declined. Exceptionally low catch rates of most species that were seen at P14540 and P14030 in 1984 were not evident in 1985 as catches rebounded to levels seen in 1981-1983.

No new species was collected from Perkiomen Creek in 1985. Six target species known or thought to occur in the stream were not collected in 1985, including white catfish, northern pike, muskellunge, brook trout, rainbow trout, and brown trout. Hybrid northern pike x muskellunge were collected in small numbers each year since 1981; most appeared to be recently stocked juveniles although occasional adult specimens were collected at P20035 in

the past. Most introductions are of the hybrid (EROL), and pure muskellunge, if they occur in the study reach at all, are exceedingly rare. Salmonids were seasonally stocked upstream of the study area and in tributaries, but none was collected in 1985.

Site Comparisons

The large fish community at each station appeared similar, although some shifts occurred in the rank order of the more common species (Tables 5.2-3 to 5.2-6; RMC 1985). Due to the proximity of stations to each other with respect to the overall length of the stream, station-to-station differences were probably due more to local differences in habitat rather than a shift in community structure due to longitudinal zonation.

Important Species

Five species, including muskellunge, carp, white sucker, redbreast sunfish, and smallmouth bass were selected as important to the Perkiomen Creek fish community according to regulatory guidelines that consider a species' functional role in the aquatic community, importance to man, and sensitivity to environmental change. Results for these species were therefore examined individually.

Muskellunge

Three hybrid muskellunge x northern pike hybrids were caught from Perkiomen Creek in 1985 that were 157, 298, and 308 mm FL. Two of these were caught at P20035, where most Esox hybrids have been caught in the past. The other hybrid was collected in May at P14170 and was the first to be caught from a Perkiomen Creek electrofishing station other than P20035 since this program began in 1981.

Carp

Relative abundance of carp was similar to that seen in past surveys (RMC 1984, 1985). Highest densities occurred at P20035 and P14540, which consist of large, deep pools. Most carp captured were large adults although a few that were between 100-200 mm FL may have been YOY or Age I fish. Ten percent of the carp examined were afflicted with wounds, fin damage, or copepod parasitism.

White sucker

White sucker was the second-most abundant species in the 1985 electrofishing sample. The overall catch rate, 43 fish/hour, was similar to the catch rate in 1981 (51 fish/hour). White sucker was a ubiquitous species and comprised a fairly similar propor-

tion of the electrofishing catch at each station. Incidence of disease among white suckers was lower than that seen in 1983-1984, when 20% to 25% of those examined were afflicted with a variety of maladies. In 1985, 9% of white sucker collected were diseased. Copepod parasitism, fin damage, body wounds, and blindness were the afflictions most frequently observed.

Redbreast sunfish

Redbreast sunfish was the most abundant species in the electrofishing catch from P14030 and P14170, ranked second to smallmouth bass at P14540, and was the most abundant species in the overall sample. Relative population density appeared lowest at the upstream station, P20035, where the overall catch rate was 12 fish/hour. In contrast, CPUE was highest at P14170 (149 fish/hour) and intermediate at P14030 and P14540 (74 fish/hour and 39 fish/hour, respectively). The high catch rate at P14170 was in part due to the presence of many small YOY fish. Parasitism by leeches was the most frequently observed malady; in all, 7% of redbreast sunfish examined were in some way diseased.

Smallmouth bass

Smallmouth bass ranked third in overall relative abundance and comprised 16.6% of the 1985 electrofishing sample. Annual CPUE, 37 fish/hour, was the highest observed in 5 years.

Increased relative density was due mostly to the production of a strong year-class. Out of 706 smallmouth bass collected in September and October, 670 (95%) were identified by length frequency distribution as YOY fish. Growth of young smallmouth bass was excellent, with many attaining 120 to 130 mm FL by early November. This observation is in contrast to what was seen in 1984 when very few YOY smallmouth bass were collected. The largest smallmouth bass captured weighed 1,020 g and measured 386 mm FL. Twice, a smallmouth bass thought to exceed 2 kg in weight was partially stunned near a fallen tree at P14540 but was not captured. A smallmouth bass of that size may approach the maximum size for this species in Perkiomen Creek. Incidence of disease, 29%, exceeded the rate seen in 1981-1984, as over one-fourth of the YOY smallmouth bass observed were parasitized by black spot. Individual infestations were seldom severe; usually only a few parasites were lodged at the base of pectoral and caudal fins.

Table 5.2-1. Summary of the Perkiomen Creek electrofishing sample sites and dates.

Name	Station	Type		A -	M -	J -	J -	A -	S -	O -	N -	Total
Schwenksville	P20035	Upstream-control	1981	X		X		X		X		4
			1982		X	X		X		X		4
			1983		X		X		X		X	4
			1984		X		X		X		X	4
			1985		X		X		X		X	4
		*										20
Graterford Pool	P14540	Intake-affected	1981	X		X		X		X		4
			1982		X	X		X		X		4
			1983		X		X		X		X	4
			1984		X		X		X		X	4
			1985		X		X		X		X	4
		*										20
West Island	P14170	Below Intake	1981	X		X		X		X		4
			1982		X	X		X		X		4
			1983		X		X		X		X	4
			1984		X		X		X		X	4
			1985		X		X		X		X	4
		*										20
East Island	P14030	Below Intake	1981	X		X		X		X		4
			1982		X	X		X		X		4
			1983		X		X		X			3
			1984		X		X		X		X	4
			1985		X		X		X		X	4
		*										19
												79

Table 5.2-2. Annual relative abundance of target fishes from the Perkiomen Creek electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		P14030 3.02 Hr	P14170 3.72 Hr	P14540 7.22 Hr	P20035 5.93 Hr	Total 19.88 Hr
American eel	Catch	1	2	2	14	19
	%	0.1	0.1	0.2	1.6	0.4
	CPUE	0.33	0.54	0.28	2.36	0.96
Esox hybrid	Catch	-	1	-	2	3
	%	-	0.1	-	0.2	0.1
	CPUE	-	0.27	-	0.34	0.15
Goldfish	Catch	-	-	1	1	2
	%	-	-	0.1	0.1	+
	CPUE	-	-	0.14	0.17	0.10
Carp	Catch	15	16	40	53	124
	%	2.1	1.0	3.2	6.1	2.8
	CPUE	4.97	4.30	5.54	8.94	6.24
Golden shiner	Catch	3	4	1	-	8
	%	0.4	0.3	0.1	-	0.2
	CPUE	0.99	1.08	0.14	-	0.40
Fallfish	Catch	1	-	1	-	2
	%	0.1	-	0.1	-	+
	CPUE	0.33	-	0.14	-	0.10
Minnow hybrid	Catch	-	-	3	-	3
	%	-	-	0.2	-	0.1
	CPUE	-	-	0.42	-	0.15
White sucker	Catch	149	257	223	221	850
	%	20.8	15.9	17.6	25.4	19.0
	CPUE	49.34	69.09	30.89	37.27	42.75
Creek chubsucker	Catch	-	5	7	3	15
	%	-	0.3	0.6	0.3	0.3
	CPUE	-	1.34	0.97	0.51	0.75
Yellow bullhead	Catch	19	59	38	15	131
	%	2.7	3.7	3.0	1.7	2.9
	CPUE	6.29	15.86	5.26	2.53	6.59
Brown bullhead	Catch	-	13	18	28	59
	%	-	0.8	1.4	3.2	1.3
	CPUE	-	3.49	2.49	4.72	2.97
Channel catfish	Catch	-	-	-	3	3
	%	-	-	-	0.3	0.1
	CPUE	-	-	-	0.51	0.15
Margined madtom	Catch	1	2	-	-	3
	%	0.1	0.1	-	-	0.1
	CPUE	0.33	0.54	-	-	0.15
Rock bass	Catch	139	405	112	54	710
	%	19.4	25.1	8.8	6.2	15.9
	CPUE	46.03	108.87	15.51	9.11	35.71
Redbreast sunfish	Catch	222	553	282	73	1130
	%	31.1	34.2	22.3	8.4	25.3
	CPUE	73.51	148.66	39.06	12.31	56.83
Green sunfish	Catch	20	18	87	67	192
	%	2.8	1.1	6.9	7.7	4.3
	CPUE	6.62	4.84	12.05	11.30	9.66
Pumpkinseed	Catch	15	48	80	56	199
	%	2.1	3.0	6.3	6.4	4.5
	CPUE	4.97	12.90	11.08	9.44	10.01
Bluegill	Catch	1	28	28	97	154
	%	0.1	1.7	2.2	11.2	3.5
	CPUE	0.33	7.53	3.88	16.36	7.75

Table 5.2-2. Annual relative abundance of target fishes from the Perkiomen Creek electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		P14030 3.02 Hr	P14170 3.72 Hr	P14540 7.22 Hr	P20035 5.93 Hr	Total 19.88 Hr
Lepomis hybrid	Catch	1	3	19	15	38
	%	0.1	0.2	1.5	1.7	0.9
	CPUE	0.33	0.81	2.63	2.53	1.91
Smallmouth bass	Catch	127	192	319	103	741
	%	17.8	11.9	25.2	11.8	16.6
	CPUE	42.05	51.61	44.18	17.37	37.27
Largemouth bass	Catch	-	8	1	41	50
	%	-	0.5	0.1	4.7	1.1
	CPUE	-	2.15	0.14	6.91	2.51
White crappie	Catch	-	-	1	6	7
	%	-	-	0.1	0.7	0.2
	CPUE	-	-	0.14	1.01	0.35
Black crappie	Catch	1	2	4	18	25
	%	0.1	0.1	0.3	2.1	0.6
	CPUE	0.33	0.54	0.55	3.04	1.26
	Catch	715	1616	1267	870	4468

Table 5.2-3. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P14030 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 0.53 Hrs	Jul 0.68 Hrs	Sep 0.98 Hrs	Nov 0.82 Hrs
American eel	Catch	-	-	1	-
	%	-	-	0.2	-
	CPUE	-	-	1.0	-
Carp	Catch	9	-	6	-
	%	37.5	-	1.4	-
	CPUE	17.0	-	6.1	-
Golden shiner	Catch	-	3	-	-
	%	-	3.4	-	-
	CPUE	-	4.4	-	-
Fallfish	Catch	-	1	-	-
	%	-	1.1	-	-
	CPUE	-	1.5	-	-
White sucker	Catch	7	11	118	13
	%	29.2	12.4	28.5	6.9
	CPUE	13.2	16.2	120.4	15.9
Yellow bullhead	Catch	2	5	6	6
	%	8.3	5.6	1.4	3.2
	CPUE	3.8	7.4	6.1	7.3
Margined madtom	Catch	-	-	1	-
	%	-	-	0.2	-
	CPUE	-	-	1.0	-
Rock bass	Catch	1	10	74	54
	%	4.2	11.2	17.9	28.7
	CPUE	1.9	14.7	75.5	65.9
Redbreast sunfish	Catch	2	40	123	57
	%	8.3	44.9	29.7	30.3
	CPUE	3.8	58.8	125.5	69.5
Green sunfish	Catch	1	6	9	4
	%	4.2	6.7	2.2	2.1
	CPUE	1.9	8.8	9.2	4.9
Pumpkinseed	Catch	1	3	4	7
	%	4.2	3.4	1.0	3.7
	CPUE	1.9	4.4	4.1	8.5
Bluegill	Catch	-	-	-	1
	%	-	-	-	0.5
	CPUE	-	-	-	1.2
Lepomis hybrid	Catch	-	-	-	1
	%	-	-	-	0.5
	CPUE	-	-	-	1.2
Smallmouth bass	Catch	-	10	72	45
	%	-	11.2	17.4	23.9
	CPUE	-	14.7	73.5	54.9
Black crappie	Catch	1	-	-	-
	%	4.2	-	-	-
	CPUE	1.9	-	-	-

Table 5.2-4. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P14170 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 0.97 Hrs	Jul 0.78 Hrs	Sep 1.07 Hrs	Nov 0.90 Hrs
American eel	Catch	1	-	1	-
	%	1.2	-	0.1	-
	CPUE	1.0	-	0.9	-
Esox hybrid	Catch	1	-	-	-
	%	1.2	-	-	-
	CPUE	1.0	-	-	-
Carp	Catch	3	-	9	4
	%	3.5	-	1.1	0.7
	CPUE	3.1	-	8.4	4.4
Golden shiner	Catch	-	-	4	-
	%	-	-	0.5	-
	CPUE	-	-	3.7	-
White sucker	Catch	20	25	174	38
	%	23.3	19.5	21.4	6.4
	CPUE	20.6	32.1	162.6	42.2
Creek chubsucker	Catch	-	-	5	-
	%	-	-	0.6	-
	CPUE	-	-	4.7	-
Yellow bullhead	Catch	11	14	19	15
	%	12.8	10.9	2.3	2.5
	CPUE	11.3	17.9	17.8	16.7
Brown bullhead	Catch	-	2	9	2
	%	-	1.6	1.1	0.3
	CPUE	-	2.6	8.4	2.2
Margined madtom	Catch	-	-	-	2
	%	-	-	-	0.3
	CPUE	-	-	-	2.2
Rock bass	Catch	15	13	216	161
	%	17.4	10.2	26.6	27.3
	CPUE	15.5	16.7	201.9	178.9
Redbreast sunfish	Catch	20	62	195	276
	%	23.3	48.4	24.0	46.8
	CPUE	20.6	79.5	182.2	306.7
Green sunfish	Catch	5	1	5	7
	%	5.8	0.8	0.6	1.2
	CPUE	5.2	1.3	4.7	7.8
Pumpkinseed	Catch	2	2	28	16
	%	2.3	1.6	3.4	2.7
	CPUE	2.1	2.6	26.2	17.8
Bluegill	Catch	6	6	15	1
	%	7.0	4.7	1.8	0.2
	CPUE	6.2	7.7	14.0	1.1
Lepomis hybrid	Catch	-	1	1	1
	%	-	0.8	0.1	0.2
	CPUE	-	1.3	0.9	1.1
Smallmouth bass	Catch	2	2	129	59
	%	2.3	1.6	15.9	10.0
	CPUE	2.1	2.6	120.6	65.6
Largemouth bass	Catch	-	-	1	7
	%	-	-	0.1	1.2
	CPUE	-	-	0.9	7.8
Black crappie	Catch	-	-	1	1
	%	-	-	0.1	0.2
	CPUE	-	-	0.9	1.1

Table 5.2-5. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P14540 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 1.50 Hrs	Jul 1.17 Hrs	Sep 2.62 Hrs	Nov 1.93 Hrs
American eel	Catch	-	-	2	-
	%	-	-	0.3	-
	CPUE	-	-	0.8	-
Goldfish	Catch	-	1	-	-
	%	-	0.9	-	-
	CPUE	-	0.9	-	-
Carp	Catch	9	6	18	7
	%	16.1	5.3	2.8	1.5
	CPUE	6.0	5.1	6.9	3.6
Golden shiner	Catch	-	-	-	1
	%	-	-	-	0.2
	CPUE	-	-	-	0.5
Fallfish	Catch	-	-	-	1
	%	-	-	-	0.2
	CPUE	-	-	-	0.5
Minnow hybrid	Catch	-	1	2	-
	%	-	0.9	0.3	-
	CPUE	-	0.9	0.8	-
White sucker	Catch	5	16	70	132
	%	8.9	14.0	11.0	28.8
	CPUE	3.3	13.7	26.7	68.4
Creek chubsucker	Catch	-	-	7	-
	%	-	-	1.1	-
	CPUE	-	-	2.7	-
Yellow bullhead	Catch	5	14	13	6
	%	8.9	12.3	2.0	1.3
	CPUE	3.3	12.0	5.0	3.1
Brown bullhead	Catch	-	5	9	4
	%	-	4.4	1.4	0.9
	CPUE	-	4.3	3.4	2.1
Rock bass	Catch	3	9	72	28
	%	5.4	7.9	11.3	6.1
	CPUE	2.0	7.7	27.5	14.5
Redbreast sunfish	Catch	5	19	193	65
	%	8.9	16.7	30.3	14.2
	CPUE	3.3	16.2	73.7	33.7
Green sunfish	Catch	7	21	45	14
	%	12.5	18.4	7.1	3.1
	CPUE	4.7	17.9	17.2	7.3
Pumpkinseed	Catch	11	8	32	29
	%	19.6	7.0	5.0	6.3
	CPUE	7.3	6.8	12.2	15.0
Bluegill	Catch	6	7	5	10
	%	10.7	6.1	0.8	2.2
	CPUE	4.0	6.0	1.9	5.2
Lepomis hybrid	Catch	1	3	7	8
	%	1.8	2.6	1.1	1.7
	CPUE	0.7	2.6	2.7	4.1
Smallmouth bass	Catch	3	2	163	151
	%	5.4	1.8	25.5	32.9
	CPUE	2.0	1.7	62.2	78.2
Largemouth bass	Catch	-	-	-	1
	%	-	-	-	0.2
	CPUE	-	-	-	0.5

Table 5.2-5. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P14540 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 1.50 Hrs	Jul 1.17 Hrs	Sep 2.62 Hrs	Nov 1.93 Hrs
White crappie	Catch	-	1	-	-
	%	-	0.9	-	-
	CPUE	-	0.9	-	-
Black crappie	Catch	1	1	-	2
	%	1.8	0.9	-	0.4
	CPUE	0.7	0.9	-	1.0

Table 5.2-6. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P20035 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 1.68 Hrs	Jul 1.40 Hrs	Sep 1.40 Hrs	Nov 1.45 Hrs
American eel	Catch	2	5	7	-
	%	1.0	2.7	3.6	-
	CPUE	1.2	3.6	5.0	-
Esox hybrid	Catch	1	-	-	1
	%	0.5	-	-	0.3
	CPUE	0.6	-	-	0.7
Goldfish	Catch	-	-	-	1
	%	-	-	-	0.3
	CPUE	-	-	-	0.7
Carp	Catch	6	29	12	6
	%	3.1	15.8	6.2	2.0
	CPUE	3.6	20.7	8.6	4.1
White sucker	Catch	18	65	61	77
	%	9.4	35.3	31.6	25.5
	CPUE	10.7	46.4	43.6	53.1
Creek chubsucker	Catch	-	-	2	1
	%	-	-	1.0	0.3
	CPUE	-	-	1.4	0.7
Yellow bullhead	Catch	4	2	4	5
	%	2.1	1.1	2.1	1.7
	CPUE	2.4	1.4	2.9	3.4
Brown bullhead	Catch	1	11	3	13
	%	0.5	6.0	1.6	4.3
	CPUE	0.6	7.9	2.1	9.0
Channel catfish	Catch	1	-	2	-
	%	0.5	-	1.0	-
	CPUE	0.6	-	1.4	-
Rock bass	Catch	14	3	9	28
	%	7.3	1.6	4.7	9.3
	CPUE	8.3	2.1	6.4	19.3
Redbreast sunfish	Catch	25	15	24	9
	%	13.1	8.2	12.4	3.0
	CPUE	14.9	10.7	17.1	6.2
Green sunfish	Catch	18	18	14	17
	%	9.4	9.8	7.3	5.6
	CPUE	10.7	12.9	10.0	11.7
Pumpkinseed	Catch	27	10	5	14
	%	14.1	5.4	2.6	4.6
	CPUE	16.1	7.1	3.6	9.7
Bluegill	Catch	45	12	13	27
	%	23.6	6.5	6.7	8.9
	CPUE	26.8	8.6	9.3	18.6
Lepomis hybrid	Catch	7	2	2	4
	%	3.7	1.1	1.0	1.3
	CPUE	4.2	1.4	1.4	2.8
Smallmouth bass	Catch	7	5	31	60
	%	3.7	2.7	16.1	19.9
	CPUE	4.2	3.6	22.1	41.4
Largemouth bass	Catch	2	2	4	33
	%	1.0	1.1	2.1	10.9
	CPUE	1.2	1.4	2.9	22.8
White crappie	Catch	-	3	-	3
	%	-	1.6	-	1.0
	CPUE	-	2.1	-	2.1

Table 5.2-6. Monthly relative abundance of target fishes from the Perkiomen Creek electrofished at P20035 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		May 1.68 Hrs	Jul 1.40 Hrs	Sep 1.40 Hrs	Nov 1.45 Hrs
Black crappie	Catch	13	2	-	3
	%	6.8	1.1	-	1.0
	CPUE	7.7	1.4	-	2.1

5.3 Creel Survey

Summary

1. A creel survey was conducted on the Perkiomen Creek between Schwenksville and Collegeville, Pennsylvania, from April through September, 1985.

2. Total fishing pressure estimated at bimonthly intervals summed to 10,232 angler-hours for the season. Fishing pressure peaked in early to mid-summer as in past years, and was similarly distributed along the stream.

3. Anglers caught fish at an overall rate of 1.66 fish/angler-hour. The total estimated catch, 13,926 fish, was lower than the catch in previous years, due mostly to less fishing pressure coupled with low catch rates early and late in the season.

4. Unidentified sunfish (caught and released) comprised almost one-half of the total catch; smallmouth bass, rock bass, and redbreast sunfish accounted for most of the remainder.

5. Redbreast sunfish comprised 55% of the angler harvest, which totalled 1,374 fish for the season. Harvest was especially low in August and September.

6. Characteristics of anglers (age, sex, and mode of stream access) and preferences for particular kinds of fish did not change appreciably from past determinations. Most fishing was conducted from shore by adult males, and was directed mostly toward "anything", "bass", "sunfish", and carp.

Introduction and Methods

A survey of recreational fishing on the Perkiomen Creek between Schwenksville and Collegeville in southeast Pennsylvania began in 1980 and was also conducted in 1981, 1983, and 1985. The creel survey reach contained Perkiomen Creek segments above, within, and below a reach that would be used to carry water diverted from the Delaware River at Point Pleasant, Pennsylvania. The proposed diversion reach extends from the confluence of East Branch Perkiomen Creek with Perkiomen Creek downstream to a water intake constructed in 1984 on Perkiomen Creek in Graterford, Pennsylvania.

The level of survey effort in 1985 was reduced to one-half the level used in previous surveys. The original sampling design (RMC 1984) was modified to estimate fishing pressure for bimonthly instead of monthly intervals. Other field and computational procedures did not change. Fishery characteristics that were investigated included 1) bimonthly fishing pressure

between stream meters 21100 and 11770, 2) bimonthly catch and harvest by species, and 3) information about preferred fish species, access, and the age and sex composition of anglers. Creel survey data can augment studies of fish population dynamics and are useful in fisheries management. Baseline preoperational creel survey data would be of potential use in evaluating postoperational changes in the large fish community following diversion of Delaware River water into Perkiomen Creek.

Results and Disscussion

Fishing Pressure

Total fishing pressure estimated at bimonthly intervals (Table 5.3-1) summed to 10,232 angler-hr for the season. This total was below the average seasonal fishing pressure, 17,527 angler-hr, measured during 1980, 1981, and 1983 (RMC 1984). Fishing pressure peaked in early to mid-summer as in past years, and was similarly distributed along the stream. The greatest amount of fishing pressure occurred at the park and dam at Ott's Road and in the towns of Schwenksville, Graterford, and Collegeville. Nine anglers were observed near the Graterford Pumping Station, which accounted for 9% of the total number of anglers seen during the year (Table 5.3-2).

Possible reasons for the lighter fishing pressure in 1985 are unclear, but one is noteworthy. The nearby Green Lane Reservoir was opened to expanded public use in 1984, and a highly popular recreational fishery has developed there. Possibly, some anglers were attracted away from Perkiomen Creek by expansion of the Green Lane facility.

Catch and Harvest

Overall catch-per-unit-effort (CPUE) was 1.66 fish/angler-hr, only slightly above the previous maximum CPUE of 1.60 fish/angler-hr measured in 1980 (Table 5.3-1). Most fish were caught during June and July. Overall, the low total catch, estimated to be 13,926 fish, was a function of less fishing pressure coupled with relatively poor CPUE early and late in the season.

Unidentified (released) sunfish accounted for nearly one-half the total catch (Table 5.3-3). Smallmouth bass, rock bass, and redbreast sunfish accounted for most of the remainder. In all, only 10 species were taken by interviewed anglers, eight fewer than the average number of species caught in past years. The reduced survey design probably underestimated the number of species in the recreational catch because there were fewer opportunities to observe the catch of less common species.

Angler harvest was also lower than in past years (Table 5.3-3), both in terms of the total number of fish harvested and the percentage of total fish caught. Redbreast sunfish comprised 55% of the estimated harvest. Harvest was especially low in the last one-third of the season when only one black crappie was kept by the 13 anglers interviewed during August and September. The weight of seasonal harvest (Table 5.3-4) was only roughly estimated due to the low sample size, but it appeared that only the harvested weight of redbreast sunfish, black crappie, smallmouth bass, and rock bass exceeded 10 kg each for the season.

Characteristics of Anglers

Characteristics of anglers fishing on Perkiomen Creek in 1985, including their age, sex, and mode of access (Table 5.3-5), and preferences for particular kinds of fish (Table 5.3-6), did not change to an important degree from what was determined in previous creel surveys (RMC-Environmental Services 1984). Most fishing was conducted from shore by adult males, and was directed mostly toward "anything", "bass", "sunfish", and carp.

Table 5.3-1. Bimonthly estimates of fishing pressure with standard error and coefficient of variation (from angler counts), and catch-per-unit effort (CPUE) based on observed effort, total catch (includes released fish), and harvest (includes only fish kept) from angler interviews on Perkiomen Creek in 1985.

Fishing pressure

Bimonthly period	Number of survey trips	Fishing pressure (angler-hours)	Standard error	Coefficient of variation (%)
Apr-May	8	2167	1188	55
Jun-Jul	8	4042	946	23
Aug-Sep	8	4023	2321	58
Total	24	10232	--	Mean: 45

CPUE

Bimonthly period	Number of anglers interviewed	Observed effort (angler-hours)	Total catch	Total CPUE	Harvest	Harvest CPUE
Apr-May	27	31.2	27	0.87	9	0.29
Jun-Jul	50	71.6	158	2.21	9	0.13
Aug-Sep	13	16.7	13	0.78	1	0.06
Total	90	119.5	198	1.66	19	0.16

Table 5.3-2. Number of anglers interviewed at Perkiomen Creek access points during 1985.

Location	Meter Number	1985
Collegeville Dam	11789	11
Collegeville Houses	12399	3
Upper Collegeville Pool	13159	4
Above Rahns Road	14189	1
Intake Area	14399	4
Intake Pool	15299	2
Graterfoor RR Bridge	15309	2
Bridge St. Graterford	15469	6
Above Graterford	17349	6
Otts Road & Dam Complex	17469	30
East Branch Confluence	18259	1
Above East Branch	18829	2
Highway 23 Bridge	18899	7
Schwenksville Dam	19259	2
Schwenksville Dock	19269	12
Schwenksville	19899	1
Schwendsville Bridge	19949	2
Control Site	21000	1
		97

Table 5.3-3. Bimonthly species composition and estimated number of fish in the total catch and harvest by anglers fishing the Perkiomen Creek creel survey area in 1985.

Bimonthly period:	Apr-May		Jun-Jul		Aug-Sep		Total	
Species	Total Catch	Harvest	Total Catch	Harvest	Total Catch	Harvest	Total Catch	Harvest
White sucker	-	-	169	-	-	-	169	-
Carp	208	-	56	-	-	-	264	-
Fallfish	-	-	56	-	-	-	-	56
Pumpkinseed	417	69	-	-	241	-	658	69
Green sunfish	69	-	-	-	-	-	69	-
Redbreast sunfish	486	417	621	339	241	-	1348	756
Unidentified sunfish	278	-	4743	-	1686	-	6707	-
Rock bass	139	139	1355	56	-	-	1494	195
Black crappie	-	-	-	-	241	241	241	241
Unidentified crappie	-	-	56	-	-	-	56	-
Smallmouth bass	278	-	1807	113	723	-	2808	113
Largemouth bass	-	-	56	-	-	-	-	-
Total	1875	625	8919	508	3132	241	13926	1374

Table 5.3-4. Estimated weight by species of angler harvest from Perkiomen Creek in 1985.

Species	Number in creel	Average weight per fish(g)	Estimated number harvested	Weight of harvest(kg)
Pumpkinseed	1	24	69	1.7
Redbreast sunfish	12	125	756	94.5
Rock bass	3	102	195	19.9
Black crappie	1	240	241	57.8
Smallmouth bass	2	183	113	20.7

Table 5.3-5. Number of anglers classified by age and sex, and number of parties classified by mode of access, observed during the Perkiomen Creek creel survey in 1985.

	1985	
Sex	Number	%
Males	86	96
Females	4	4
	90	100
Age(Years)		
Child (<13)	10	11
Teen (13-19)	11	12
Adult (20-64)	68	76
Senior (>64)	1	1
	90	100
Mode of Access		
Boat	11	11
Bridge	1	1
Shore	70	72
Wading	15	15
	97	100

Table 5.3-6. Preferred fishes of Perkiomen Creek anglers during 1985.

Number of anglers identifying as:

Category	1st Choice	2nd Choice	Total
Bass	41	9	50
Anything	24	-	24
Carp	10	2	12
Sunfish	4	7	11
Catfish	6	1	7
Sucker	3	-	3
Crappie	2	-	2
Eel	-	2	2
Muskellunge	-	1	1

6.0 Schuylkill River

The Schuylkill River meanders 209 km from its source at Tuscarora Springs, Schuylkill County, Pennsylvania, to its confluence with the Delaware River at Philadelphia. The river cuts through portions of the Appalachian Mountain, Great Valley, Reading Prong, Triassic Lowland, Piedmont Upland, and Coastal Plain physiographic regions, and drains 4,972 km^2 of southeastern Pennsylvania. The river near the LGS site is productive and dependent to a large degree on allochthonous sources of energy as it is measurably heterotrophic most of the year.

The main effort of the ecological and water quality studies has focused on a 10-km reach of river which extends from river meter 72120 (Vincent Pool Dam, the only impoundment in the study area) to river meter 81750 (just above the Hooker Chemical Company, formerly Firestone Tire and Rubber Company plant). This reach includes both control (upriver of LGS) and potentially affected (downriver of LGS) sections. The river in this reach is about 100 m wide, low gradient (0.4-0.5 m/km), averages 53 m^3/s discharge, and has a predominantly gravel-rubble bottom. The study area is about 95% run habitat; riffle and pool habitats each account for about 2.5% of the study area and some backwater areas also are present. Limerick Island, situated at the cooling water intake location, is the only substantial island in the study area. It is wooded, about 300 m long and 100 m wide, and

divides the river into two channels near the plant intake and discharge structure. Occasional sampling was conducted outside the primary study area.

Sample stations on the Schuylkill River are designated by the letter 'S' followed by a number which indicates distance in meters from the mouth of the river. Where sample stations included several meters of stream, the numbers designate the downstream end of the station.

Ecological and water quality studies were conducted from 1973 through 1978 and are summarized in the LGS EROL (Section 2.2.2.1). Additional studies of water quality (1979-1984), benthic macroinvertebrates (1983 and 1984), and fishes (1980-1984) conducted on the Schuylkill River were reported in subsequent progress reports (RMC-Environmental Services 1984 and 1985). The results of these studies conducted in 1985 are reported below.

LGS received its full power operating license in August 1985 and began to operate at increasing levels of power generation until full power operation (100% power generation) was reached on 26 December. An event of potential significance to the Schuylkill River fisheries programs, a fish kill associated with heavy rainfall, occurred on the Schuylkill River between 31 July and 2 August 1985. The cause(s) of the fish kill remain

speculative. Three hypotheses concerning the causes that were suggested by various individuals employed by the Pennsylvania Fish Commission and Pennsylvania Department of Environmental Resources were as follows:

1. leakage of ethyl benzene from an industrial plant in Reading (or washing of previous leakage from the banks of the river).

2. dumping of raw sewage by a municipal sewage treatment plant from 1400 hours on Wednesday, 31 July to 0200 hours on 1 August.

3. pumping of oil residues from a tank an industrial plant in Pottstown and/or run-off of oil residues from this property caused by rainfall.

Of these three possible causes the last one seemed the most likely, but no conclusive evidence was collected.

The magnitude of the fish kill was great. An estimated 1000 large dead fish were observed by an RMC biologist on the morning of 2 August at 0930 hours in the general vicinity of Cromby Generating Station. Another biologist reported approximately 500 dead fish in Vincent Pool at 1400 hours on Saturday, 3 August. These fish were of various species, predominantly white sucker, but also included redbreast sunfish, bullheads, smallmouth bass, and other species. The kill appeared to have been selective for

larger fish, possibly resulting from either the greater volumes of water required by larger fish for respiration, or by the position of large fish in the main channel to where the toxic substances may have been somewhat restricted.

6.1 Water Quality

Summary

1. Monitoring of Schuylkill River water quality was continued on a biweekly basis in 1985. Subsurface grab samples were obtained at two stations, one 200 m upstream of the LGS intake and the other some 200 m below the discharge.

2. The longest period of sustained low flow since the program was initiated occurred in 1985. In addition, water temperatures were above average for several months.

3. New minimum and maximum values were recorded for several parameters. Most of the new extremes were associated with the unusually low flows and occasional high flow events, and most were just slightly outside of the previously established ranges.

4. Several of the new maximum values occurred simultaneously at both sample stations. Those that did not were examined for possible LGS effect. The data from this program show that the LGS influence, if any, on water quality, was minimal.

Introduction and Methods

Water quality studies of the Schuylkill River in relation to LGS were initiated in May 1974 and continued through 1985. Data obtained in 1985, are summarized in this third post-EROL progress report. The objectives of this program are to monitor ambient water quality in order to provide data to complement concurrent aquatic ecological studies and to evaluate water quality changes in the Schuylkill River in relation to LGS operation.

As in previous years, two sample stations were monitored in 1985: Station S77660 approximately 200 m upstream of the LGS intake, and S77140 520 m downstream of S77660 and approximately 200 m below the LGS discharge. Sampling began on 2 January and both stations were sampled once every 2 wk. Subsurface grab samples were collected by wading off the Montgomery County shore to mid-channel or, in cases of high flow, to just offshore. Analyses were performed according to standard, widely accepted methods.

Results and Discussion

The 1985 monitoring period included the longest period of sustained low flow since the water quality program began in 1974 (Tables 6.1-1 and 6.1-2). Comparison with discharge data for the period 1970-1985 indicates that 1985 accounted for new low flow

minima in five months (April-August). In addition, the mean monthly flows in 1985 were lower than the overall 1970-1985 mean monthly flows in every month but November. Median flows for 1985 were lower than the corresponding 1970-1985 medians in every month.

Schuylkill River temperatures were also above average for most months in 1985 when compared to long term (1970-1985) averages (Tables 6.1-3 and 6.1-4).

Seasonal summaries of water quality data for upriver (control) station S77660 for the post-EROL period 1979-1985 are included in Table 6.1-5 and for 1985 alone in Table 6.1-6. The data are indicative of a moderately hard, warmwater stream which is moderately polluted.

Several new minimum and maximum values were recorded in 1985 (Tables 6.1-7 and 6.1-8). Most of the new extremes were associated with the unusually low flows observed in 1985 and most were only slightly outside the previously observed ranges. An exception in the winter quarter was the new manganese maximum which was just 0.02 mg/l greater than the previously established range. It occurred on the day for which the highest flow of the quarter was measured.

An exception in the spring quarter was the low dissolved oxygen observed on 24 April which was 3 mg/l lower than the

previous minimum. This extreme occurred during a period of unusually low river flow for April and on a day when the water temperature (Table 6.1-3) was relatively high. Additional dissolved oxygen data obtained during the course of other LGS environmental monitoring program elements on this date confirmed the occurrence of record-setting low dissolved oxygen conditions both above and below LGS. The new minimum iron concentration on this date and the new minimum manganese value in May were also related to the unusually low flows.

Also recorded for 24 April were new maxima for specific conductance, nitrite nitrogen, and orthophosphate phosphorous. These parameters vary inversely with flow and are reflective of high nutrient content wastewater discharges to the Schuylkill from upstream sources and reduced dilution under low flow conditions.

The co-occurrence of three new minima on 20 November was related to the high flow period during which sampling took place. Concentration of these parameters varies inversely with flow.

Seasonal summaries for downstream station S77140 are provided in Table 6.1-9 for the post-EROL period and in Table 6.1-10 for 1985. In general, the water quality at S77140 was very similar to that at S77660.

The new minimum and maximum values established for S77140 in 1985 are shown in Tables 6.1-11 and 6.1-12, respectively. Again, several of these values were just slightly outside of the previously observed ranges, and several of these occurrences took place at both sampling stations on the same date.

New maxima that did not occur simultaneously at both stations were examined for possible LGS effect. In the winter quarter the new maximum total coliform value was not accompanied by a similar high value at the upstream site and for the quarter overall the median value for S77140 was more than twice the median for S77660. In the spring and summer quarters the total coliform concentrations were very similiar and in the fall quarter a higher value was recorded for the upriver site.

Except for potassium in the spring quarter all new maxima and nitrite nitrogen, corresponded to new maxima at the upriver site. On 24 April the new maximum potassium concentration of 3.1 mg/l at S77140 was less than the value (3.6 mg/l) recorded for S77660. The new nitrite nitrogen maximum at the downstream site (0.207 mg/l) was higher than the value for S77660 (0.114 mg/l), but still at least an order of magnitude below levels that might prove harmful to fishes.

Only two new maxima that did not occur simultaneously at both stations were observed in the summer quarter. The high pH of

9.19 on 2 July at S77140 was accompanied by a similarly high value of 9.05 at S77660. Each value exceeded slightly both the Pennsylvania water quality standard level of 9.0 and the National Secondary Drinking-Water Regulation maximum of 8.5. Chloride concentrations were elevated at both stations on 28 August when the new maximum of 43.7 mg/l was recorded at S77140 and 40.5 mg/l was determined for S77660. Although this chloride level is a new maximum for the water quality program, it is not high when compared to the National Secondary Drinking-Water Regulations which specify 250 mg/l as the maximum contaminant level for chloride.

In the fall quarter, the two new chemical parameter maxima at S77140 without corresponding new maxima at S77660 were potassium and copper. In the case of potassium, the value at the upstream station on 25 September equalled the established maximum (5.5 mg/l) recorded prior to 1985. Potassium concentrations as low as these do not constitute a water quality problem. The copper concentration of 0.033 mg/l on 6 November occurred during a high flow event and corresponded to a value of 0.006 mg/l at S77660 on this date. While this value establishes a new maximum, it remains the lowest maximum of any of the other quarters. As a point of reference, the National Secondary Drinking-Water Regulations assign a maximum contaiminant level of 1.0 mg/l for copper.

In summary, the water quality data for 1985 often varied within or near established ranges. The early onset and extended duration of low flows together with occasional high flow events were reflected in the data. As determined by this program, the water quality effects, if any, due to LGS operation were minimal.

Table 6.1-1. Mean daily Schuylkill River discharge (cu ft/sec) measured at the Pottstown US Geological Survey gage in 1985.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	1580	957	1670	1180	510	851	564	3120	446	1450	481	6190
02	1900	1040	1490	1360	799	868	563	1420	363	1220	460	N/A
03	2000	880	1400	1200	4160	771	592	877	353	1770	442	N/A
04	1960	760	1330	1180	3710	936	676	701	450	1540	462	4740
05	1990	797	1570	1140	2700	897	572	617	495	1220	1100	3940
06	1920	746	1450	1130	2300	1200	537	474	476	1460	1260	3530
07	1820	755	1240	1120	2030	902	838	446	452	1240	1120	3050
08	1760	775	1170	1040	1680	818	622	877	484	1060	738	2720
09	1590	977	1200	1050	1480	808	649	819	615	931	652	2480
10	1460	1150	1120	983	1350	754	593	608	627	952	609	N/A
11	1490	731	1070	927	1280	699	518	504	498	913	591	2070
12	1450	3140	1320	920	1200	668	466	510	415	865	580	2150
13	1440	6230	1570	897	1270	621	423	499	424	829	671	2220
14	1400	4300	1330	858	1270	522	430	507	448	817	805	2290
15	1150	3180	1220	842	1030	517	490	472	426	810	1040	2110
16	1000	2050	1160	844	974	1130	620	438	418	735	1660	1980
17	1050	1780	1120	870	1170	1670	479	418	417	652	6770	1950
18	1090	1670	1100	805	1640	1270	451	388	408	581	5610	1870
19	1010	1600	1050	757	1280	1090	383	380	528	571	4410	1700
20	902	1690	988	771	1020	966	346	369	577	564	3260	1680
21	929	1540	977	750	943	926	326	375	584	554	2390	1690
22	1260	1470	939	715	956	751	339	323	593	570	N/A	N/A
23	1430	1730	988	688	924	686	390	287	616	568	3260	1650
24	1270	2070	1080	659	955	700	355	276	484	580	2600	N/A
25	1120	2220	1130	657	848	645	358	618	434	641	2330	N/A
26	1080	2370	1180	636	771	585	700	810	435	708	N/A	1480
27	1060	2190	945	612	726	551	1270	674	7810	607	3680	N/A
28	999	1840	898	577	718	544	1100	555	7450	575	5540	N/A
29	994		937	556	757	638	687	466	2940	553	6440	N/A
30	985		960	533	750	786	493	419	1880	515	5470	N/A
31	956		934		702		931	463		478		1250
Minimum	902	731	898	533	510	517	326	276	353	478	442	1250
Mean	1356	1809	1179	875	1352	826	573	636	1085	856	2301	2511
Median	1270	1635	1130	851	1030	779	537	499	480	735	1190	2110
Maximum	2000	6230	1670	1360	4160	1670	1270	3120	7810	1770	6770	6190

Table 6.1-2. Mean monthly Schuylkill River discharge (cu ft/sec) measured at the Pottstown US Geological Survey gage, 1970 - 1985.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	982	3717	2217	4889	1613	1175	1459	1045	540	32	96	51
1971	49	145	111	45	54	39	21	64	46	1017	2796	2992
1972	2429	2692	4253	2389	2952	7634	2721	825	609	768	3510	4872
1973	3928	3734	2386	4799	3181	3095	2141	1408	1609	1030	1006	4733
1974	3343	2315	2911	4030	1916	1143	843	697	1478	833	766	2660
1975	2962	3402	3718	3249	2645	2500	3189	1399	3433	3348	3263	2025
1976	4953	3619	2588	2556	2002	1686	1562	1124	1033	3870	1716	1428
1977	731	1513	5497	3534	1490	852	795	822	720	2206	3192	5213
1978	5418	1897	5451	2526	3822	1538	1012	1683	949	904	837	2158
1979	7383	4097	4144	2720	2621	1399	991	814	2112	3235	1960	1932
1980	1394	834	3029	3497	2412	1007	611	483	457	487	525	419
1981	316	2933	1101	1675	1687	1230	1080	450	452	505	666	881
1982	1907	2786	2154	3043	1550	4171	1480	993	619	631	936	1320
1983	1392	2807	3535	7820	2654	2169	894	514	357	852	2543	6805
1984	1728	4093	3078	5065	4952	3105	3940	1604	782	743	858	1788
1985	1356	1809	1179	875	1352	826	573	636	1085	856	2301	2511
Minimum	26	19	60	32	29	20	16	19	24	12	24	36
Mean	2517	2651	2960	3294	2306	2098	1457	910	1017	1332	1683	2614
Median	1639	2070	2430	2687	1950	1375	994	756	607	811	991	1800
Maximum	37800	24600	20600	27400	22600	71200	17100	5670	18600	13000	10400	30100

Table 6.1-3. Daily Schuylkill River temperature (C) measured at the Pottstown Water Treatment Plant in 1985.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	10	4	9	14	17	22	24	26	25	21	15	13
02	10	4	8	12	19	22	23	26	25	21	15	13
03	10	3	9	12	18	23	23	26	25	21	15	13
04	10	5	9	10	15	24	23	26	25	20	15	13
05	10	4	9	10	15	23	23	26	26	18	15	13
06	10	3	11	13	15	23	24	26	26	17	14	11
07	9	3	9	13	17	21	25	26	27	17	14	10
08	7	4	9	13	18	21	25	26	27	17	14	9
09	7	4	10	13	17	21	25	26	27	15	16	11
10	6	5	10	13	17	21	25	26	27	15	16	12
11	5	5	10	13	18	22	25	26	27	16	15	12
12	6	5	10	13	19	22	25	26	25	16	15	10
13	8	5	11	13	20	23	26	26	24	18	15	10
14	5	4	11	13	21	23	26	27	23	18	16	10
15	6	6	11	14	21	22	26	27	22	19	16	9
16	6	5	11	14	22	22	26	27	22	19	16	8
17	4	5	10	14	21	22	26	28	22	10	15	8
18	4	5	9	15	22	22	26	28	22	18	15	8
19	5	6	10	15	21	22	26	27	20	18	14	7
20	4	7	10	17	21	22	26	27	20	18	14	7
21	3	7	10	17	21	23	26	27	20	18	14	6
22	4	6	11	16	21	22	27	25	20	18	15	5
23	4	7	10	17	22	23	26	25	21	18	14	5
24	4	7	10	21	22	23	26	25	21	18	14	6
25	4	9	11	17	20	24	26	25	21	18	14	5
26	5	9	12	17	20	24	26	25	22	17	13	5
27	6	10	12	17	20	24	26	26	22	18	13	5
28	6	10	12	17	20	24	25	26	22	17	13	6
29	5		14	17	22	24	26	26	22	16	13	5
30	3		14	17	22	24	26	26	22	16	13	5
31	4		14		22		26	26		16		5
Minimum	3	3	8	10	15	21	23	25	20	10	13	5
Mean	6	6	11	15	20	23	25	26	23	17	15	9
Median	6	5	10	14	20	23	26	26	22	18	15	8
Maximum	10	10	14	21	22	24	27	28	27	21	16	13

Table 6.1-4. Mean monthly Schuylkill River temperature (C) measured at the Pottstown Water Treatment Plant, 1970 - 1985.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	4	5	7	11	19	23	25	26	25	19	14	8
1971	5	6	9	14	18	24	27	25	24	19	13	10
1972	8	6	9	13	18	22	24	26	24	17	12	9
1973	7	6	10	13	16	22	25	26	24	19	13	10
1974	7	6	9	13	19	23	26	27	23	17	13	8
1975	7	6	9	11	18	22	24	26	21	16	12	8
1976	5	6	10	15	19	24	25	25	22	16	9	6
1977	4	5	10	14	19	22	27	26	24	17	14	7
1978	6	5	7	13	15	23	26	26	24	19	15	9
1979	6	2	7	14	19	22	25	26	23	17	13	8
1980	5	5	7	12	17	21	25	27	24	16	10	5
1981	3	5	8	13	17	22	25	25	22	15	10	5
1982	5	8	9	12	18	20	24	24	22	17	13	9
1983	6	6	9	10	16	21	25	26	24	18	11	8
1984	5	7	8	12	15	21	23	24	21	17	12	9
1985	6	6	11	15	20	23	25	26	23	17	15	9
Minimum	1	0	0	7	11	15	19	22	16	10	6	3
Mean	5	6	9	13	18	22	25	26	23	17	12	8
Median	5	6	9	13	18	22	25	26	23	17	13	8
Maximum	12	18	14	22	25	28	30	29	29	23	19	13

Table 6.1-5. Summary of Schuylkill River water quality at Station 577660, 20 March 1979 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	4.0	11.0	21.5	14.0	23.5	30.0	3.0	15.8	24.0	163
Dissolved Oxygen (mg/l)	6.6	11.0	14.4	3.2	10.2	13.4	5.0	8.0	15.4	5.8	9.0	12.4	173
Biochemical Oxygen Demand (mg/l)	0.9	2.8	7.1	1.0	2.8	6.2	1.1	2.7	7.3	0.9	1.9	5.9	176
Chemical Oxygen Demand (mg/l)	0.0	12.2	197.5	0.0	11.5	53.9	0.0	11.1	46.9	0.0	13.2	39.5	175
Total Organic Carbon (mg/l)	0.0	3.4	20.9	0.0	2.4	15.3	0.0	3.2	19.0	0.0	3.6	30.6	169
pH	7.06	7.58	8.20	7.15	7.62	8.99	7.23	7.85	9.09	7.38	7.66	8.65	176
Total Alkalinity (mg/l)	14.2	64.2	130.6	28.9	54.3	71.3	2.7	73.4	105.5	14.2	83.9	126.9	176
Total Hardness (mg/l)	64.6	122.7	687.1	37.0	104.0	156.4	88.7	136.3	786.6	83.7	169.8	255.0	175
Specific Conductance (usm/cm)	159	316	537	181	277	386	215	363	550	224	437	581	176
Total Suspended Solids (mg/l)	0	5	238	0	12	36	0	9	273	0	2	42	176
Total Dissolved Solids (mg/l)	127	231	388	101	218	346	77	290	495	138	299	425	175
Total Inorganic Carbon (mg/l)	16.7	71.2	142.1	31.5	58.5	76.8	2.9	69.0	108.2	15.3	86.9	132.7	98
Chloride (mg/l)	12.0	23.6	62.0	9.3	18.6	50.2	8.8	25.0	41.2	10.8	35.1	51.5	176
Sulfate (mg/l)	33.0	62.7	146.0	25.9	54.2	105.9	28.0	79.0	141.9	30.9	90.6	141.9	176
Sodium (mg/l)	8.70	17.40	46.90	7.15	13.87	29.30	6.43	19.20	38.20	9.48	26.90	40.40	176
Potassium (mg/l)	1.9	3.0	4.8	1.5	2.2	4.3	1.4	2.7	7.0	1.2	3.8	5.5	176
Calcium (mg/l)	13.7	26.5	63.6	10.8	25.0	41.7	13.4	28.8	46.3	17.2	30.2	60.4	176
Magnesium (mg/l)	7.30	14.52	29.00	6.30	12.30	19.30	10.70	16.99	25.90	8.48	19.90	28.60	176
Ammonia Nitrogen (mg/l)	0.030	0.410	2.680	0.000	0.229	1.200	0.000	0.072	0.560	0.000	0.140	0.580	176
Nitrite Nitrogen (mg/l)	0.009	0.037	0.143	0.015	0.065	0.191	0.000	0.064	0.175	0.030	0.076	0.420	176
Nitrate Nitrogen (mg/l)	1.37	3.00	4.20	1.71	2.44	3.59	0.00	2.29	3.04	0.00	2.76	9.96	176
Total Phosphate Phosphorus (mg/l)	0.00	0.20	0.67	0.04	0.11	2.45	0.04	0.19	3.48	0.00	0.28	0.50	167
Ortho Phosphate Phosphorus (mg/l)	0.00	0.15	1.60	0.00	0.08	0.33	0.00	0.14	0.33	0.00	0.20	0.35	174
Chromium (mg/l)	0.001	0.009	0.075	0.001	0.008	0.139	0.002	0.007	0.194	0.000	0.008	0.104	175
Copper (mg/l)	0.000	0.006	0.048	0.001	0.008	0.031	0.000	0.007	0.295	0.000	0.006	0.030	176
Iron (mg/l)	0.00	0.30	6.83	0.10	0.42	1.32	0.00	0.27	3.75	0.00	0.18	1.42	176
Lead (mg/l)	0.000	0.002	0.028	0.000	0.004	0.041	0.000	0.002	0.171	0.000	0.000	0.028	176
Manganese (mg/l)	0.05	0.23	0.76	0.09	0.23	0.68	0.00	0.09	0.41	0.00	0.05	0.29	176
Zinc (mg/l)	0.00	0.04	0.81	0.01	0.03	1.20	0.00	0.02	8.34	0.00	0.02	0.62	176
Cyanide (mg/l)	0.000	0.000	0.008	0.000	0.000	0.009	0.000	0.000	0.004	0.000	0.000	0.007	174
Phenols (mg/l)	0.000	0.000	0.030	0.000	0.000	0.019	0.000	0.000	0.020	0.000	0.000	0.050	175
Trichloroethylene (ug/l)	0.0	0.0	3.9	0.0	0.0	6.2	0.0	0.0	8.2	0.0	0.0	3.2	147
Total Coliforms (c/.1l)	4	2600	62000	151	3200	116000	60	7300	67000	140	6600	138000	173
Fecal Coliforms (c/.1l)	0	270	61000	10	395	12100	3	1378	43000	10	465	30500	171

Table 6.1-6. Summary of Schuylkill River water quality at Station S77660, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	1.8	8.0	8.0	11.0	21.5	20.0	26.0	29.5	11.3	16.4	24.0	26
Dissolved Oxygen (mg/l)	6.6	10.5	13.2	3.2	8.9	13.4	5.6	11.7	15.2	8.0	8.3	10.8	23
Biochemical Oxygen Demand (mg/l)	1.0	2.2	7.1	1.1	2.8	4.4	1.1	1.9	4.0	1.2	1.8	4.0	26
Chemical Oxygen Demand (mg/l)	8.0	14.4	22.8	13.9	14.7	19.9	9.2	12.0	22.6	0.0	24.1	39.5	26
Total Organic Carbon (mg/l)	1.7	2.5	3.5	2.5	2.6	3.5	2.9	4.3	4.9	3.7	4.2	4.8	26
pH	7.06	7.61	8.13	7.26	7.63	8.99	7.50	8.34	9.09	7.54	8.07	8.19	26
Total Alkalinity (mg/l)	46.4	64.2	79.3	51.1	65.3	71.3	69.7	79.0	96.3	63.3	87.4	116.6	26
Total Hardness (mg/l)	64.6	115.9	149.9	92.1	108.2	126.9	111.0	133.2	166.2	83.7	123.8	151.0	26
Specific Conductance (usm/cm)	193	276	373	223	319	386	329	385	453	235	391	440	26
Total Suspended Solids (mg/l)	0	13	100	1	4	5	0	8	11	1	6	26	26
Total Dissolved Solids (mg/l)	133	165	216	179	222	292	202	309	399	138	258	355	25
Chloride (mg/l)	12.7	25.7	34.2	20.4	26.1	31.2	25.1	37.0	40.5	18.1	35.8	43.2	26
Sulfate (mg/l)	33.6	51.6	73.2	40.0	57.4	69.7	62.6	72.5	114.0	30.9	63.3	73.4	26
Sodium (mg/l)	9.23	15.95	23.78	16.99	18.90	22.67	17.88	23.41	30.34	10.65	25.74	30.17	26
Potassium (mg/l)	2.4	2.7	4.3	2.5	2.9	3.6	3.1	3.8	5.1	2.9	4.1	5.5	26
Calcium (mg/l)	17.2	24.3	36.2	31.5	35.4	37.1	33.9	44.2	46.3	25.9	39.1	48.2	26
Magnesium (mg/l)	8.33	14.22	16.35	10.54	14.12	16.06	13.77	17.17	19.96	9.60	17.78	19.55	26
Ammonia Nitrogen (mg/l)	0.151	0.366	1.552	0.195	0.333	0.617	0.039	0.117	0.199	0.163	0.210	0.285	26
Nitrite Nitrogen (mg/l)	0.030	0.044	0.083	0.042	0.096	0.191	0.044	0.062	0.175	0.053	0.098	0.116	26
Nitrate Nitrogen (mg/l)	2.32	2.89	4.03	1.85	2.48	2.74	1.62	2.25	2.77	1.83	2.87	3.22	26
Total Phosphate Phosphorus (mg/l)	0.12	0.18	0.44	0.11	0.17	0.41	0.21	0.28	0.40	0.18	0.26	0.35	25
Ortho Phosphate Phosphorus (mg/l)	0.06	0.12	0.20	0.04	0.09	0.33	0.19	0.25	0.33	0.10	0.22	0.27	24
Chromium (mg/l)	0.004	0.007	0.023	0.004	0.006	0.017	0.004	0.007	0.011	0.004	0.008	0.010	26
Copper (mg/l)	0.003	0.006	0.038	0.004	0.005	0.007	0.002	0.004	0.012	0.004	0.006	0.007	26
Iron (mg/l)	0.20	0.41	4.08	0.10	0.15	0.28	0.00	0.15	0.28	0.00	0.32	0.74	26
Lead (mg/l)	0.000	0.002	0.022	0.000	0.001	0.003	0.000	0.001	0.005	0.000	0.001	0.004	26
Manganese (mg/l)	0.12	0.16	0.76	0.09	0.14	0.25	0.00	0.00	0.21	0.00	0.12	0.18	26
Zinc (mg/l)	0.00	0.05	0.08	0.01	0.03	0.07	0.01	0.01	0.02	0.00	0.02	0.02	26
Cyanide (mg/l)	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.001	0.002	26
Phenols (mg/l)	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (c/.1l)	300	8400	50000	800	1050	2100	200	800	2000	1800	10500	21500	25
Fecal Coliforms (c/.1l)	0	170	6000	10	60	400	3	40	170	80	260	4300	25

Table 6.1-7. New minimum values observed for water quality parameters measured in 1985 at Station S77660 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Dissolved Oxygen (mg/l)	6.6	01/16/85
	pH	7.06	01/16/85
	Total Hardness (mg/l)	64.6	12/04/85
	Fecal Coliforms (c/.1l)	0	02/27/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	3.2	04/24/85
	Iron (mg/l)	0.10	04/24/85
	Manganese (mg/l)	0.09	05/22/85
	Fecal Coliforms (c/.1l)	10	03/27/85
Jun, Jul, Aug	Iron (mg/l)	0.00	07/02/85
	Fecal Coliforms (c/.1l)	3	07/17/85
Sep, Oct, Nov	Total Hardness (mg/l)	83.7	11/20/85
	Total Dissolved Solids (mg/l)	138	11/20/85
	Sulfate (mg/l)	30.9	11/20/85

Table 6.1-8. New maximum values observed for water quality parameters measured in 1985 at Station S77660 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Biochemical Oxygen Demand (mg/l)	7.1	02/13/85
	Manganese (mg/l)	0.76	02/13/85
Mar, Apr, May	Temperature (C)	21.5	05/22/85
	Dissolved Oxygen (mg/l)	13.4	04/11/85
	pH	8.99	03/27/85
	Total Alkalinity (mg/l)	71.3	03/27/85
	Specific Conductance (usm/cm)	386	04/24/85
	Nitrite Nitrogen (mg/l)	0.191	04/24/85
	Ortho Phosphate Phosphorus (mg/l)	0.33	04/24/85
Jun, Jul, Aug	pH	9.09	07/17/85
	Calcium (mg/l)	46.3	08/14/85
	Nitrite Nitrogen (mg/l)	0.175	06/19/85
	Ortho Phosphate Phosphorus (mg/l)	0.33	07/31/85
Sep, Oct, Nov	Chemical Oxygen Demand (mg/l)	39.5	10/09/85

Table 6.1-9. Summary of Schuylkill River water quality at Station S77140, 20 March 1979 through 18 December 1985.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	4.0	11.0	21.5	14.0	24.0	30.0	3.5	15.8	24.5	163
Dissolved Oxygen (mg/l)	6.1	11.0	13.8	3.1	10.6	13.9	4.7	8.1	15.0	5.6	9.1	12.6	175
Biochemical Oxygen Demand (mg/l)	0.9	2.9	8.4	0.7	2.8	7.6	1.1	2.8	7.1	0.8	2.0	5.8	176
Chemical Oxygen Demand (mg/l)	0.0	12.6	196.6	0.0	11.5	56.2	0.0	11.7	64.5	0.0	12.3	37.7	174
Total Organic Carbon (mg/l)	0.0	2.8	18.7	0.0	2.3	16.3	0.0	4.2	20.0	0.0	3.0	29.3	168
pH	7.01	7.59	8.21	7.22	7.63	8.98	6.91	7.81	9.19	7.24	7.74	8.67	176
Total Alkalinity (mg/l)	8.9	63.9	172.1	27.7	54.8	73.7	4.3	71.0	102.9	49.1	87.9	130.7	175
Total Hardness (mg/l)	65.5	123.7	675.2	51.9	107.7	160.6	69.2	143.3	724.9	83.5	173.0	448.0	174
Specific Conductance (usm/cm)	156	315	611	157	272	387	215	360	518	223	431	577	176
Total Suspended Solids (mg/l)	0	5	232	0	13	55	0	8	280	0	3	43	175
Total Dissolved Solids (mg/l)	131	220	509	135	207	338	160	275	445	141	304	419	175
Total Inorganic Carbon (mg/l)	23.2	70.0	184.1	29.7	58.1	74.6	4.7	67.8	106.0	56.2	87.0	136.1	97
Chloride (mg/l)	11.7	24.2	62.4	9.5	18.3	51.3	8.8	24.7	43.7	10.6	33.7	51.3	175
Sulfate (mg/l)	33.6	62.4	185.2	30.9	53.5	99.7	28.0	78.0	144.6	32.4	87.6	152.2	175
Sodium (mg/l)	8.70	17.59	62.00	4.90	13.85	29.12	6.74	19.96	36.00	9.07	26.91	38.60	176
Potassium (mg/l)	1.9	3.0	6.5	0.8	2.1	3.1	1.4	2.8	8.0	1.2	3.9	6.4	176
Calcium (mg/l)	14.1	26.2	83.5	5.9	25.3	44.3	13.0	31.2	69.7	17.4	32.0	62.4	176
Magnesium (mg/l)	8.00	13.92	35.80	3.60	12.25	20.30	10.20	17.20	28.93	9.12	20.20	26.90	176
Ammonia Nitrogen (mg/l)	0.000	0.420	2.470	0.000	0.205	1.480	0.000	0.080	0.490	0.000	0.110	0.580	176
Nitrite Nitrogen (mg/l)	0.008	0.039	0.138	0.023	0.070	0.207	0.000	0.066	0.190	0.030	0.071	0.900	175
Nitrate Nitrogen (mg/l)	1.40	3.02	4.80	1.60	2.37	3.63	0.00	2.34	4.38	0.03	2.68	4.68	175
Total Phosphate Phosphorus (mg/l)	0.02	0.20	0.85	0.03	0.13	0.89	0.04	0.21	3.48	0.00	0.28	2.24	166
Ortho Phosphate Phosphorus (mg/l)	0.00	0.15	0.85	0.00	0.08	0.33	0.00	0.14	0.33	0.00	0.20	0.37	174
Chromium (mg/l)	0.002	0.010	0.060	0.002	0.008	0.068	0.000	0.007	0.070	0.000	0.008	0.036	175
Copper (mg/l)	0.000	0.008	0.072	0.001	0.007	0.039	0.000	0.007	0.055	0.000	0.006	0.033	176
Iron (mg/l)	0.00	0.28	7.45	0.11	0.45	1.54	0.00	0.24	4.48	0.00	0.17	1.68	176
Lead (mg/l)	0.000	0.001	0.025	0.000	0.002	0.014	0.000	0.001	0.022	0.000	0.000	0.019	176
Manganese (mg/l)	0.08	0.23	0.72	0.07	0.23	0.88	0.00	0.09	0.44	0.00	0.06	0.34	176
Zinc (mg/l)	0.00	0.04	0.70	0.00	0.03	0.89	0.00	0.03	2.56	0.00	0.02	0.16	176
Cyanide (mg/l)	0.000	0.000	0.010	0.000	0.000	0.009	0.000	0.000	0.018	0.000	0.000	0.007	174
Phenols (mg/l)	0.000	0.000	0.035	0.000	0.000	0.042	0.000	0.000	0.022	0.000	0.000	0.039	174
Trichloroethylene (ug/l)	0.0	0.0	3.6	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	3.4	147
Total Coliforms (c/.1l)	13	2200	69000	170	2900	107000	40	5900	77000	140	5900	150000	172
Fecal Coliforms (c/.1l)	0	330	55000	10	340	11500	2	708	63000	27	440	29000	172

Table 6.1-10. Summary of Schuylkill River water quality at Station S77140, 02 January 1985 through 18 December 1985.

Parameter	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	1.8	8.0	8.0	11.0	21.5	20.5	26.0	29.5	11.0	16.2	24.5	26
Dissolved Oxygen (mg/l)	6.1	9.6	13.5	3.1	10.7	12.8	4.7	11.3	12.3	8.2	8.7	10.8	25
Biochemical Oxygen Demand (mg/l)	2.0	3.0	7.1	1.4	2.5	3.9	1.1	1.7	3.5	1.2	2.1	4.1	26
Chemical Oxygen Demand (mg/l)	9.0	16.5	31.9	11.0	16.8	26.7	0.0	11.8	46.9	0.0	21.2	37.7	26
Total Organic Carbon (mg/l)	1.6	2.5	6.3	2.0	2.8	3.9	2.9	4.4	5.1	3.6	4.4	5.0	26
pH	7.01	7.56	8.11	7.52	7.93	8.98	7.58	8.42	9.19	7.60	8.09	8.35	26
Total Alkalinity (mg/l)	8.9	64.4	77.7	51.5	64.4	73.7	65.4	81.7	98.3	66.8	92.1	124.7	26
Total Hardness (mg/l)	65.5	115.9	148.9	90.6	112.0	124.0	119.2	133.2	173.4	83.5	131.4	170.6	26
Specific Conductance (usm/cm)	191	257	365	227	317	367	332	383	465	238	402	479	26
Total Suspended Solids (mg/l)	0	11	122	1	3	9	1	3	8	1	8	26	26
Total Dissolved Solids (mg/l)	131	176	217	195	213	266	189	324	303	190	300	331	26
Chloride (mg/l)	18.4	25.3	34.0	19.7	26.8	31.3	24.1	38.4	43.7	18.4	36.7	47.1	26
Sulfate (mg/l)	33.6	51.6	71.8	39.7	56.4	71.1	64.5	73.7	114.9	32.4	67.1	75.4	26
Sodium (mg/l)	9.51	16.12	24.48	16.21	19.23	20.74	18.17	23.79	30.81	10.93	26.23	32.51	26
Potassium (mg/l)	2.2	3.0	4.1	2.4	2.9	3.1	2.9	3.7	5.0	2.9	4.1	6.4	26
Calcium (mg/l)	16.0	24.4	32.2	30.8	32.6	38.0	34.7	40.6	49.9	26.5	40.7	55.8	26
Magnesium (mg/l)	8.80	12.83	16.08	11.09	13.87	15.94	14.10	17.20	19.90	9.71	18.78	21.00	26
Ammonia Nitrogen (mg/l)	0.158	0.375	0.790	0.117	0.308	0.536	0.039	0.097	0.167	0.158	0.207	0.268	26
Nitrite Nitrogen (mg/l)	0.030	0.043	0.084	0.042	0.098	0.207	0.041	0.058	0.169	0.054	0.102	0.139	26
Nitrate Nitrogen (mg/l)	2.38	2.72	3.48	1.88	2.39	2.75	1.63	2.25	2.79	2.00	2.65	3.79	26
Total Phosphate Phosphorus (mg/l)	0.13	0.18	0.51	0.12	0.20	0.42	0.22	0.29	0.38	0.16	0.26	0.29	25
Ortho Phosphate Phosphorus (mg/l)	0.06	0.12	0.23	0.03	0.10	0.33	0.19	0.26	0.33	0.13	0.21	0.33	24
Chromium (mg/l)	0.003	0.008	0.022	0.005	0.006	0.011	0.004	0.006	0.010	0.004	0.008	0.010	26
Copper (mg/l)	0.004	0.007	0.035	0.004	0.006	0.010	0.002	0.009	0.015	0.004	0.010	0.033	26
Iron (mg/l)	0.17	0.39	4.54	0.11	0.16	0.28	0.00	0.10	0.32	0.15	0.33	0.74	26
Lead (mg/l)	0.000	0.002	0.023	0.000	0.001	0.002	0.000	0.001	0.002	0.000	0.001	0.007	26
Manganese (mg/l)	0.12	0.18	0.72	0.07	0.14	0.25	0.00	0.05	0.24	0.00	0.09	0.19	26
Zinc (mg/l)	0.00	0.05	0.14	0.00	0.02	0.07	0.01	0.02	0.02	0.00	0.02	0.03	26
Cyanide (mg/l)	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.001	0.002	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (c/.1l)	200	18000	69000	800	1400	2900	300	750	1100	1500	7000	17000	24
Fecal Coliforms (c/.1l)	0	30	4300	10	105	900	2	55	350	90	215	3000	25

Table 6.1-11. New minimum values observed for water quality parameters measured in 1985 at Station S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Dissolved Oxygen (mg/l)	6.1	01/16/85
	pH	7.01	01/16/85
	Total Alkalinity (mg/l)	8.9	01/02/85
	Total Hardness (mg/l)	65.5	12/04/85
	Total Dissolved Solids (mg/l)	131	12/04/85
	Sulfate (mg/l)	33.6	12/04/85
	Zinc (mg/l)	0.00	12/04/85
	Fecal Coliforms (c/.1l)	0	01/30/85
Mar, Apr, May	Dissolved Oxygen (mg/l)	3.1	04/24/85
	Iron (mg/l)	0.11	03/27/85
	Manganese (mg/l)	0.07	05/22/85
	Zinc (mg/l)	0.00	04/11/85
	Fecal Coliforms (c/.1l)	10	03/27/85
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	4.7	07/31/85
	Fecal Coliforms (c/.1l)	2	07/17/85
Sep, Oct, Nov	Total Hardness (mg/l)	83.5	11/20/85
	Sulfate (mg/l)	32.4	11/20/85

Table 6.1-12. New maximum values observed for water quality parameters measured in 1985 at Station S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Manganese (mg/l)	0.72	02/13/85
	Total Coliforms (c/.1l)	69000	01/02/85
Mar, Apr, May	Temperature (C)	21.5	05/22/85
	pH	8.98	03/27/85
	Total Alkalinity (mg/l)	73.7	03/27/85
	Potassium (mg/l)	3.1	04/24/85
	Nitrite Nitrogen (mg/l)	0.207	04/11/85
	Ortho Phosphate Phosphorus (mg/l)	0.33	04/24/85
Jun, Jul, Aug	pH	9.19	07/02/85
	Chloride (mg/l)	43.7	08/28/85
	Ortho Phosphate Phosphorus (mg/l)	0.33	07/31/85
Sep, Oct, Nov	Temperature (C)	24.5	09/11/85
	Potassium (mg/l)	6.4	09/25/85
	Copper (mg/l)	0.033	11/06/85
	Chemical Oxygen Demand (mg/l)	37.7	10/09/85

6.2 Benthic Macroinvertebrates

Summary

1. Samples were collected at 4 stations on 28-29 January, 16 April, 10 July, and 8 October 1985.

2. In 1985, a total of 75 taxa was collected at all stations with 48-59 taxa collected at individual stations. Taxonomic composition was similar at all stations.

3. Total macroinvertebrate standing crop (mean number/m^2) was greatest at S78620. It was substantially lower at both S75770 and S76760, which were similar. Standing crop at these two stations was also usually lower than that measured at S77120.

4. Nearly the same taxa were numerically important at all stations. Certain taxa (Chironomidae, Crangonyx, and Oligochaeta) were present in the greatest numbers at two or more stations.

5. The macroinvertebrate communities present at all stations were not greatly changed from 1984 to 1985. Taxonomic composition, annual mean standing crop, and composition of the numerically important taxa generally were similar in both years.

6. Impacts due to LGS operation were evaluated by comparing data obtained on the one sample date (8 October) that followed granting of the full power operating license with that obtained during the same month in prior years. No effects on downriver macroinvertebrate communities were evident.

Introduction and Methods

Studies of the macroinvertebrate community of the Schuylkill River near LGS were conducted in 1970-1976 and resumed in late 1983. Data obtained during the earlier period were used in preparation of the EROL and those obtained in 1983-1984 were reported in subsequent progress reports (RMC-Environmental Services 1984 and 1985).

Presently (1983-1985), four sample stations are located in the vicinity of LGS, one upstream (S78620) and three at various distances downstream (S77120, S76760, and S75770). Three replicate samples are collected quarterly at each station using Buried Cylinder Samplers. Sample station location and all methods are fully described in the EROL (Section 6.1).

In 1985, samples were collected on 28-29 January, 16 April, 10 July, and 8 October. There was no deviation from the previously established sampling or sample handling methods.

Results and Discussion

1985

A total of 75 taxa was collected at all stations, including Oligochaeta (worms), Decapoda (crayfish), Ephemeroptera (mayflies), Plecoptera (stoneflies), Coleoptera (beetles), Trichoptera (caddisflies), Diptera (true flies), and Mollusca (snails and clams) (Table 6.2-1). Similar total numbers of taxa were collected at the four stations. In addition, taxonomic composition was very similar at all stations.

Total macroinvertebrate standing crop (mean number/m^2) was greatest at S78620 on all sample dates (Table 6.2-2). Standing crops at S75770 and S76760 were quite similar on several dates and usually lower than that observed at S77120.

Standing crop for each taxon measured in 1985 and the corresponding percent composition of the community are shown in Table 6.2-3. Although a large number of taxa were present at each station, only a few taxa were present in sufficiently large number to be considered numerically important (i.e., represented ≥2% of total numbers). Nearly the same taxa were numerically important at all stations. Chironomidae, Crangonyx, and Oligochaeta were present in the greatest numbers at two or more stations. Other taxa were numerically important at individual stations: S75770 - Gammarus, Goniobasis, Physa, Pisidium,

Stenacron, and Stenelmis; S76760 - Gammarus, Goniobasis, Pisidium and Stenacron; S77120 - Gammarus, Oligochaeta, Physa, and Pisidium; and S78620 - Cheumatopsyche, Physa, Simuliidae, Musculium, Pisidium, Stenacron, and Stenelmis.

Similar to what was observed in 1984 (RMC-Environmental Services 1985), the macroinvertebrate communities present at the sample stations in 1985 may be separated into 2 groups: S75770, S76760, and S77120; and S78620. The latter station's community may be distinguished from those present at the other locations by substantially higher standing crop of all taxa combined and Cheumatopsyche and Simuliidae in particular. The observed differences in communities between the groups of stations may be related to river current velocity. The current velocity is greatest at S78620 and would be expected to favor taxa that prefer such conditions, including Cheumatopsyche and Simuliidae.

1973-1976 and 1984-1985

The objective of this section is to compare data obtained in 1985 with that prepared previously (1973-1976 and 1984) to identify any changes in community structure that have taken place. During the 1970's samples were collected monthly, whereas in 1984 and 1985 they were collected quarterly. Therefore, in order to more properly compare data among the years, only particular 1970's data were used. These data represent only samples col-

lected on those calendar dates closest to the 1984 sample dates. These sample dates are listed in Table 6.2-4. The thrust of inter-year comparison is directed toward 1984-1985, although some reference to the previous years is made. Changes observed between the 1970's and 1984 were discussed in greater detail in the previous progress report (RMC-Environmental Services 1985).

The total number of taxa collected at all stations in 1985 was nearly the same as collected in 1976 and 1984 (Table 6.2-5). The taxonomic composition was quite similar in these years and in the earlier years (1973-1975) as well.

Compared to 1984, annual mean standing crop was slightly greater in 1985 at three stations and approximately two-thirds greater at the other (Table 6.2-6). Standing crop at all stations in these years was substantially larger than recorded in the 1970's.

There was little variation observed in the composition of those taxa considered numerically important at any station from 1984 to 1985 (Tables 6.2-7 through 10). However, changes in the standing crop of individual taxa resulted in shifts in relative importance among them at all stations. Cheumatopsyche, Ferrissia, Goniobasis, and Sphaerium declined substantially at three or more stations whereas Crangonyx, Gammarus, Physa, Pisidium, and Chironomidae increased substantially at three or

more stations. Other taxa declined (Argia, Oligochaeta, Gammarus, and Hydropsyche) or increased (Stenacron, Oligochaeta, Musculium, Simuliidae, and Stenelmis) greatly at fewer stations.

In summary, the macroinvertebrate communities present at the stations in 1985 were not greatly changed from those observed in 1984. Nearly the same taxa were present in both years and annual mean standing crop was only somewhat greater at several stations in 1985. Composition of the numerically important taxa was virtually unchanged at all stations from 1984 to 1985, although shifts in relative importance among them were observed.

LGS Operational Impacts

In order to describe any observed LGS operational impacts to the Schuylkill River benthic macroinvertebrate community, it is important to note that in 1985 the plant operated at greater than 5% capacity only after receipt of its full power license from the Nuclear Regulatory Commission on 8 August (see Section 6.0 Schuylkill River). Consequently, the only date on which samples were collected during the LGS operational period was 8 October. This date followed approximately 2 months of plant operation. Therefore, the following analysis of LGS impacts is preliminary in that it is based on samples collected on only one date.

Since operational period samples were collected only on 8 October, the resulting data were compared to those obtained from samples collected only in October during previous years. These dates are shown in Table 6.2-11. As in the previous section, data from the 1970's are presented. However, the 1980's data is emphasized in discussion.

The macroinvertebrate taxa collected in October in all years are shown in Table 6.2-12. A general increase in the number of taxa through the period 1975-1985 is evident. Nearly the same taxa were collected in 1984 and 1985.

Macroinvertebrate standing crop at three stations, including S78620 located upstream of the LGS discharge, was substantially lower in 1985 than in 1984 and more closely reflected measurements made in 1983 (Table 6.2-13). This reduced standing crop probably was the result of river bottom scouring by high flows associated with rains from Hurricane Gloria approximately one week before the sample date (see Section 6.1 Water Quality).

The numerically important taxa collected at all sample stations are shown in Tables 6.2-14 through 17. A fairly wide spread and great decline in standing crop among several of these taxa was observed. Standing crop of a number of taxa was substantially reduced at three or more stations, including S78620: Cheumatopsyche, Chirononomidae, Ferrissia, Hydropsyche, Physa,

Pisidium, and Gammarus. Seven other taxa greatly declined at only one or two stations. Although standing crop of other taxa substantially increased, the observed reductions were not balanced. Standing crop of only two taxa, Berosus and Crangonyx, substantially increased at three stations. Nine other taxa also substantially increased, but mostly at only one station. The observed fluctuation in standing crop of individual taxa from 1984 to 1985 resulted in change in relative numerical importance among them at individual stations. Such standing crop fluctuation and resultant reordering of numerical importance among the taxa were not phenomena restricted to only these years; they also were observed between all consecutive years at all stations.

In summary, it does not appear that the operation of LGS during the two months prior to the October sample date had any effect on the macroinvertebrate communities located downriver of the plant discharge. The total number of collected taxa and the taxonomic composition were similar before and after plant operation. Total standing crop was reduced both upriver and downriver of the plant discharge. Fluctuation in standing crop of individual numerically important taxa resulting in reordering of the relative importance among them occurred at all stations from 1984 to 1985 and this also was observed in previous years.

Table 6.2-1. Macroinvertebrate taxa collected in the Schuylkill River during 1985.

Taxon	S75770	S76760	S77120	S78620
Acroneuria				X
Alboglossiphonia	X	X	X	X
Allocapnia	X			X
Anax		X		
Ancyronyx	X		X	X
Argia	X	X	X	X
Asellus	X	X	X	X
Baetis		X		X
Berosus	X	X	X	X
Caenis			X	X
Cambarus	X			
Campeloma		X		
Ceratopogonidae	X	X	X	X
Cheumatopsyche	X	X	X	X
Chimarra	X	X		X
Chironomidae	X	X	X	X
Corydalus				X
Crangonyx	X	X	X	X
Dromogomphus		X	X	X
Dubiraphia	X	X	X	X
Dugesia	X	X	X	X
Ectopria		X	X	
Elliptio	X		X	
Empididae	X	X	X	X
Ephydridae			X	
Erpobdella	X	X	X	X
Ferrissia	X	X	X	X
Gammarus	X	X	X	X
Goniobasis	X	X	X	X
Gyraulus	X	X		X
Helisoma	X	X	X	X
Helobdella	X	X	X	X
Hydrolimax	X	X	X	X
Hydropsyche	X	X	X	X
Hydroptila	X		X	X
Ischnura	X	X	X	X
Isonychia		X		X
Lampsilis	X			
Lanthus		X	X	X
Lepidostoma			X	X
Limnophila		X		
Lymnaea	X	X	X	X
Macromychus			X	
Manayunkia		X	X	X
Musculium	X	X	X	X
Nigronia			X	X
Oecetis	X	X		X
Oligochaeta	X	X	X	X
Optioservus	X	X	X	X
Orconectes	X	X	X	X
Parargyractis		X		X
Pericoma			X	
Phasganophora		X	X	X
Physa	X	X	X	X
Pisidium	X	X	X	X
Polycentropus				X
Prostoma	X	X	X	X
Protoptila	X	X	X	X
Psephenus	X	X	X	X
Ptilostomis		X		
Sialis	X	X	X	X
Simuliidae	X	X	X	X
Sphaerium	X		X	X
Stenacron	X	X	X	X
Stenelmis	X	X	X	X
Stenonema	X	X		X
Stratiomyiidae		X		
Stygobromus			X	
Tabanidae		X		
Telmatoscopus			X	
Tetragoneuria			X	
Tipula	X	X	X	X
Tipulidae				X

Table 6.2-1. Macroinvertebrate taxa collected in the Schuylkill River during 1985.

Taxon	S75770	S76760	S77120	S78620
Triaenodes	X	X	X	X
Tricorythodes	X	X	X	X
Total Number of Taxa	48	55	55	59

Table 6.2-2. Total macroinvertebrate standing crop (mean number/sq. meter) measured in the Schuylkill River during 1985.

Date	S75770	S76760	S77120	S78620
Jan	13174.9	19661.2	29431.7	44765.0
Apr	7191.3	4644.8	17038.3	42016.4
Jul	26092.9	29114.8	28163.9	45683.1
Oct	5169.4	5803.3	7857.9	22551.9
Mean	12907.1	14806.0	20623.0	38754.1

Table 6.2-3. Macroinvertebrate standing crop (mean number/sq. meter) measured in the Schuylkill River during 1985.

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Acroneuria	-	-	-	-	-	-	9.6	+
Alboglossiphonia	8.2	+	2.7	+	1.4	+	61.5	0.2
Allocapnia	1.4	+	-	-	-	-	1.4	+
Anax	-	-	1.4	+	-	-	-	-
Ancyronyx	2.7	+	-	-	2.7	+	10.9	+
Argia	24.6	0.2	139.3	0.9	38.3	0.2	333.3	0.9
Asellus	2.7	+	53.3	0.4	20.5	+	65.6	0.2
Baetis	-	-	1.4	+	-	-	66.9	0.2
Berosus	31.4	0.2	75.1	0.5	133.9	0.6	84.7	0.2
Caenis	-	-	-	-	1.4	+	2.7	+
Cambarus	1.4	+	-	-	-	-	-	-
Campeloma	-	-	1.4	+	-	-	-	-
Ceratopogonidae	1.4	+	6.8	+	20.5	+	5.5	+
Cheumatopsyche	187.2	1.5	140.7	1.0	80.6	0.4	3229.5	8.3
Chimarra	1.4	+	1.4	+	-	-	5.5	+
Chironomidae	3061.5	23.7	3407.1	23.0	3711.8	18.0	14696.7	37.9
Corydalus	-	-	-	-	-	-	23.2	+
Crangonyx	2289.6	17.7	3251.4	22.0	4374.3	21.2	1687.2	4.4
Dromogomphus	-	-	2.7	+	2.7	+	2.7	+
Dubiraphia	49.2	0.4	77.9	0.5	162.6	0.8	34.2	+
Dugesia	39.6	0.3	64.2	0.4	229.5	1.1	58.7	0.2
Ectopria	-	-	1.4	+	1.4	+	-	-
Elliptio	1.4	+	-	-	4.1	+	-	-
Empididae	6.8	+	8.2	+	4.1	+	57.4	0.1
Ephydridae	-	-	-	-	1.4	+	-	-
Erpobdella	38.3	0.3	34.2	0.2	88.8	0.4	94.3	0.2
Ferrissia	110.7	0.9	150.3	1.0	113.4	0.5	676.2	1.7
Gammarus	1566.9	12.1	1945.4	13.1	1336.1	6.5	2.7	+
Goniobasis	1056.0	8.2	568.3	3.8	710.4	3.4	603.8	1.6
Gyraulus	80.6	0.6	10.9	+	-	-	57.4	0.1
Helisoma	222.7	1.7	5.5	+	5.5	+	21.9	+
Helobdella	13.7	0.1	39.6	0.3	32.8	0.2	1.4	+
Hydrolimax	26.0	0.2	161.2	1.1	56.0	0.3	26.0	+
Hydropsyche	168.0	1.3	112.0	0.8	92.9	0.5	647.5	1.7
Hydroptila	2.7	+	-	-	1.4	+	36.9	+
Ischnura	4.1	+	9.6	+	21.9	0.1	1.4	+
Isonychia	-	-	1.4	+	-	-	12.3	+
Lampsilis	1.4	+	-	-	-	-	-	-
Lanthus	-	-	4.1	+	1.4	+	1.4	+
Lepidostoma	-	-	-	-	1.4	+	35.5	+
Limnophila	-	-	1.4	+	-	-	-	-
Lymnaea	1.4	+	174.9	1.2	5.5	+	23.2	+
Macronychus	-	-	-	-	1.4	+	-	-
Manayunkia	-	-	4.1	+	4.1	+	1.4	+
Musculium	98.4	0.8	19.1	0.1	28.7	0.1	877.1	2.3
Nigronia	-	-	-	-	2.7	+	1.4	+
Oecetis	1.4	+	2.7	+	-	-	16.4	+
Oligochaeta	1224.0	9.5	2881.2	19.5	7098.4	34.4	2169.4	5.6
Optioservus	17.8	0.1	5.5	+	23.2	0.1	172.1	0.4
Orconectes	2.7	+	6.8	+	2.7	+	2.7	+
Parargyractis	-	-	5.5	+	-	-	174.9	0.5
Pericoma	-	-	-	-	1.4	+	-	-
Phasganophora	-	-	2.7	+	1.4	+	10.9	+
Physa	1236.3	9.6	189.9	1.3	814.2	3.9	2657.1	6.9
Pisidium	348.4	2.7	513.7	3.5	694.0	3.4	1629.8	4.2
Polycentropus	-	-	-	-	-	-	2.7	+
Prostoma	16.4	0.1	9.6	+	51.9	0.3	120.2	0.3
Protoptila	4.1	+	4.1	+	1.4	+	54.6	0.1
Psephenus	8.2	+	10.9	+	2.7	+	38.3	+
Ptilostomis	-	-	1.4	+	-	-	-	-
Sialis	23.2	0.2	47.8	0.3	35.5	0.2	57.4	0.1
Simuliidae	106.6	0.8	60.1	0.4	53.3	0.3	4557.4	11.8
Sphaerium	42.4	0.3	-	-	12.3	+	15.0	+
Stenacron	263.7	2.0	293.7	2.0	10.9	+	1032.8	2.7
Stenelmis	333.3	2.6	157.1	1.1	390.7	1.9	1987.7	5.1
Stenonema	20.5	0.2	6.8	+	-	-	277.3	0.7
Stratiomyiidae	-	-	1.4	+	-	-	-	-
Stygobromus	-	-	-	-	1.4	+	-	-
Tabanidae	-	-	5.5	+	-	-	-	-
Telmatoscopus	-	-	-	-	1.4	+	-	-
Tetragoneuria	-	-	-	-	1.4	+	-	-
Tipula	2.7	+	15.0	0.1	8.2	+	1.4	+

Table 6.2-3. Macroinvertebrate standing crop (mean number/sq. meter) measured in the Schuylkill River during 1985.

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Tipulidae	-	-	-	-	-	-	1.4	+
Triaenodes	13.7	0.1	19.1	0.1	24.6	0.1	4.1	+
Tricorythodes	140.7	1.1	87.4	0.6	97.0	0.5	211.8	0.5
*All Taxa	12907.1	N/A	14806.0	N/A	20623.0	N/A	38754.1	N/A

Table 6.2-4. Dates of sample collection in 1973-1976, 1984, and 1985 that were used in data comparison.

Station	Year					
	1973	1974	1975	1976	1984	1985
S75770	17 Jan	17 Jan	--	--	10 Jan	28 Jan
	19 Apr	24 Apr	--	21 Apr	27 Apr	16 Apr
	15 Aug	13 Aug	--	22 Jul	7 Aug	10 Jul
	12 Oct	15 Oct	--	19 Oct	17 Oct	8 Oct
S76760	16 Jan	17 Jan	12 Feb	21 Jan	10 Jan	28 Jan
	19 Apr	25 Apr	16 Apr	21 Apr	27 Apr	16 Apr
	15 Aug	14 Aug	14 Aug	22 Jul	7 Aug	10 Jul
	10 Oct	--	28 Oct	19 Oct	17 Oct	8 Oct
S77120	--	--	11 Feb	21 Jan	10 Jan	28 Jan
	--	--	15 Apr	21 Apr	27 Apr	16 Apr
	--	13 Aug	14 Aug	22 Jul	7 Aug	10 Jul
	--	15 Oct	28 Oct	19 Oct	17 Oct	8 Oct
S78620	16 Jan	17 Jan	11 Feb	21 Jan	10 Jan	29 Jan
	19 Apr	24 Apr	15 Apr	21 Apr	27 Apr	16 Apr
	16 Aug	13 Aug	14 Aug	22 Jul	7 Aug	10 Jul
	10 Oct	15 Oct	28 Oct	19 Oct	17 Oct	8 Oct

Table 6.2-5. Macroinvertebrate taxa collected in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973	1974	1975	1976	1984	1985
Acroneuria	X	X		X	X	X
Actinobdella	X					
Agraylea		X				
Alasmidonta			X			
Alboglossiphonia		X				X
Allocapnia	X	X		X	X	X
Ameletus		X				
Anax						X
Ancyronyx						X
Anodonta				X		
Antocha		X	X	X	X	
Argia	X	X	X	X	X	X
Asellus		X	X	X	X	X
Atherix					X	
Baetis	X	X	X	X	X	X
Batracobdella		X	X	X		
Belostoma				X		
Berosus	X	X	X	X	X	X
Caenis			X		X	X
Cambarus	X	X		X	X	X
Campeloma						X
Ceraclea					X	
Ceratopogonidae	X	X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X
Chimarra	X	X	X	X	X	X
Chironomidae	X	X	X	X	X	X
Corydalus		X			X	X
Crangonyx	X	X	X	X		X
Diplectrona					X	
Dolichopodidae	X	X	X			
Dromogomphus					X	X
Dubiraphia	X	X	X	X	X	X
Dugesia	X	X	X	X	X	X
Ectopria					X	X
Elliptio				X	X	X
Empididae	X	X	X	X	X	X
Enallagma		X				
Ephemera		X	X	X		
Ephemerella	X	X	X	X		
Ephydridae	X		X			X
Erpobdella	X	X	X	X	X	X
Erythemis					X	
Ferrissia	X	X	X	X	X	X
Gammarus		X		X	X	X
Gomphidae					X	
Gomphus				X		
Goniobasis	X	X	X	X	X	X
Gyraulus	X			X	X	X
Helichus			X			
Helisoma	X	X	X	X	X	X
Helobdella	X	X	X	X	X	X
Hydracarina	X					
Hydrolimax		X	X	X	X	X
Hydrophilidae					X	
Hydroporus			X	X		
Hydropsyche	X	X	X	X	X	X
Hydroptila	X	X	X	X	X	X
Ischnura	X	X	X	X	X	X
Isonychia			X	X	X	X
Isoperla	X					
Lampsilis					X	X
Lanthus		X	X	X	X	X
Lepidostoma					X	X
Leucotrichia				X	X	
Limnophila			X			X
Limonia	X					
Lymnaea				X	X	X
Macromia	X		X	X	X	
Macronemum					X	
Macronychus					X	X
Manayunkia						X
Menetus	X					
Muscidae			X	X		
Musculium						X

Table 6.2-5. Macroinvertebrate taxa collected in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973	1974	1975	1976	1984	1985
Mycetophilidae		X				
Mystacides					X	
Nectopsyche					X	
Neureclipsis		X	X	X	X	
Nigronia				X		X
Oecetis	X		X	X	X	X
Oligochaeta	X	X	X	X	X	X
Ophiogomphus				X	X	
Optioservus	X	X	X	X	X	X
Orconectes		X	X	X	X	X
Ormosia		X				
Paraleptophlebia				X		
Parargyractis		X	X	X	X	X
Peltodytes		X				
Pericoma						X
Perlesta		X		X		
Phasganophora					X	X
Phoridae					X	
Physa	X	X	X	X	X	X
Piscicolaria		X				
Pisidium	X	X	X	X	X	X
Placobdella			X	X	X	
Polycentropus	X	X		X		X
Potamanthus	X				X	
Prostoma	X	X	X	X	X	X
Protoptila					X	X
Psephenus	X	X	X	X	X	X
Pseudocloeon				X		
Pseudolimnophila	X	X	X			
Psychoda	X	X	X		X	
Psychomyia				X		
Ptilostomis						X
Rhyacophila				X		
Sialis	X	X	X	X	X	X
Simulidae		X	X	X	X	X
Sphaerium	X	X	X	X	X	X
Stenacron					X	X
Stenelmis	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X
Stratiomyiidae		X	X		X	X
Stygobromus	X	X		X		X
Stylurus				X		
Tabanidae	X	X	X		X	X
Taeniopteryx	X			X		
Telmatoscopus	X	X	X	X	X	X
Tetragoneuria						X
Tipula	X	X	X	X	X	X
Tipulidae						X
Triaenodes				X	X	X
Tricorythodes		X	X	X	X	X
Total Number of Taxa	53	65	59	73	77	75

Table 6.2-6. Annual macroinvertebrate standing crop (mean number/sq. meter), all taxa combined, in the Schuylkill River, during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Station	1973	1974	1975	1976	1984	1985
S75770	2288.9	4970.3	-	6397.5	11207.7	12907.1
S76760	3250.0	5482.2	11107.6	5669.1	10225.4	14806.0
S77120	-	6448.8	7935.5	4200.8	12504.1	20623.0
S78620	6133.2	8633.2	13573.8	13607.6	35497.3	38754.1

Table 6.2-7. Annual macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa at Station S75770 in the Schuylkill River, during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%
Cheumatopsyche	3.1	0.1	43.0	0.9	-	-	26.0	0.4	605.2	5.4	187.2	1.5
Chironomidae	557.4	24.4	647.5	13.0	-	-	1296.4	20.3	2439.9	21.8	3061.5	23.7
Crangonyx	9.2	0.4	23.6	0.5	-	-	359.3	5.6	-	-	2289.6	17.7
Ferrissia	80.9	3.5	19.5	0.4	-	-	1.4	0.0	247.3	2.2	110.7	0.9
Gammarus	-	-	5.1	0.1	-	-	-	-	610.7	5.4	1566.9	12.1
Goniobasis	778.7	34.0	2990.8	60.2	-	-	1338.8	20.9	1267.8	11.3	1056.0	8.2
Hydroptila	-	-	41.0	0.8	-	-	329.2	5.1	9.6	0.1	2.7	0.0
Oligochaeta	588.1	25.7	329.9	6.6	-	-	1702.2	26.6	4041.0	36.1	1224.0	9.5
Physa	142.4	6.2	235.7	4.7	-	-	53.3	0.8	157.1	1.4	1236.3	9.6
Pisidium	1.0	0.0	38.9	0.8	-	-	715.8	11.2	168.0	1.5	348.4	2.7
Sphaerium	32.8	1.4	376.0	7.6	-	-	248.6	3.9	284.2	2.5	42.3	0.3
Stenacron	-	-	-	-	-	-	-	-	184.4	1.6	263.7	2.0
Stenelmis	10.2	0.4	16.4	0.3	-	-	20.5	0.3	176.2	1.6	333.3	2.6

No samples collected in 1975.

Table 6.2-8. Annual macroinvertebrate standing crop (mean number/sq. meter and percent composition of important taxa at Station S76760 in the Schuylkill River, during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%
Cheumatopsyche	2.0	0.1	17.8	0.3	178.3	1.6	55.3	1.0	467.2	4.6	140.7	1.0
Chironomidae	829.9	25.5	785.5	14.3	1812.5	16.3	1347.3	23.8	2520.5	24.6	3407.1	23.0
Crangonyx	53.3	1.6	26.0	0.5	197.7	1.8	277.7	4.9	-	-	3251.4	22.0
Ferrissia	50.2	1.5	66.9	1.2	2.0	0.0	6.1	0.1	564.2	5.5	150.3	1.0
Gammarus	-	-	9.6	0.2	-	-	-	-	345.6	3.4	1945.4	13.1
Goniobasis	172.1	5.3	2881.1	52.6	5205.9	46.9	1627.0	28.7	2177.6	21.3	568.3	3.8
Hydropsyche	2.0	0.1	2.7	0.0	131.1	1.2	33.8	0.6	270.5	2.6	112.0	0.8
Oligochaeta	1915.0	58.9	864.8	15.8	2850.4	25.7	1904.7	33.6	2666.7	26.1	2881.1	19.5
Physa	59.4	1.8	453.6	8.3	31.8	0.3	20.5	0.4	77.9	0.8	189.9	1.3
Pisidium	8.2	0.3	15.0	0.3	376.0	3.4	114.8	2.0	129.8	1.3	513.7	3.5
Sphaerium	10.2	0.3	112.0	2.0	24.6	0.2	77.9	1.4	31.4	0.3	-	-
Stenacron	-	-	-	-	-	-	-	-	140.7	1.4	293.7	2.0

Table 6.2-9. Annual macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa at Station S77120 in the Schuylkill River, during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%
Argia	-	-	381.1	5.9	14.3	0.2	115.8	2.8	118.9	1.0	38.3	0.2
Cheumatopsyche	-	-	186.5	2.9	76.8	1.0	43.0	1.0	340.2	2.7	80.6	0.4
Chironomidae	-	-	118.9	1.8	1749.0	22.0	880.1	21.0	1478.1	11.8	3711.7	18.0
Crangonyx	-	-	43.0	0.7	125.0	1.6	120.9	2.9	-	-	4374.3	21.2
Gammarus	-	-	-	-	-	-	1.0	0.0	603.8	4.8	1336.1	6.5
Goniobasis	-	-	4711.1	73.1	3016.4	38.0	1547.1	36.8	3468.6	27.7	710.4	3.4
Oligochaeta	-	-	51.2	0.8	2600.4	32.8	1098.4	26.1	4786.9	38.3	7098.4	34.4
Physa	-	-	489.8	7.6	4.1	0.1	25.6	0.6	215.8	1.7	814.2	3.9
Pisidium	-	-	20.5	0.3	80.9	1.0	76.8	1.8	318.3	2.5	694.0	3.4
Sphaerium	-	-	334.0	5.2	33.8	0.4	57.4	1.4	162.6	1.3	12.3	0.1
Stenelmis	-	-	4.1	0.1	-	-	2.0	0.0	353.8	2.8	390.7	1.9

No samples collected in 1973.

Table 6.2-10. Annual macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa at Station S78620 in the Schuylkill River, during 1973 - 1976 (Selected sample dates only, see Table 6.2-4.), 1984, and 1985.

Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%
Cheumatopsyche	156.8	2.6	2417.0	28.0	1223.4	9.0	3223.4	23.7	7187.2	20.2	3229.5	8.3
Chironomidae	3862.7	63.0	2263.3	26.2	7326.8	54.0	5854.5	43.0	7049.2	19.9	14696.7	37.9
Crangonyx	84.0	1.4	23.6	0.3	155.7	1.1	105.5	0.8	-	-	1687.2	4.4
Ferrissia	87.1	1.4	105.5	1.2	23.6	0.2	223.4	1.6	1826.5	5.1	676.2	1.7
Gammarus	-	-	-	-	-	-	-	-	1140.7	3.2	2.7	0.0
Goniobasis	6.1	0.1	1229.5	14.2	1837.1	13.5	2125.0	15.6	2680.3	7.6	603.8	1.6
Helisoma	349.4	5.7	1172.1	13.6	395.5	2.9	-	-	8.2	0.0	21.9	0.1
Hydropsyche	71.7	1.2	33.8	0.4	809.4	6.0	165.0	1.2	2221.3	6.3	647.5	1.7
Musculium	-	-	-	-	-	-	-	-	-	-	877.0	2.3
Oligochaeta	311.5	5.1	111.7	1.3	780.7	5.8	228.5	1.7	4334.7	12.2	2169.4	5.6
Physa	753.1	12.3	634.2	7.3	82.0	0.6	500.0	3.7	3158.5	8.9	2657.1	6.9
Pisidium	108.6	1.8	19.5	0.2	238.7	1.8	548.2	4.0	450.8	1.3	1629.8	4.2
Simuliidae	-	-	3.1	0.0	1.0	0.0	10.2	0.1	2060.1	5.8	4557.4	11.8
Sphaerium	198.8	3.2	377.0	4.4	336.1	2.5	284.8	2.1	209.0	0.6	15.0	0.0
Stenacron	-	-	-	-	-	-	-	-	892.1	2.5	1032.8	2.7
Stenelmis	20.5	0.3	9.2	0.1	12.3	0.1	11.3	0.1	788.3	2.2	1987.7	5.1

Table 6.2-11. Dates of sample collection in 1973-1976 and 1983-1985 that were used in data comparison for detection of LGS plant operation effects.

Preoperational Period

Station	1973	1974	1975	1976	1983	1984
S75770	12 Oct	15 Oct	--	19 Oct	6 Oct	17 Oct
S76760	10 Oct	--	28 Oct	19 Oct	6 Oct	17 Oct
S77120	--	15 Oct	28 Oct	19 Oct	6 Oct	17 Oct
S78620	10 Oct	15 Oct	28 Oct	19 Oct	6 Oct	17 Oct

Operational Period

Station	1985
S75770	8 Oct
S76760	8 Oct
S77120	8 Oct
S78620	8 Oct

Table 6.2-12. Macroinvertebrate taxa collected in the Schuylkill River in the month of October during years 1973 - 1976 and 1983 - 1985.

	Preoperational Period						Operational Period
Taxon	1973	1974	1975	1976	1983	1984	1985
Acroneuria	X			X	X	X	
Allocapnia							X
Ancyronyx							X
Anodonta				X			
Argia	X	X	X	X	X	X	X
Asellus			X			X	X
Baetis		X		X	X	X	X
Batracobdella			X	X			
Berosus	X	X	X	X	X	X	X
Caenis							X
Cambarus					X		
Ceraclea						X	
Ceratopogonidae				X	X	X	X
Cheumatopsyche	X	X	X	X	X	X	X
Chimarra	X		X				X
Chironomidae	X	X	X	X	X	X	X
Corydalus					X	X	X
Crangonyx	X	X	X	X			X
Dromogomphus						X	X
Dubiraphia	X		X	X	X	X	X
Dugesia		X	X	X		X	X
Ectopria							X
Elliptio					X	X	X
Empididae			X			X	X
Enallagma		X					
Epicordulia					X		
Erpobdella	X	X	X	X	X	X	X
Ferrissia	X	X	X	X	X	X	X
Gammarus					X	X	X
Goniobasis	X	X	X	X	X	X	X
Gyraulus	X			X	X		X
Helisoma	X	X				X	X
Helobdella	X	X	X	X	X	X	X
Hydracarina	X						
Hydrolimax		X	X	X		X	X
Hydropsyche	X	X	X	X	X	X	X
Hydroptila	X	X					
Ischnura	X	X	X	X	X	X	X
Isonychia							X
Lampsilis						X	
Lanthus		X	X	X		X	X
Lepidostoma						X	
Leucotrichia						X	
Lymnaea				X		X	X
Macromia	X						
Macronychus						X	
Muscidae				X			
Musculium							X
Mystacides						X	
Neureclipsis		X		X		X	
Nigronia					X		X
Oecetis				X	X	X	X
Oligochaeta	X	X	X	X	X	X	X
Optioservus		X	X	X	X	X	X
Orconectes		X	X		X	X	X
Parargyractis			X		X	X	X
Pericoma							X
Phasganophora						X	
Physa	X	X	X	X	X	X	X
Pisidium	X	X	X	X	X	X	X
Polycentropus	X				X		
Prostoma	X	X	X	X	X	X	X
Protoptila						X	X
Psephenus	X		X	X	X	X	X
Pseudocloeon					X		
Pseudolimnophila	X		X				
Ptilostomis							X
Sialis			X	X	X	X	X
Simuliidae		X				X	X
Sphaerium	X	X	X	X	X	X	
Stenacron					X	X	X

Table 6.2-12. Macroinvertebrate taxa collected in the Schuylkill River in the month of October during years 1973 - 1976 and 1983 - 1985.

	Preoperational Period						Operational Period
Taxon	1973	1974	1975	1976	1983	1984	1985
Stenelmis	X	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X	X
Stygobromus		X					
Tabanidae			X			X	X
Tipula	X			X	X		X
Tipulidae							X
Triaenodes				X	X	X	X
Tricorythodes		X		X	X	X	X
Total Number of Taxa	31	31	33	38	40	52	56

Table 6.2-13. Macroinvertebrate standing crop (mean number/sq. meter), all taxa combined, in the Schuylkill River in the month of October during years 1973 - 1976 and 1983 - 1985.

Station	1973	1974	1975	1976	1983	1984	1985
S75770	3241.8	7594.3	-	6676.2	5699.5	16541.0	5169.4
S76760	3155.7	-	6663.9	4741.8	6098.4	19191.3	5803.3
S77120	-	7008.2	4602.5	4897.5	9442.6	9267.8	7857.9
S78620	3463.1	10766.4	6188.5	16811.5	43721.3	85694.0	22551.9

Table 6.2-14. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station S75770 in the Schuylkill River in the month of October during the years 1973 - 1976 and 1983 - 1985.

	Preoperational Period								Operational Period					
	1973		1974		1975		1976		1983		1984		1985	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Argia	-	-	209.0	2.8	-	-	225.4	3.4	448.1	7.9	185.8	1.1	-	-
Berosus	-	-	12.3	0.2	-	-	-	-	797.8	14.0	10.9	0.1	92.9	1.8
Cheumatopsyche	4.1	0.1	151.6	2.0	-	-	12.3	0.2	-	-	1333.3	8.1	191.3	3.7
Chironomidae	4.1	0.1	57.4	0.8	-	-	188.5	2.8	54.6	1.0	4218.6	25.5	114.8	2.2
Crangonyx	-	-	20.5	0.3	-	-	163.9	2.5	-	-	-	-	475.4	9.2
Dubiraphia	-	-	-	-	-	-	-	-	16.4	0.3	65.6	0.4	131.1	2.5
Ferrissia	147.5	4.6	-	-	-	-	4.1	0.1	-	-	852.5	5.2	5.5	0.1
Gammarus	-	-	-	-	-	-	-	-	92.9	1.6	978.1	5.9	1382.5	26.7
Goniobasis	2954.9	91.2	5381.1	70.9	-	-	1332.0	20.0	1464.5	25.7	218.6	1.3	989.1	19.1
Hydropsyche	-	-	4.1	0.1	-	-	16.4	0.2	-	-	535.5	3.2	169.4	3.3
Oligochaeta	32.8	1.0	430.3	5.7	-	-	1877.0	28.1	2054.6	36.0	4857.9	29.4	934.4	18.1
Physa	57.4	1.8	94.3	1.2	-	-	135.2	2.0	5.5	0.1	486.3	2.9	-	-
Pisidium	-	-	98.4	1.3	-	-	1778.7	26.6	240.4	4.2	273.2	1.7	10.9	0.2
Prostoma	-	-	49.2	0.6	-	-	184.4	2.8	-	-	16.4	0.1	5.5	0.1
Simuliidae	-	-	-	-	-	-	-	-	-	-	688.5	4.2	-	-
Sphaerium	32.8	1.0	897.5	11.8	-	-	463.1	6.9	213.1	3.7	322.4	1.9	-	-
Stenacron	-	-	-	-	-	-	-	-	-	-	726.8	4.4	-	-
Stenelmis	-	-	4.1	0.1	-	-	20.5	0.3	60.1	1.1	185.8	1.1	530.1	10.3

No samples collected in 1975.

Table 6.2-15. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station S76760 in the Schuylkill River in the month of October during the years 1973 - 1976 and 1983 - 1985.

	Preoperational Period								Operational Period					
	1973		1974		1975		1976		1983		1984		1985	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Argia	-	-	-	-	86.1	1.3	45.1	1.0	256.8	4.2	655.7	3.4	5.5	0.1
Berosus	4.1	0.1	-	-	-	-	-	-	82.0	1.3	38.3	0.2	136.6	2.4
Cheumatopsyche	4.1	0.1	-	-	479.5	7.2	82.0	1.7	5.5	0.1	1349.7	7.0	87.4	1.5
Chironomidae	98.4	3.1	-	-	143.4	2.2	536.9	11.3	224.0	3.7	6196.7	32.3	311.5	5.4
Crangonyx	143.4	4.5	-	-	229.5	3.4	381.1	8.0	-	-	-	-	524.6	9.0
Dubiraphia	8.2	0.3	-	-	8.2	0.1	4.1	0.1	10.9	0.2	131.1	0.7	185.8	3.2
Ferrissia	131.1	4.2	-	-	4.1	0.1	20.5	0.4	-	-	2213.1	11.5	-	-
Gammarus	-	-	-	-	-	-	-	-	92.9	1.5	1142.1	6.0	519.1	8.9
Goniobasis	684.4	21.7	-	-	1508.2	22.6	1573.8	33.2	2431.7	39.9	770.5	4.0	1180.3	20.3
Helobdella	114.8	3.6	-	-	4.1	0.1	28.7	0.6	5.5	0.1	43.7	0.2	10.9	0.2
Hydropsyche	-	-	-	-	344.3	5.2	61.5	1.3	5.5	0.1	961.7	5.0	16.4	0.3
Ischnura	4.1	0.1	-	-	8.2	0.1	8.2	0.2	235.0	3.9	-	-	16.4	0.3
Oligochaeta	1778.7	56.4	-	-	3311.5	49.7	1053.3	22.2	2371.6	38.9	3606.6	18.8	2393.4	41.2
Pisidium	12.3	0.4	-	-	282.8	4.2	454.9	9.6	-	-	169.4	0.9	43.7	0.8
Prostoma	131.1	4.2	-	-	57.4	0.9	131.1	2.8	-	-	27.3	0.1	16.4	0.3
Sphaerium	-	-	-	-	-	-	188.5	4.0	16.4	0.3	5.5	0.0	-	-
Stenacron	-	-	-	-	-	-	-	-	-	-	551.9	2.9	-	-
Stenonema	4.1	0.1	-	-	32.8	0.5	-	-	-	-	464.5	2.4	-	-
Triaenodes	-	-	-	-	-	-	8.2	0.2	158.5	2.6	32.8	0.2	-	-

No samples collected in 1974.

Table 6.2-16. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station S77120 in the Schuylkill River in the month of October during the years 1973 - 1976 and 1983 - 1985.

	Preoperational Period												Operational Period	
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1983 Mean	%	1984 Mean	%	1985 Mean	%
Argia	-	-	196.7	2.8	24.6	0.5	426.2	8.7	371.6	3.9	207.7	2.2	32.8	0.4
Berosus	-	-	8.2	0.1	8.2	0.2	4.1	0.1	136.6	1.4	10.9	0.1	251.4	3.2
Cheumatopsyche	-	-	262.3	3.7	53.3	1.2	77.9	1.6	5.5	0.1	38.3	0.4	60.1	0.8
Chironomidae	-	-	45.1	0.6	237.7	5.2	627.0	12.8	1043.7	11.1	1612.0	17.4	568.3	7.2
Crangonyx	-	-	49.2	0.7	57.4	1.2	86.1	1.8	-	-	-	-	655.7	8.3
Dubiraphia	-	-	-	-	12.3	0.3	12.3	0.3	43.7	0.5	32.8	0.4	491.8	6.3
Erpobdella	-	-	4.1	0.1	8.2	0.2	4.1	0.1	32.8	0.3	76.5	0.8	218.6	2.8
Gammarus	-	-	-	-	-	-	-	-	98.4	1.0	1136.6	12.3	464.5	5.9
Goniobasis	-	-	6041.0	86.2	1159.8	25.2	1340.2	27.4	5224.0	55.3	661.2	7.1	978.1	12.4
Oligochaeta	-	-	16.4	0.2	2811.5	61.1	1258.2	25.7	1032.8	10.9	3759.6	40.6	3409.8	43.4
Physa	-	-	163.9	2.3	4.1	0.1	98.4	2.0	316.9	3.4	136.6	1.5	5.5	0.1
Pisidium	-	-	-	-	61.5	1.3	303.3	6.2	300.5	3.2	595.6	6.4	49.2	0.6
Prostoma	-	-	-	-	45.1	1.0	254.1	5.2	-	-	32.8	0.4	43.7	0.6
Sphaerium	-	-	118.9	1.7	12.3	0.3	155.7	3.2	158.5	1.7	21.9	0.2	-	-
Stenelmis	-	-	-	-	-	-	8.2	0.2	54.6	0.6	601.1	6.5	103.8	1.3
Tricorythodes	-	-	12.3	0.2	-	-	12.3	0.3	5.5	0.1	-	-	267.8	3.4

No samples collected in 1973.

Table 6.2-17. Macroinvertebrate standing crop (mean number/sq. meter) and percent composition of important taxa (>2%) at Station S78620 in the Schuylkill River in the month of October during the years 1973 - 1976 and 1983 - 1985.

	Preoperational Period								Operational Period					
	1973		1974		1975		1976		1983		1984		1985	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Argia	45.1	1.3	135.2	1.3	36.9	0.6	163.9	1.0	1382.5	3.2	92.9	0.1	1218.6	5.4
Cheumatopsyche	602.5	17.4	3053.3	28.4	1618.9	26.2	6471.3	38.5	24278.7	55.5	17683.1	20.6	3868.9	17.2
Chironomidae	1163.9	33.6	1594.3	14.8	377.0	6.1	696.7	4.1	3885.2	8.9	16890.7	19.7	1726.8	7.7
Crangonyx	286.9	8.3	8.2	0.1	86.1	1.4	131.1	0.8	-	-	-	-	2327.9	10.3
Ferrissia	36.9	1.1	61.5	0.6	24.6	0.4	840.2	5.0	1721.3	3.9	6355.2	7.4	437.2	1.9
Gammarus	-	-	-	-	-	-	-	-	87.4	0.2	2573.8	3.0	10.9	0.0
Goniobasis	24.6	0.7	4131.1	38.4	1401.6	22.6	3471.3	20.6	945.4	2.2	1551.9	1.8	1109.3	4.9
Helisoma	77.9	2.2	245.9	2.3	-	-	-	-	-	-	5.5	0.0	10.9	0.0
Hydropsyche	262.3	7.6	61.5	0.6	1069.7	17.3	332.0	2.0	961.7	2.2	7650.3	8.9	557.4	2.5
Musculium	-	-	-	-	-	-	-	-	-	-	-	-	2901.6	12.9
Oligochaeta	69.7	2.0	82.0	0.8	295.1	4.8	262.3	1.6	147.5	0.3	11071.0	12.9	469.9	2.1
Parargyractis	-	-	-	-	8.2	0.1	-	-	1710.4	3.9	770.5	0.9	661.2	2.9
Physa	704.9	20.4	168.0	1.6	123.0	2.0	1471.3	8.8	6224.0	14.2	6961.7	8.1	207.7	0.9
Pisidium	-	-	53.3	0.5	188.5	3.0	1881.1	11.2	284.2	0.6	251.4	0.3	2174.9	9.6
Prostoma	-	-	20.5	0.2	541.0	8.7	94.3	0.6	5.5	0.0	-	-	344.3	1.5
Simuliidae	-	-	12.3	0.1	-	-	-	-	-	-	7366.1	8.6	10.9	0.0
Sphaerium	69.7	2.0	1004.1	9.3	315.6	5.1	770.5	4.6	-	-	393.4	0.5	-	-
Stenacron	-	-	-	-	-	-	-	-	32.8	0.1	3557.4	4.2	76.5	0.3
Stenelmis	24.6	0.7	8.2	0.1	4.1	0.1	12.3	0.1	349.7	0.8	322.4	0.4	3098.4	13.7

6.3 Fishes Collected by Seine

Summary

1. Fish species of small body size and young-of-year (YOY) of larger species in the Schuylkill River near LGS were sampled with a small-mesh seine at monthly intervals in 1985.

2. A total of 9,471 specimens of 29 species and Lepomis sunfish hybrids was collected. The most abundant species in the sample were redbreast sunfish (24% of the catch), spottail shiner (23%), spotfin shiner (19%), and swallowtail shiner (9%).

3. Unusually large catches of several species that spawn in spring and early summer were made. White sucker, goldfish, spottail shiner, redbreast sunfish, pumpkinseed, and smallmouth bass produced strong year classes as evidenced by the capture of YOY specimens in record or near-record numbers. Also, YOY of these species appeared in seine sampled earlier in the year than ever before. Low, stable river flow and rapidly climbing water temperatures in the spring were thought to provide favorable spawning conditions for many species.

4. Annual catch was comparatively low, however, due to poor recruitment by spotfin shiner and swallowtail shiner, two species that spawn later in the summer that dominated seine catches in previous years.

5. A fish kill (Section 6.0) on 31 July had an observable impact on the large fish population, but there were no visible signs of minnow mortality. Seine catches were abnormally low for several species immediately after the kill, notably spotfin shiner and swallowtail shiner. Thus, the lowered annual catch and poor recruitment by these two dominant species were possibly related to effects from the fish kill, which occurred both upstream and downstream of LGS.

6. Relative fish density varied considerably among stations. Greatest numbers of fish were consistently taken from stations with extensive beds of aquatic vegetation and sheltered backwater areas.

7. Compared to the effects of flow regime, a fish kill, and between station habitat differences, any effects from the operation of LGS on the sampled community were not evident.

Introduction and Methods

A reach of the Schuylkill River near LGS was sampled monthly with small-mesh seine from January 1975 through December 1978 and from March 1981 through December 1985. Fishes vulnerable to the seine are those of small body size such as minnows, darters, and the young of many other species. The kinds of information provided by the seine program included species composition and relative abundance of the targeted fish community, approximate time of spawning estimated from dates that young-of-year (YOY) fish were first collected, relative spawning success based on the contribution of YOY fish to the sample, observations on preferred habitat, and incidence of disease and abnormalities. This report focuses on the species compositon and relative abundance of fishes in the 1985 seine collections, drawing on supporting information as necessary to clarify particular observations or contrast 1985 data with data collected in previous years.

Six sampling stations (two upstream and four downstream of LGS) were seined once per month in 1985. The 3.2-mm mesh seine used to collect fish measured 2.4 m long by 1.2 m deep. Seining effort consisted of six uniform seine hauls along 30 m of shoreline at each station. Catches from individual seine hauls were pooled to form a composite sample from each station on each sampling date. Adult pan and sport fishes and other large specimens were measured to the nearest 5-mm interval fork length

(FL), examined for disease, and released. Smaller specimens comprised the bulk of most collections and were preserved for subsequent laboratory processing. Each collection was sorted by species into 5-mm FL intervals. A length-frequency distribution was determined from a subsample of 100 individuals when 200 or more fish of a given species were present in a collection. Presence of disease and other abnormalities of individual fish was also recorded.

Results and Discussion

Seine collections in 1985 yielded 9,471 specimens of 29 species and Lepomis (sunfish) hybrids (Table 6.3-1). The most abundant species were redbreast sunfish (24% of the total catch), spottail shiner (23%), spotfin shiner (19%), and swallowtail shiner (9%). Relative abundance of these more common species differed substantially from that observed in previous years. Together, spotfin shiner and swallowtail shiner comprised 57-93% of past yearly samples, but in 1985 they contributed only 28% to the total number of fish collected. In contrast, greater numbers of twelve other species were collected in 1985 than in any previous year. For example, more YOY white sucker were taken than in any other year. Nearly twice as many redbreast sunfish were captured in 1985 than in 1983, the year when the second-highest catch of this species was made. More YOY goldfish were

collected in 1985 than in all other years combined; the same was true for YOY smallmouth bass and pumpkinseed. In addition, more spottail shiner were collected in 1985 than in any year except 1977.

Shifts in relative abundance within the sampled fish community were probably related to the unusually low, stable flow regime present in 1985. Spring flows were the lowest on record, and low, stable stream discharge persisted throughout much of the summer. Extensive beds of submerged aquatic vegetation developed along the shoreline, expecially in areas out of the main river current. At the same time, water temperatures conducive to spawning were reached earlier than normal in the year. Cold, scouring floods deleterious to reproduction were absent. From January through May, seine catches exhibited the continued dominance of spotfin shiner and swallowtail shiner which were by far the most abundant species the previous year. For the remainder of 1985 these two species were not dominant components of the seine catch due to their low spawning success compared to relatively high production of young by several other species (Table 6.3-2). Apparently, the unusual conditions in 1985 favored the production of large year classes by many species but not by spotfin shiner and swallowtail shiner.

The unusual conditions encouraged many species to spawn early, and YOY of many kinds of fish appeared in Schuylkill River

seine collections earlier in the year than ever before. White sucker spawned initially before other species, and its young were first collected in early May (Table 6.3-3). YOY of most other species were collected by June or July 1985. Typically, young of many fishes were often not taken until July or August in past years.

The total seine catch displayed a general pattern of seasonal variation reflective of the population dynamics of small, short-lived species. Due to recruitment of YOY fish, catches were greater in late spring, summer, and early fall than at other times of the year (Table 6.3-2). Lowest catches were made in the colder months. In winter, many species are semi-dormant and often aggregate in very specific habitats; these factors probably accentuated seasonal differences in the seine catch.

There were no discernable differences between seining stations upstream and downstream of LGS that could be isolated from natural effects and attributed to plant operation. Station-to-station differences in vegetation density, current velocity, and other habitat features were likely factors contributing to variation in the size and composition of seine catches. Young fish were concentrated in weedy areas away from current and seine catches were greater at stations with such habitat (e.g. S77010, S77220, and S77940) than at stations where faster current swept over a cleaner bottom (Table 6.3-4).

Seine collections in early August 1985 yielded an unexpectedly small number of specimens. These collections were made 5-6 days after a major fish kill that occurred on the Schuylkill River between Pottstown and Phoenixville. It appeared that mostly adult fish were killed, and although the August seine catch combined over all stations decreased, several less common species were relatively more numerous. Large numbers of fish were seined in September. Electrofishing catch rates of larger adult fish declined sharply immediately after the kill (Section 6.4), but catches of YOY of several species (goldfish, redbreast sunfish, smallmouth bass, brown bullhead, and yellow bullhead) by this method were exceptionally large. Although the August decline in seine catch suggests that the kill affected at least some of the smaller species, electrofishing and seining samples taken a month later indicated that the population of larger adults was more severely affected by the kill than the populations of smaller species and YOY fish. Poor recruitment by spotfin shiner and swallowtail shiner, which spawn relatively late in the season, may have been related to effects from this fish kill.

Table 6.3-1. Total catch and relative abundance of fishes collected by seine from the Schuylkill River, 1975 - 1978 and 1981 - 1985.

Species	1975 Catch	%	1976 Catch	%	1977 Catch	%	1978 Catch	%	1981 Catch	%	1982 Catch	%	1983 Catch	%	1984 Catch	%	1985 Catch	%	Total Catch	%
Esox hybrid	-	-	1	+	-	-	-	-	-	-	-	-	-	-	-	-	2	+	3	
Goldfish	1	+	3	+	273	1.4	3	+	16	0.1	1	+	22	0.1	-	-	394	4.2	713	0.6
Carp	-	-	-	-	3	+	1	+	-	-	-	-	1	+	-	-	31	0.3	36	
Cutlips minnow	-	-	2	+	2	+	6	+	4	+	2	+	4	+	4	0.1	15	0.2	39	
Golden shiner	258	2.8	274	3.3	585	3.0	58	0.3	37	0.2	11	0.1	153	0.9	12	0.2	78	0.8	1466	1.2
Notropis	-	-	-	-	886	4.5	-	-	-	-	-	-	-	-	-	-	-	-	886	0.7
Comely shiner	91	1.0	73	0.9	16	0.1	86	0.4	47	0.3	107	0.7	43	0.2	33	0.5	44	0.5	540	0.4
Common shiner	11	0.1	38	0.5	41	0.2	84	0.4	49	0.3	16	0.1	23	0.1	13	0.2	298	3.1	573	0.5
Spottail shiner	33	0.4	346	4.2	7286	37.2	175	0.9	121	0.7	34	0.2	326	1.8	22	0.3	2166	22.9	10509	8.5
Swallowtail shiner	5025	55.5	3057	37.2	3003	15.3	6579	32.4	4465	27.2	6472	41.9	8837	49.7	2616	36.8	826	8.7	40880	33.1
Spotfin shiner	3329	36.7	3283	40.0	2743	14.0	12322	60.7	10638	64.7	7990	51.8	6502	36.6	3975	55.9	1786	18.9	52568	42.6
Bluntnose minnow	3	+	7	0.1	1	+	4	+	2	+	7	+	2	+	4	0.1	10	0.1	40	
Fathead minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	-	1	
Blacknose dace	4	+	49	0.6	11	0.1	15	0.1	4	+	18	0.1	15	0.1	24	0.3	56	0.6	196	0.2
Longnose dace	-	-	5	0.1	5	+	2	+	-	-	-	-	-	-	1	+	-	-	13	
Creek chub	-	-	7	0.1	245	1.2	3	+	1	+	1	+	17	0.1	5	0.1	10	0.1	289	0.2
Fallfish	1	+	-	-	4	+	1	+	1	+	1	+	4	+	-	-	26	0.3	38	
Quillback	-	-	5	0.1	4	+	1	+	-	-	-	-	-	-	-	-	4	+	14	
White sucker	6	0.1	227	2.8	1222	6.2	161	0.8	11	0.1	7	+	24	0.1	12	0.2	272	2.9	1942	1.6
Creek chubsucker	1	+	2	+	2	+	-	-	-	-	-	-	-	-	-	-	1	+	6	
White catfish	-	-	-	-	3	+	2	+	1	+	-	-	-	-	-	-	-	-	6	
Yellow bullhead	2	+	4	+	5	+	1	+	1	+	-	-	2	+	-	-	37	0.4	52	
Brown bullhead	8	0.1	6	0.1	1061	5.4	1	+	2	+	-	-	1	+	1	+	14	0.1	1094	0.9
Channel catfish	-	-	-	-	-	-	-	-	-	-	1	+	-	-	-	-	1	+	2	
Margined madtom	-	-	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Banded killifish	45	0.5	131	1.6	615	3.1	168	0.8	374	2.3	169	1.1	215	1.2	82	1.2	353	3.7	2152	1.7
Rock bass	5	0.1	19	0.2	56	0.3	16	0.1	35	0.2	39	0.3	86	0.5	22	0.3	382	4.0	660	0.5
Lepomis	-	-	-	-	337	1.7	-	-	-	-	-	-	-	-	-	-	-	-	337	0.3
Redbreast sunfish	82	0.9	405	4.9	547	2.8	130	0.6	480	2.9	241	1.6	1094	6.2	139	2.0	2226	23.5	5344	4.3
Green sunfish	40	0.4	40	0.5	180	0.9	17	0.1	20	0.1	15	0.1	15	0.1	4	0.1	13	0.1	344	0.3
Pumpkinseed	54	0.6	44	0.5	118	0.6	48	0.2	38	0.2	43	0.3	253	1.4	18	0.3	125	1.3	741	0.6
Bluegill	16	0.2	25	0.3	11	0.1	163	0.8	3	+	170	1.1	44	0.2	29	0.4	53	0.6	514	0.4
Lepomis hybrid	7	0.1	1	+	2	+	2	+	-	-	3	+	-	-	-	-	2	+	17	
Smallmouth bass	-	-	5	0.1	1	+	6	+	9	0.1	36	0.2	23	0.1	9	0.1	190	2.0	279	0.2
Largemouth bass	5	0.1	10	0.1	-	-	13	0.1	6	+	2	+	10	0.1	2	+	3	+	51	
White crappie	2	+	16	0.2	-	-	2	+	3	+	14	0.1	4	+	5	0.1	-	-	46	
Black crappie	13	0.1	11	0.1	1	+	-	-	-	-	-	-	-	-	6	0.1	-	-	31	
Tessellated darter	19	0.2	118	1.4	335	1.7	234	1.2	70	0.4	38	0.2	62	0.3	69	1.0	53	0.6	998	0.8
Total Catch	9061		8215		19604		20304		16438		15438		17782		7108		9471		123421	
Number of ~~Species~~ Taxa	24		30		31		29		26		24		26		25		29		37	
Number of Stations	6		6		6		5		6		6		6		6		6		6	

+ = Less than 0.1%

(Excludes sites not sampled in 1985)

Table 6.3-2. Monthly catch (all stations combined) of fishes collected by seine from the Schuylkill River during 1985.

Species	1/14 Catch	2/19 Catch	3/15 Catch	4/8 Catch	5/6 Catch	6/4 Catch	7/9 Catch	8/6 Catch	9/17 Catch	10/14 Catch	11/7 Catch	12/31 Catch	Total Catch
Esox hybrid	-	-	-	-	-	-	-	-	-	-	2	-	2
Goldfish	-	-	-	-	-	217	105	24	6	31	6	5	394
Carp	-	-	-	-	-	20	-	-	4	5	2	-	31
Cutlips minnow	-	-	-	-	-	2	12	-	-	1	-	-	15
Golden shiner	-	-	-	2	-	-	43	8	5	17	3	-	78
Comely shiner	3	3	3	3	1	-	1	1	-	-	2	27	44
Common shiner	-	-	-	5	6	45	208	14	10	3	6	1	298
Spottail shiner	-	-	-	-	1	454	1491	111	64	21	18	6	2166
Swallowtail shiner	26	65	36	29	53	42	55	24	120	132	178	66	826
Spotfin shiner	24	114	32	158	179	124	8	71	195	358	362	161	1786
Bluntnose minnow	-	-	1	2	5	2	-	-	-	-	-	-	10
Blacknose dace	-	9	11	16	7	7	6	-	-	-	-	-	56
Creek chub	-	-	-	-	3	-	3	-	4	-	-	-	10
Fallfish	-	-	-	-	-	3	16	1	2	3	1	-	26
Quillback	-	-	-	-	-	-	4	-	-	-	-	-	4
White sucker	-	-	-	-	20	219	19	4	-	10	-	-	272
Creek chubsucker	-	-	-	-	-	1	-	-	-	-	-	-	1
Yellow bullhead	-	-	-	-	-	-	8	18	5	4	-	2	37
Brown bullhead	-	-	-	-	-	-	2	6	1	5	-	-	14
Channel catfish	-	-	-	-	-	-	-	1	-	-	-	-	1
Banded killifish	6	10	11	10	9	2	3	64	107	60	55	16	353
Rock bass	-	2	-	1	1	14	199	41	37	38	43	6	382
Redbreast sunfish	1	4	2	2	10	2	149	467	711	630	232	16	2226
Green sunfish	-	-	-	-	-	-	3	-	4	1	1	4	13
Pumpkinseed	-	-	1	-	4	-	1	-	39	55	24	1	125
Bluegill	6	1	2	1	1	-	-	7	25	3	7	-	53
Lepomis hybrid	-	-	-	-	-	1	-	-	1	-	-	-	2
Smallmouth bass	-	-	-	-	1	49	116	4	2	9	8	1	190
Largemouth bass	-	-	-	-	1	-	-	-	-	1	1	-	3
Tessellated darter	1	-	2	4	-	11	9	3	4	9	7	3	53
Total Catch	67	208	101	233	302	1215	2461	869	1346	1396	958	315	9471
Number of Species	7	8	10	12	16	17	22	18	19	21	19	14	183
Number of Stations	6	6	6	6	6	6	6	6	6	6	6	6	72

Table 6.3-3. Initial appearance of young in the Schuylkill River seine catch in 1985 and relative year-class strength of selected species.

Species	First catch of young-of-year	Relative year-class strength
Goldfish	4 June	Strong
Swallowtail shiner	9 July	Weak
Spotfin shiner	6 August	Weak
White sucker	6 May	Strong
Banded killifish	9 July	Strong
Tesselated darter	4 June	Weak
Redbreast sunfish	9 July	Strong
Pumpkinseed	9 July	Strong
Smallmouth bass	9 July	Strong

Table 6.3-4. Total catch and relative abundance of fishes collected by seine from the Schuylkill River by station during 1985.

Species	S76840 Catch	%	S77010 Catch	%	S77220 Catch	%	S77240 Catch	%	S77960 Catch	%	S78460 Catch	%
Esox hybrid	-	-	1	+	1	+	-	-	-	-	-	-
Goldfish	4	0.4	53	2.0	298	12.3	2	0.3	35	1.9	2	0.3
Carp	1	0.1	5	0.2	21	0.9	2	0.3	2	0.1	-	-
Cutlips minnow	2	0.2	4	0.2	2	0.1	-	-	1	0.1	6	0.8
Golden shiner	14	1.4	53	2.0	4	0.2	3	0.4	4	0.2	-	-
Comely shiner	2	0.2	4	0.2	8	0.3	2	0.3	28	1.5	-	-
Common shiner	27	2.6	76	2.9	13	0.5	12	1.6	118	6.3	52	6.9
Spottail shiner	143	13.9	1026	38.6	690	28.4	2	0.3	247	13.2	58	7.7
Swallowtail shiner	48	4.7	174	6.6	293	12.1	63	8.6	225	12.0	23	3.1
Spotfin shiner	336	32.7	292	11.0	337	13.9	156	21.3	547	29.2	118	15.7
Bluntnose minnow	-	-	1	+	-	-	1	0.1	7	0.4	1	0.1
Blacknose dace	10	1.0	21	0.8	8	0.3	8	1.1	3	0.2	6	0.8
Creek chub	-	-	3	0.1	-	-	5	0.7	-	-	2	0.3
Fallfish	1	0.1	12	0.5	3	0.1	6	0.8	1	0.1	3	0.4
Quillback	-	-	4	0.2	-	-	-	-	-	-	-	-
White sucker	38	3.7	92	3.5	43	1.8	37	5.0	36	1.9	26	3.5
Creek chubsucker	1	0.1	-	-	-	-	-	-	-	-	-	-
Yellow bullhead	2	0.2	8	0.3	6	0.2	2	0.3	11	0.6	8	1.1
Brown bullhead	-	-	12	0.5	2	0.1	-	-	-	-	-	-
Channel catfish	-	-	-	-	-	-	-	-	-	-	1	0.1
Banded killifish	29	2.8	51	1.9	190	7.8	20	2.7	49	2.6	14	1.9
Rock bass	41	4.0	104	3.9	84	3.5	35	4.8	109	5.8	9	1.2
Redbreast sunfish	296	28.8	576	21.7	298	12.3	304	41.4	356	19.0	396	52.7
Green sunfish	1	0.1	2	0.1	-	-	5	0.7	4	0.2	1	0.1
Pumpkinseed	7	0.7	47	1.8	39	1.6	3	0.4	19	1.0	10	1.3
Bluegill	4	0.4	5	0.2	22	0.9	5	0.7	16	0.9	1	0.1
Lepomis hybrid	-	-	-	-	-	-	-	-	1	0.1	1	0.1
Smallmouth bass	6	0.6	16	0.6	58	2.4	54	7.4	47	2.5	9	1.2
Largemouth bass	1	0.1	1	+	-	-	-	-	-	-	1	0.1
Tessellated darter	12	1.2	12	0.5	11	0.5	7	1.0	7	0.4	4	0.5
Total Catch	1026		2655		2431		734		1873		752	
Number of Species	23		27		22		22		22		22	
Number of Stations	1		1		1		1		1		1	

+ = Less than 0.1%

6.4 Fishes Collected by Electrofishing

Summary

1. An electrofishing survey of the Schuylkill River large fish community near LGS continued in 1985 for the fifth consecutive year.

2. A total of 9,814 fish of 21 species and 3 hybrids was caught in 40.38 hours of electrofishing at an overall rate of 243 fish/hour.

3. Unusually low, stable flows throughout the spring and early summer created apparently ideal spawning conditions for many species, particularly goldfish, yellow bullhead, brown bullhead, and smallmouth bass.

4. A substantial fish kill in early August was followed by a decrease in CPUE of larger adult fish, particularly white sucker and redbreast sunfish.

5. Compared to the effects of flow regime and the fish kill, which occurred both upstream and downstream of LGS, any effect from the start-up and testing of the Unit I reactor in 1985 were not evident.

Introduction and Methods

An electrofishing survey of the Schuylkill River large fish community near LGS continued in 1985 for the fifth consecutive year. The primary objective of the survey is to provide data on species composition and relative abundance of a target portion of the riverine fish community. The target species list (RMC 1983) has been expanded to include members of the herring family which are finding their way into the system.

Fishes were collected with a 240-volt pulsed DC electrofishing unit mounted on a flat-bottomed boat having fixed electrodes suspended from bow and side booms. Each station was sampled by electrofishing in a downstream direction within two opposing shoreline zones, two adjacent off-shore zones, and one mid-channel zone. Fishing a zone constituted a pass, and each pass was timed to the nearest minute to permit expression of catch values on a catch-per-unit-effort (CPUE) basis. CPUE values were expressed as fish-per-hour-of-electrofishing-effort, or fish/hour.

After collection, individual fish were measured to the nearest mm fork length (FL), weighed to the nearest g, and examined for the presence of disease, broadly defined herein to include presence of parasites and anamolies. Fish smaller than

50 mm FL were excluded from analysis to avoid possible gear bias against small fish.

Spatial and temporal variation in these aspects of fish ecology were addressed by sampling several stations at monthly intervals between April and October (Table 6.4-1). Beginning in 1983, one station below and one above the LGS cooling tower blowdown discharge (S76940 and S77640, respectively) were sampled monthly from November through March, weather permitting, to assess reaction of fishes to the potentially heated discharge in winter. Descriptions of sample stations, locations, and minor changes in procedure appear in earlier progress reports (RMC 1984, 1985) and the EROL.

Results and Discussion

Species Composition and Relative Abundance

In 1985, a total of 9,814 fish of 21 species and 3 hybrids was caught in 40.38 hours of electrofishing at an overall rate of 243 fish/hour (Tables 6.4-2 to 6.4-7).

A catch of 5,061 goldfish, the largest ever, comprised 51.6% of the total electrofishing sample in 1985. This large catch ranked goldfish greatest in relative abundance as was the case in 1983. Annual electrofishing catch rates of goldfish have varied nearly seven-fold in recent years due to the production of large

year-classes in 1983 and 1985. As in 1983, the vast majority of goldfish collected in 1985 were YOY fish less than 150 mm FL. Catch rates of carp and carp x goldfish hybrid (listed as minnow hybrid in Table 6.4-2 to 6.4-6) have followed a similar pattern.

Catch rates of yellow bullhead and brown bullhead also increased substantially in 1985 relative to previous years. Adult brown bullheads were abundant in 1981 electrofishing samples, but catches declined steadily thereafter through 1984, when yellow bullhead became the most common catfish in electrofishing samples. In the spring of 1985, large adults of both bullhead species were common in April through June samples, and by midsummer, many YOY of each were recruited to the electrofishing gear (Table 6.4-8).

A few YOY yellow bullhead were taken each year since 1981, but only four young brown bullheads were captured between 1981 and 1984. In 1985, 581 yellow bullheads and 256 brown bullheads less than 100 mm long were collected. A total of 16 YOY channel catfish was taken in 1985, the first time in recent years that young of this species were captured. These data indicate the production of by far the largest year class of yellow bullhead and brown bullhead in the river near LGS since the present program began in 1981. Possibly, the same is true for channel catfish, since 1985 was the only recent year in which young were collected. Only one adult white catfish was taken in 1985, and

no YOY was identified. This species is uncommon in the LGS vicinity and in 1985 did not produce a noticeable year class as did other catfishes.

Relative abundance indices for most species of sunfish declined somewhat in 1985 (Table 6.4-2). For example, overall catch rates for redbreast sunfish ranged between 33 and 87 fish/hour and averaged 52 fish/hour during the period 1981-1984. Redbreast sunfish were caught in 1985 at an overall rate of 17 fish/hour. The percent of the total catch comprised of redbreast sunfish fell from a 4-year (1981-1984) mean of 31% to 7%, but this index of relative abundance was in part lowered by the disproportionate quantity of YOY goldfish in the 1985 sample. Indices for most other species in the sunfish family similarly declined. Relative abundance of rock bass remained high for this species, and CPUE for smallmouth bass, 11 fish/hour, was the greatest yet seen due to the production of many YOY that appeared in late summer and autumn samples. Many YOY rock bass and redbreast sunfish were also captured, indicating that these sunfishes also reproduced successfully in 1985.

Relative abundance of several other species, including American eel, hybrid muskellunge x northern pike (listed as Esox hybrid on tables), golden shiner, and white sucker, was similar to that in recent years.

One young-of-year American shad was caught from S77640 in September. This specimen presumably was stocked earlier in the year by the Pennsylvania Fish Commission.

Target species known or thought to occur in the Schuylkill River near LGS, but not collected in 1985 were:

- bowfin
- brown and rainbow trout (stocked in tributaries)
- muskellunge (the stocked hybrid with northern pike was collected)
- redfin pickerel (a tributary species)
- chain pickerel (a tributary species)
- alewife (stocked as a forage species in upstream reservoirs and taken in low numbers on the LGS intake screens during the winter of 1985-1986)
- quillback
- margined madtom (a tributary species)
- yellow perch
- walleye (introduced)

Important Species

Several species were selected for close study due to their importance to the Schuylkill River fish community. Using NRC criteria (EROL), American eel, American shad, muskellunge, goldfish, white sucker, brown bullhead, redbreast sunfish,

pumpkinseed, and largemouth bass were the large fish species originally selected (EROL); smallmouth bass has since been considered important due to the increase in abundance of this predatory game fish (RMC 1984, 1985).

American eel

Thirty-five American eels were taken in 1985 at a rate of 0.9 per hour, which comprised 0.4% of the total electrofishing sample. Catch locations were more evenly distributed throughout the study area than in 1984, when two-thirds of eels captured came from the upper two stations (RMC 1984). This catadromous species has apparently maintained a low but stable population in the river.

American shad

A single juvenile American shad 125 mm FL weighing 28 g, was collected at S77640 on 18 September 1985. Earlier in the summer, the Pennsylvania Fish Commission stocked approximately 100,000 YOY American shad near the mouth of Manatawny Creek located upriver. It is presumed that the one American shad collected near LGS in 1985 came from that introduction.

Muskellunge

Recent introductions of large esocids have consisted primarily of the sterile hybrid of muskellunge with northern pike, the so-called "tiger muskellunge". Low numbers of juvenile Esox hybrids have been collected every year since 1983, and three were collected in 1985 that ranged in size from 236 to 270 mm FL.

Goldfish

The production of an exceptionally large year-class of goldfish has been noted previously. Numerous large adults were collected in early spring prior to the advent of spawning. Unlike those made in the 1970's (EROL), electrofishing collections since 1981 contained many goldfish longer than 250 mm FL. Goldfish grow rapidly in the river and probably mature sexually at a length of 185 mm (Carlander 1977). Since goldfish from the large 1983 year class were probably even longer and sexually mature at Age II, a large spawning stock could have contributed to the tremendous reproductive success seen in 1985. Any effect of spawning stock size on recruitment was undoubtedly confounded with the effect of apparently ideal spawning conditions, i.e., low, stable flows through the spawning season and an abundance of dense aquatic vegetation.

Only 5% of goldfish examined in 1985 were noticeably diseased in some way. Low incidence of disease is related to the abundance of YOY goldfish in the sample. Older fish are more likely to exhibit disease, and excluding those less than 185 mm FL, the rate of disease among goldfish was 27%. Parasitic copepods, fin damage, and body wounds were common maladies.

White sucker

This species ranked third in relative abundance in 1985, and has maintained a stable population in recent years. Overall catch rates since 1981 have varied only by a factor of 2.1 times, and have been even more stable since 1982. White suckers were taken in 1981 at a rate of 38 fish/hour. Catch rates in subsequent years were: 1982 - 16 fish/hour, 1983 - 26 fish/hour, 1984 - 19 fish/hour, and 1985 - 18 fish/hour.

The white sucker prefers mid-channel areas with current and was somewhat more abundant at S79310 and S76940 than at S77640 and S76440, where current is less swift. Numerous YOY white suckers were collected at all stations in late summer and early fall, indicative of a successful spawn. In 1985, 15% of white suckers examined were diseased, compared to from 8% to 13% of those examined in previous samples (EROL, RMC 1984, 1985). Fin damage, often associated with a bacterial or fungul infection,

and body wounds were often observed, especially in May when white suckers are weakened by post-spawning stress.

An undetermined but large number of white sucker died in an extensive fish kill in early August. The kill seemed to be selective for adults of white sucker and other resident species. Only one adult white sucker was captured in the entire August sample. By October, adult white suckers were taken in fair numbers at the upstream station, but were rare in samples from downstream stations.

Brown bullhead

Recent trends in relative abundance and the first record of significant reproductive success in many years for this important species were previously noted. The overall rate of disease in this species, 24%, was lower than that noted recently (RMC 1983, 1984). Excluding YOY fish, however, nearly one-half of older brown bullhead examined were diseased. Several afflictions were common, including tumors about the mouth, damaged and infected fins, and leech infestations.

Redbreast sunfish

Although a large year class of YOY was produced, the adult population of redbreast sunfish was noticeably reduced in 1985.

The decline in relative abundance was probably caused by attrition of adults from the large 1980 year class, and relatively weak representation of 1981 and 1982 year classes, exacerbated by the effects of the fish kill in early August. Even the strong 1983 year class was poorly represented in fall 1985 electrofishing samples.

The incidence of disease in redbreast sunfish, 9% in 1985, was similar to that seen in recent years.

Pumpkinseed

Relative abundance of pumpkinseed declined somewhat in 1985, as did that of several other sunfish species. Catch rate declined from a four-year (1981-1984) mean of 16 fish/hour to 8 fish/hour in 1985. Incidence of disease (7%) was similar to rates recently observed, falling within the range of 7% to 14% found in samples from 1981 through 1984.

Largemouth bass

Only 8 largemouth bass were collected in 1985 from the Schuylkill River near LGS, but this species has never been abundant in the area. Electrofishing surveys indicated a moderate increase in population density that peaked in 1984. Catch rates rose steadily from 0.4 fish/hour in 1981 to 1.1 fish/hour in

1984. In 1985, it took five hours of electrofishing effort to capture one largemouth bass. This important predatory species is known to be more abundant in the deeper, slower reaches of the river nearer to Philadelphia.

Smallmouth bass

Not as many adult smallmouth bass were collected in 1985 as in 1984, but the overall relative density of this important game fish was higher than in any previous year due to the production of the largest year class seen since 1981 when the present program began. YOY smallmouth bass also grew quickly. Many individuals attained a size of 130 to 140 mm FL. This rate of growth may be unusually rapid. Typically, smallmouth bass do not achieve a length of 150 mm until near the end of the second summer of life (R. Hoopes, Warmwater Unit Leader, Pennsylvania Fish Commission, personal communication).

Approximately 20% of Age I+ smallmouth bass were diseased, with mild infestations of blackspot the most common affliction. An undetermined number of smallmouth bass, primarily adults, died in the August 1985 fish kill.

Preliminary Assessment of LGS Operational Effects

Three readily identifiable factors operated in 1985 to potentially affect measurements of large fish species composition and relative abundance in the Schuylkill River near LGS. First, the river exhibited an unusually low, stable flow regime throughout the spring and early summer. Second, an undetermined but large number of fish died in a midsummer fish kill. Third, the start-up and testing of the Unit I reactor at LGS marked the initiation of cooling water withdrawal and discharge of cooling tower blowdown. Each of these factors will be examined in turn to make a preliminary assessment of LGS operational impacts on the large fish community.

Flow regime- Measurements of species composition and relative abundance were strongly influenced by production of exceptionally large year classes by many resident species. For goldfish and several catfish species, relative year class strength as determined by CPUE of YOY fish was the greatest on record. Relatively high numbers of YOY white sucker, redbreast sunfish, rock bass, and smallmouth bass were also captured. It is believed that the unusual flow regime in spring of 1985 was responsible for this degree of reproductive success. Several mechanisms associated with the absence of high, muddy flows probably operated to promote successful spawning:

- river temperatures condusive to spawning were reached early in the year
- eggs and larvae were not exposed to the damaging effects of cold, scouring floods
- nest guarding behavior of sunfishes was not disrupted by sudden drops in temperature
- dense weed beds developed rapidly and provided extensive nursery areas
- probably, a protracted spawning period and longer-than-normal growing season promoted above-average fry production and rapid growth of YOY fish.

Fish kill- After a fish kill in early August, a considerable drop in CPUE of larger adult fishes was observed in the August sample. Adult white sucker and redbreast sunfish seemed to be particularly affected. However, YOY fish of most species continued to be caught in great numbers. If a toxic "slug" was responsible for the kill, perhaps young fish escaped being killed because they inhabited the dense weed beds near shore. Adult fishes, on the other hand, tend to congregate along the outer edges of weed beds nearer to mid-channel, where exposure to a toxic substance might have been greater. The etiology of the fish kill, however, remains speculative.

Operation of LGS- Withdrawal of cooling water and discharge of cooling tower blow-down might affect populations of large fish

species if fish impingement on intake screens is high or selective for particular species, if a significant fraction of fish eggs and larvae are entrained, or if the plant's effluent somehow chemically or physically alters the river below the discharge to make it less productive for fish. Many of these effects may be evident only over a long period of time, and cannot be addressed with the limited amount of available operational data. Nothing was observed in 1985 to suggest that start-up and testing of LGS had an appreciable affect on local large fish populations. Changes in relative abundance noted earlier occurred throughout the reach at stations upstream and downstream of the plant.

No thermal discharge was detected any time during field sampling. Thus, attraction of fishes to a heated effluent, often seen in winter at power plants that discharge significant amounts of waste heat, should not occur at LGS. Poor weather and frozen or high flow river conditions prevented sampling of the discharge area in November and December of 1985, so a direct assessment of potential winter attraction cannot be made at present.

Only 135 fish were found in periodic impingement surveys. Although this count may be conservatively low, it is apparent that, when compared to the large population of fish in the river, this magnitude of impingement is insignificant. However, a noteworthy observation is the apparent selection of the screens for young catfish, which comprised 69% of the impingement sample

but less than 15% of the 1985 electrofishing catch. It is not known at this time, however, how selective the screens would be under different conditions.

In conclusion, the electrofishing program in 1985 detected ecologically significant changes in the relative abundance of many species in the Schuylkill River, specifically, tremendous year class production brought about by near optimum conditions for reproduction, and the effect of a substantial fish kill that was apparently selective for larger adult fish. Both phenomena occurred both upstream and downstream of LGS and were thus unrelated to plant operation. Given the magnitude of the effects from these factors, any effects from station operation on the large fish community of the Schuylkill River near LGS were not evident.

Table 6.4-1. Summary of the Schuylkill River electrofishing sample sites and dates.

Name	Station	Type		F	M	A	M	J	J	A	S	O	N	D	Total
Firestone	S79310	Upstream-control	1981			X		X		X		X			4
			1982			X			X	X		X			4
			1983				X	X	X	X	X	X			6
			1984			X	X	X	X	X	X	X			7
			1985			X	X	X	X	X		X			6
		*													27
Limerick A	S77640	Intake-affected	1981			X		X		X		X			4
			1982			X			X	X		X			4
			1983	X	X		X	X	X	X	X	X	X		9
			1984		X	X	X	X	X	X	X	X	X	X	10
			1985	X	X	X	X	X	X	X	X	X	X		10
		*													37
Limerick B	S76940	Discharge-affected	1981			X		X		X		X			4
			1982			X			X	X		X			4
			1983	X	X		X	X	X	X	X	X	X		9
			1984		X	X	X	X	X	X	X	X	X	X	10
			1985	X	X	X	X	X	X	X	X	X			9
		*													36
Limerick C	S76440	Recovery Zone	1981			X		X		X		X			4
			1982			X			X	X		X			4
			1983				X	X	X	X	X	X			6
			1984			X	X	X	X	X	X	X			7
			1985			X	X	X	X	X	X	X			7
		*													28
															128

Table 6.4-2. Species composition and relative abundance of large fishes electrofished from the Schuylkill River, 1985.

Species	Number Caught	Percent Total	Catch Per Hour
American eel	35	0.4	0.9
American shad	1	+	0.0
Esox hybrid	3	+	0.1
Goldfish	5061	51.6	125.3
Carp	405	4.1	10.0
Golden shiner	57	0.6	1.4
Fallfish	1	+	0.0
Minnow hybrid	30	0.3	0.7
White sucker	719	7.3	17.8
Creek chubsucker	11	0.1	0.3
White catfish	1	+	0.0
Yellow bullhead	913	9.3	22.6
Brown bullhead	510	5.2	12.6
Channel catfish	16	0.2	0.4
Rock bass	460	4.7	11.4
Redbreast sunfish	706	7.2	17.5
Green sunfish	65	0.7	1.6
Pumpkinseed	322	3.3	8.0
Bluegill	16	0.2	0.4
Lepomis hybrid	12	0.1	0.3
Smallmouth bass	456	4.6	11.3
Largemouth bass	8	+	0.2
White crappie	4	+	0.1
Black crappie	2	+	0.0
	9814		

+ = Less then 0.1%

Table 6.4-3. Annual relative abundance of target fishes from the Schuylkill River electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		S76440 9.17 Hr	S76940 10.88 Hr	S77640 14.82 Hr	S79310 5.52 Hr	Total 40.38 Hr
American eel	Catch	5	12	6	12	35
	%	0.3	0.3	0.2	0.8	0.4
	CPUE	0.55	1.10	0.40	2.17	0.87
American shad	Catch	-	-	1	-	1
	%	-	-	+	-	+
	CPUE	-	-	0.07	-	0.02
Esox hybrid	Catch	1	2	-	-	3
	%	0.1	0.1	-	-	+
	CPUE	0.11	0.18	-	-	0.07
Goldfish	Catch	715	2345	1542	459	5061
	%	40.5	66.7	50.9	30.6	51.6
	CPUE	77.97	215.53	104.05	83.15	125.32
Carp	Catch	73	174	117	41	405
	%	4.1	5.0	3.9	2.7	4.1
	CPUE	7.96	15.99	7.89	7.43	10.03
Golden shiner	Catch	-	9	48	-	57
	%	-	0.3	1.6	-	0.6
	CPUE	-	0.83	3.24	-	1.41
Fallfish	Catch	-	1	-	-	1
	%	-	+	-	-	+
	CPUE	-	0.09	-	-	0.02
Minnow hybrid	Catch	4	13	8	5	30
	%	0.2	0.4	0.3	0.3	0.3
	CPUE	0.44	1.19	0.54	0.91	0.74
White sucker	Catch	169	218	194	138	719
	%	9.6	6.2	6.4	9.2	7.3
	CPUE	18.43	20.04	13.09	25.00	17.80
Creek chubsucker	Catch	2	4	5	-	11
	%	0.1	0.1	0.2	-	0.1
	CPUE	0.22	0.37	0.34	-	0.27
White catfish	Catch	-	-	1	-	1
	%	-	-	+	-	+
	CPUE	-	-	0.07	-	0.02
Yellow bullhead	Catch	278	221	204	210	913
	%	15.7	6.3	6.7	14.0	9.3
	CPUE	30.32	20.31	13.77	38.04	22.61
Brown bullhead	Catch	74	150	259	27	510
	%	4.2	4.3	8.6	1.8	5.2
	CPUE	8.07	13.79	17.48	4.89	12.63
Channel catfish	Catch	5	1	3	7	16
	%	0.3	+	0.1	0.5	0.2
	CPUE	0.55	0.09	0.20	1.27	0.40
Rock bass	Catch	115	103	134	108	460
	%	6.5	2.9	4.4	7.2	4.7
	CPUE	12.54	9.47	9.04	19.57	11.39
Redbreast sunfish	Catch	155	126	102	323	706
	%	8.8	3.6	3.4	21.5	7.2
	CPUE	16.90	11.58	6.88	58.51	17.48
Green sunfish	Catch	9	4	26	26	65
	%	0.5	0.1	0.9	1.7	0.7
	CPUE	0.98	0.37	1.75	4.71	1.61
Pumpkinseed	Catch	29	70	210	13	322
	%	1.6	2.0	6.9	0.9	3.3
	CPUE	3.16	6.43	14.17	2.36	7.97

Table 6.4-3. Annual relative abundance of target fishes from the Schuylkill River electrofished in 1985 (+ = Less than 0.01%, CPUE = fish per hour).

Species		S76440 9.17 Hr	S76940 10.88 Hr	S77640 14.82 Hr	S79310 5.52 Hr	Total 40.38 Hr
Bluegill	Catch	7	3	3	3	16
	%	0.4	0.1	0.1	0.2	0.2
	CPUE	0.76	0.28	0.20	0.54	0.40
Lepomis hybrid	Catch	3	1	7	1	12
	%	0.2	+	0.2	0.1	0.1
	CPUE	0.33	0.09	0.47	0.18	0.30
Smallmouth bass	Catch	121	57	151	127	456
	%	6.9	1.6	5.0	8.5	4.7
	CPUE	13.20	5.24	10.19	23.01	11.29
Largemouth bass	Catch	2	2	4	-	8
	%	0.1	0.1	0.1	-	0.1
	CPUE	0.22	0.18	0.27	-	0.20
White crappie	Catch	-	-	4	-	4
	%	-	-	0.1	-	+
	CPUE	-	-	0.27	-	0.10
Black crappie	Catch	-	-	2	-	2
	%	-	-	0.1	-	+
	CPUE	-	-	0.13	-	0.05
	Catch	1767	3516	3031	1500	9814
	%					

Table 6.4-4. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S79310 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 0.80 Hrs	May 0.67 Hrs	Jun 0.82 Hrs	Jul 0.97 Hrs	Aug 1.07 Hrs	Oct 1.20 Hrs
American eel	Catch	-	2	3	2	4	1
	%	-	4.8	1.7	1.5	1.1	0.1
	CPUE	-	3.0	3.7	2.1	3.7	0.8
Goldfish	Catch	1	-	1	-	116	341
	%	3.8	-	0.6	-	32.7	44.5
	CPUE	1.3	-	1.2	-	108.4	284.2
Carp	Catch	-	-	1	-	8	32
	%	-	-	0.6	-	2.3	4.2
	CPUE	-	-	1.2	-	7.5	26.7
Minnow hybrid	Catch	-	-	-	-	-	5
	%	-	-	-	-	-	0.7
	CPUE	-	-	-	-	-	4.2
White sucker	Catch	7	14	37	7	3	70
	%	26.9	33.3	20.6	5.3	0.8	9.1
	CPUE	8.8	20.9	45.1	7.2	2.8	58.3
Yellow bullhead	Catch	8	3	12	23	119	45
	%	30.8	7.1	6.7	17.6	33.5	5.9
	CPUE	10.0	4.5	14.6	23.7	111.2	37.5
Brown bullhead	Catch	-	2	1	-	15	9
	%	-	4.8	0.6	-	4.2	1.2
	CPUE	-	3.0	1.2	-	14.0	7.5
Channel catfish	Catch	-	-	-	-	-	7
	%	-	-	-	-	-	0.9
	CPUE	-	-	-	-	-	5.8
Rock bass	Catch	1	2	36	30	18	21
	%	3.8	4.8	20.0	22.9	5.1	2.7
	CPUE	1.3	3.0	43.9	30.9	16.8	17.5
Redbreast sunfish	Catch	6	15	70	59	53	120
	%	23.1	35.7	38.9	45.0	14.9	15.7
	CPUE	7.5	22.4	85.4	60.8	49.5	100.0
Green sunfish	Catch	-	-	12	6	6	2
	%	-	-	6.7	4.6	1.7	0.3
	CPUE	-	-	14.6	6.2	5.6	1.7
Pumpkinseed	Catch	-	-	-	1	-	12
	%	-	-	-	0.8	-	1.6
	CPUE	-	-	-	1.0	-	10.0
Bluegill	Catch	-	-	2	1	-	-
	%	-	-	1.1	0.8	-	-
	CPUE	-	-	2.4	1.0	-	-
Lepomis hybrid	Catch	-	-	1	-	-	-
	%	-	-	0.6	-	-	-
	CPUE	-	-	1.2	-	-	-
Smallmouth bass	Catch	3	4	4	2	13	101
	%	11.5	9.5	2.2	1.5	3.7	13.2
	CPUE	3.8	6.0	4.9	2.1	12.1	84.2

Table 6.4-5. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S77640 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Feb 1.15 Hrs	Mar 1.03 Hrs	Apr 0.98 Hrs	May 1.00 Hrs	Jun 1.25 Hrs	Jul 1.48 Hrs	Aug 1.70 Hrs	Sep 2.08 Hrs	Oct 2.48 Hrs	Nov 1.65 Hrs
American eel	Catch	-	1	-	-	2	1	-	1	-	1
	%	-	3.7	-	-	1.2	1.3	-	0.1	-	0.2
	CPUE	-	1.0	-	-	1.6	0.7	-	0.5	-	0.6
American shad	Catch	-	-	-	-	-	-	-	1	-	-
	%	-	-	-	-	-	-	-	0.1	-	-
	CPUE	-	-	-	-	-	-	-	0.5	-	-
Goldfish	Catch	46	11	2	3	30	30	111	310	863	136
	%	41.4	40.7	11.8	4.9	18.4	38.0	50.7	43.5	69.6	33.9
	CPUE	40.0	10.7	2.0	3.0	24.0	20.3	65.3	149.0	348.0	82.4
Carp	Catch	3	-	1	3	4	2	8	21	49	26
	%	2.7	-	5.9	4.9	2.5	2.5	3.7	2.9	4.0	6.5
	CPUE	2.6	-	1.0	3.0	3.2	1.4	4.7	10.1	19.8	15.8
Golden shiner	Catch	3	-	-	-	1	1	-	26	13	4
	%	2.7	-	-	-	0.6	1.3	-	3.6	1.0	1.0
	CPUE	2.6	-	-	-	0.8	0.7	-	12.5	5.2	2.4
Minnow hybrid	Catch	1	-	-	-	-	-	-	1	5	1
	%	0.9	-	-	-	-	-	-	0.1	0.4	0.2
	CPUE	0.9	-	-	-	-	-	-	0.5	2.0	0.6
White sucker	Catch	6	-	3	13	41	8	4	53	42	24
	%	5.4	-	17.6	21.3	25.2	10.1	1.8	7.4	3.4	6.0
	CPUE	5.2	-	3.1	13.0	32.8	5.4	2.4	25.5	16.9	14.5
Creek chubsucker	Catch	-	-	-	-	-	-	-	3	2	-
	%	-	-	-	-	-	-	-	0.4	0.2	-
	CPUE	-	-	-	-	-	-	-	1.4	0.8	-
White catfish	Catch	-	-	-	-	1	-	-	-	-	-
	%	-	-	-	-	0.6	-	-	-	-	-
	CPUE	-	-	-	-	0.8	-	-	-	-	-
Yellow bullhead	Catch	3	2	2	2	5	2	34	101	27	26
	%	2.7	7.4	11.8	3.3	3.1	2.5	15.5	14.2	2.2	6.5
	CPUE	2.6	1.9	2.0	2.0	4.0	1.4	20.0	48.6	10.9	15.8
Brown bullhead	Catch	1	9	1	15	24	7	36	73	51	42
	%	0.9	33.3	5.9	24.6	14.7	8.9	16.4	10.2	4.1	10.5
	CPUE	0.9	8.7	1.0	15.0	19.2	4.7	21.2	35.1	20.6	25.5

Table 6.4-5. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S77640 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Feb 1.15 Hrs	Mar 1.03 Hrs	Apr 0.98 Hrs	May 1.00 Hrs	Jun 1.25 Hrs	Jul 1.48 Hrs	Aug 1.70 Hrs	Sep 2.08 Hrs	Oct 2.48 Hrs	Nov 1.65 Hrs
Channel catfish	Catch	-	-	-	-	-	-	-	3	-	-
	%	-	-	-	-	-	-	-	0.4	-	-
	CPUE	-	-	-	-	-	-	-	1.4	-	-
Rock bass	Catch	1	-	2	9	16	5	7	52	35	7
	%	0.9	-	11.8	14.8	9.8	6.3	3.2	7.3	2.8	1.7
	CPUE	0.9	-	2.0	9.0	12.8	3.4	4.1	25.0	14.1	4.2
Redbreast sunfish	Catch	1	-	-	9	16	6	2	23	27	18
	%	0.9	-	-	14.8	9.8	7.6	0.9	3.2	2.2	4.5
	CPUE	0.9	-	-	9.0	12.8	4.1	1.2	11.1	10.9	10.9
Green sunfish	Catch	2	1	1	-	-	2	1	10	6	3
	%	1.8	3.7	5.9	-	-	2.5	0.5	1.4	0.5	0.7
	CPUE	1.7	1.0	1.0	-	-	1.4	0.6	4.8	2.4	1.8
Pumpkinseed	Catch	23	3	2	5	20	4	9	28	71	45
	%	20.7	11.1	11.8	8.2	12.3	5.1	4.1	3.9	5.7	11.2
	CPUE	20.0	2.9	2.0	5.0	16.0	2.7	5.3	13.5	28.6	27.3
Bluegill	Catch	2	-	-	-	1	-	-	-	-	-
	%	1.8	-	-	-	0.6	-	-	-	-	-
	CPUE	1.7	-	-	-	0.8	-	-	-	-	-
Lepomis hybrid	Catch	1	-	-	-	1	-	-	2	2	1
	%	0.9	-	-	-	0.6	-	-	0.3	0.2	0.2
	CPUE	0.9	-	-	-	0.8	-	-	1.0	0.8	0.6
Smallmouth bass	Catch	10	-	3	2	1	11	7	4	46	67
	%	9.0	-	17.6	3.3	0.6	13.9	3.2	0.6	3.7	16.7
	CPUE	8.7	-	3.1	2.0	0.8	7.4	4.1	1.9	18.5	40.6
Largemouth bass	Catch	2	-	-	-	-	-	-	1	1	-
	%	1.8	-	-	-	-	-	-	0.1	0.1	-
	CPUE	1.7	-	-	-	-	-	-	0.5	0.4	-
White crappie	Catch	4	-	-	-	-	-	-	-	-	-
	%	3.6	-	-	-	-	-	-	-	-	-
	CPUE	3.5	-	-	-	-	-	-	-	-	-
Black crappie	Catch	2	-	-	-	-	-	-	-	-	-
	%	1.8	-	-	-	-	-	-	-	-	-
	CPUE	1.7	-	-	-	-	-	-	-	-	-

Table 6.4-6. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S76940 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Feb 0.92 Hrs	Mar 0.83 Hrs	Apr 0.98 Hrs	May 1.48 Hrs	Jun 0.90 Hrs	Jul 0.88 Hrs	Aug 1.33 Hrs	Sep 2.07 Hrs	Oct 1.48 Hrs
American eel	Catch	-	-	1	1	5	1	-	2	2
	%	-	-	2.6	1.1	3.4	0.8	-	0.2	0.1
	CPUE	-	-	1.0	0.7	5.6	1.1	-	1.0	1.4
Esox hybrid	Catch	-	-	-	-	-	-	-	-	2
	%	-	-	-	-	-	-	-	-	0.1
	CPUE	-	-	-	-	-	-	-	-	1.4
Goldfish	Catch	8	1	8	7	16	35	421	597	1252
	%	27.6	6.7	20.5	7.9	10.7	29.4	63.2	66.1	83.1
	CPUE	8.7	1.2	8.2	4.7	17.8	39.8	316.5	288.4	845.9
Carp	Catch	-	-	1	2	3	6	20	60	82
	%	-	-	2.6	2.2	2.0	5.0	3.0	6.6	5.4
	CPUE	-	-	1.0	1.4	3.3	6.8	15.0	29.0	55.4
Golden shiner	Catch	-	-	-	-	6	-	-	1	2
	%	-	-	-	-	4.0	-	-	0.1	0.1
	CPUE	-	-	-	-	6.7	-	-	0.5	1.4
Fallfish	Catch	-	-	-	-	-	-	-	1	-
	%	-	-	-	-	-	-	-	0.1	-
	CPUE	-	-	-	-	-	-	-	0.5	-
Minnow hybrid	Catch	-	-	-	-	-	-	1	1	11
	%	-	-	-	-	-	-	0.2	0.1	0.7
	CPUE	-	-	-	-	-	-	0.8	0.5	7.4
White sucker	Catch	16	1	10	11	25	16	27	88	24
	%	55.2	6.7	25.6	12.4	16.8	13.4	4.1	9.7	1.6
	CPUE	17.4	1.2	10.2	7.4	27.8	18.2	20.3	42.5	16.2
Creek chubsucker	Catch	-	-	-	-	-	-	1	-	3
	%	-	-	-	-	-	-	0.2	-	0.2
	CPUE	-	-	-	-	-	-	0.8	-	2.0
Yellow bullhead	Catch	2	4	8	2	3	4	95	72	31
	%	6.9	26.7	20.5	2.2	2.0	3.4	14.3	8.0	2.1
	CPUE	2.2	4.8	8.2	1.4	3.3	4.5	71.4	34.8	20.9
Brown bullhead	Catch	-	2	2	22	12	10	34	30	38
	%	-	13.3	5.1	24.7	8.1	8.4	5.1	3.3	2.5
	CPUE	-	2.4	2.0	14.9	13.3	11.4	25.6	14.5	25.7

Table 6.4-6. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S76940 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Feb 0.92 Hrs	Mar 0.83 Hrs	Apr 0.98 Hrs	May 1.48 Hrs	Jun 0.90 Hrs	Jul 0.88 Hrs	Aug 1.33 Hrs	Sep 2.07 Hrs	Oct 1.48 Hrs
Channel catfish	Catch	-	-	-	-	-	-	1	-	-
	%	-	-	-	-	-	-	0.2	-	-
	CPUE	-	-	-	-	-	-	0.8	-	-
Rock bass	Catch	-	2	2	12	13	9	37	11	17
	%	-	13.3	5.1	13.5	8.7	7.6	5.6	1.2	1.1
	CPUE	-	2.4	2.0	8.1	14.4	10.2	27.8	5.3	11.5
Redbreast sunfish	Catch	-	-	3	14	32	22	14	21	20
	%	-	-	7.7	15.7	21.5	18.5	2.1	2.3	1.3
	CPUE	-	-	3.1	9.5	35.6	25.0	10.5	10.1	13.5
Green sunfish	Catch	-	1	-	-	2	-	1	-	-
	%	-	6.7	-	-	1.3	-	0.2	-	-
	CPUE	-	1.2	-	-	2.2	-	0.8	-	-
Pumpkinseed	Catch	-	3	4	14	26	2	3	8	10
	%	-	20.0	10.3	15.7	17.4	1.7	0.5	0.9	0.7
	CPUE	-	3.6	4.1	9.5	28.9	2.3	2.3	3.9	6.8
Bluegill	Catch	-	-	-	2	1	-	-	-	-
	%	-	-	-	2.2	0.7	-	-	-	-
	CPUE	-	-	-	1.4	1.1	-	-	-	-
Lepomis hybrid	Catch	-	-	-	-	-	-	1	-	-
	%	-	-	-	-	-	-	0.2	-	-
	CPUE	-	-	-	-	-	-	0.8	-	-
Smallmouth bass	Catch	3	1	-	2	4	14	9	11	13
	%	10.3	6.7	-	2.2	2.7	11.8	1.4	1.2	0.9
	CPUE	3.3	1.2	-	1.4	4.4	15.9	6.8	5.3	8.8
Largemouth bass	Catch	-	-	-	-	1	-	1	-	-
	%	-	-	-	-	0.7	-	0.2	-	-
	CPUE	-	-	-	-	1.1	-	0.8	-	-

Table 6.4-7. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S76440 in 1985 (+ = Less than 0.1%, CPUE = fish per hour).

Species		Apr 1.10 Hrs	May 1.47 Hrs	Jun 1.02 Hrs	Jul 1.17 Hrs	Aug 1.20 Hrs	Sep 1.95 Hrs	Oct 1.27 Hrs
American eel	Catch	-	-	2	1	-	2	-
	%	-	-	1.9	1.2	-	0.4	-
	CPUE	-	-	2.0	0.9	-	1.0	-
Esox hybrid	Catch	-	-	1	-	-	-	-
	%	-	-	1.0	-	-	-	-
	CPUE	-	-	1.0	-	-	-	-
Goldfish	Catch	14	1	8	6	196	205	285
	%	17.9	1.8	7.7	7.5	45.7	36.0	63.1
	CPUE	12.7	0.7	7.8	5.1	163.3	105.1	224.4
Carp	Catch	-	-	-	1	42	15	15
	%	-	-	-	1.2	9.8	2.6	3.3
	CPUE	-	-	-	0.9	35.0	7.7	11.8
Minnow hybrid	Catch	1	-	-	-	-	2	1
	%	1.3	-	-	-	-	0.4	0.2
	CPUE	0.9	-	-	-	-	1.0	0.8
White sucker	Catch	-	4	9	23	14	74	45
	%	-	7.3	8.7	28.7	3.3	13.0	10.0
	CPUE	-	2.7	8.8	19.7	11.7	37.9	35.4
Creek chubsucker	Catch	-	-	-	-	2	-	-
	%	-	-	-	-	0.5	-	-
	CPUE	-	-	-	-	1.7	-	-
Yellow bullhead	Catch	8	7	7	7	69	162	18
	%	10.3	12.7	6.7	8.7	16.1	28.5	4.0
	CPUE	7.3	4.8	6.9	6.0	57.5	83.1	14.2
Brown bullhead	Catch	-	16	11	15	11	17	4
	%	-	29.1	10.6	18.8	2.6	3.0	0.9
	CPUE	-	10.9	10.8	12.8	9.2	8.7	3.1
Channel catfish	Catch	-	-	-	-	1	4	-
	%	-	-	-	-	0.2	0.7	-
	CPUE	-	-	-	-	0.8	2.1	-
Rock bass	Catch	30	15	19	2	12	28	9
	%	38.5	27.3	18.3	2.5	2.8	4.9	2.0
	CPUE	27.3	10.2	18.6	1.7	10.0	14.4	7.1
Redbreast sunfish	Catch	13	4	36	16	11	44	31
	%	16.7	7.3	34.6	20.0	2.6	7.7	6.9
	CPUE	11.8	2.7	35.3	13.7	9.2	22.6	24.4
Green sunfish	Catch	3	5	-	-	-	1	-
	%	3.8	9.1	-	-	-	0.2	-
	CPUE	2.7	3.4	-	-	-	0.5	-
Pumpkinseed	Catch	6	1	6	4	6	5	1
	%	7.7	1.8	5.8	5.0	1.4	0.9	0.2
	CPUE	5.5	0.7	5.9	3.4	5.0	2.6	0.8
Bluegill	Catch	3	-	3	-	-	-	1
	%	3.8	-	2.9	-	-	-	0.2
	CPUE	2.7	-	2.9	-	-	-	0.8
Lepomis hybrid	Catch	-	-	1	-	-	1	1
	%	-	-	1.0	-	-	0.2	0.2
	CPUE	-	-	1.0	-	-	0.5	0.8
Smallmouth bass	Catch	-	2	1	5	65	8	40
	%	-	3.6	1.0	6.3	15.2	1.4	8.8
	CPUE	-	1.4	1.0	4.3	54.2	4.1	31.5
Largemouth bass	Catch	-	-	-	-	-	1	1
	%	-	-	-	-	-	0.2	0.2
	CPUE	-	-	-	-	-	0.5	0.8

Table 6.4-8. Total catch of young-of-year catfishes in annual electrofishing samples from the Schuylkill River since 1981.

Species	1981	1982	1983	1984	1985
White catfish				1	
Yellow bullhead	5	1	22	7	581
Brown bullhead	4				256
Channel catfish					16

6.5 Age and Growth of Selected Fish

Summary

1. Redbreast sunfish age and growth characteristics and year-class strength were studied for fish collected in 1985 from the Schuylkill River.

2. Little difference in growth rate attributable to sample location was detected. Growth in 1984 was depressed due to high river flows and cool water temperatures. A much higher than average growth rate in 1985 was indicated by size at capture of young-of-year redbreast sunfish and by observed length at capture of older fish. Back-calculations from 1986 collections will be used to confirm this high growth rate.

3. Greatest linear growth continued to occur in the second year of life.

4. The 1983 and 1985 year-classes dominated the catch of redbreast sunfish. The 1985 year-class appears to be the strongest year-class in this decade.

Introduction and Methods

The age and growth program is part of a study designed to detect LGS operation-induced changes in the growth and year-class

strength of representative fish. Redbreast sunfish were selected for study on the Schuylkill River because they are considered important and representative and are collected in relatively large numbers in the vicinity of LGS. Direct and indirect effects of impingement, entrainment, or exposure to chemical or thermal discharges could cause mortality of fishes or produce changes in the growth rate and age structure of fish populations in the river.

Fish were aged by reading scale samples taken from specimens collected by electrofishing in the fall of the year, after most annual growth has been completed. Sample stations along the 3 km segment of the Schuylkill River included one upstream control (S79400) and two downstream stations (S77240 and S76440, intake and discharge affected, respectively).

Goals were set for sample size of 125 at each station, although it was known in advance that on occasion these goals would not be met. Only 99 redbreast sunfish could be collected at S77240 for the age and growth sample in 1985.

Methodology was fully described in Section 4.5 of the 1979-83 Progress Report (RMC 1984).

The age and size composition of the redbreast sunfish population in the sampled section of the Schuylkill River had an unusual effect on the sample size in the 1985 age and growth sample. Due to the abundance and rapid growth of young-of-year

(YOY; Age 0) redbreast sunfish, many YOY redbreast between 60 and 70 mm in length were collected as part of the sample. However, since these fish have no annuli on their scales, they cannot be utilized for back-calculating growth. This phenomenon reduced the effective sample size. In previous annual samples redbreast sunfish between 60 and 70 mm were almost exclusively Age I fish.

Results and Discussion

Age Determination and Growth History

Schuylkill River redbreast sunfish collected in 1985 were assigned to age-groups I-V on the basis of scale reading. Mean lengths at annulus were back-calculated for 258 fish (Table 6.5-1). Greatest linear growth occurred in the second year of life. Little difference in growth rate attributable to station could be detected.

Back-calculated mean lengths at annulus by age (Table 6.5-2) indicate that Age I and II redbreast sunfish grew slower than usual during 1984, reaching only 30 mm and 79 mm, respectively by the end of the year. This phenomenon had been predicted in the 1984 Progress Report (RMC, 1985). The retarded growth can be attributed to high, muddy flows and low temperatures which occurred throughout much of the growing season in 1984 (Tables 6.1-2 and 6.1-4).

Comparison of observed length at capture with back-calculated mean lengths (Table 6.5-3) shows that Age I and Age II fish have more than compensated for slow-growth during 1984 by growing exceptionally well during 1985. The high growth rate is attributable to the low clear flows and relatively high temperatures occurring during the 1985 growing season (Tables 6.1-2 and 6.1-4). This high rate of growth in 1985 should be readily observable in back-calculations for fish to be collected in the 1986 sample.

Year Class Strength

Redbreast sunfish collected from the Schuylkill River in 1985 displayed a slightly uneven age distribution (Table 6.5-4). This phenomenon was almost completely due to the great difference between levels of reproductive success in 1983 and 1984. The predominant 1983 year-class (Age II) comprised 55.0% (142 of 258) of the fish collected. Age I fish (1984 year-class) comprised only 9.3% (24 of 258) of fish collected. In a hypothetical situation, where reproductive success is constant, numbers of Age I fish should exceed numbers of Age II fish due to the longer period of time during which the older fish are subjected to natural mortality. In this sample the opposite relationship exists, with Age II redbreast sunfish being nearly six times as abundant as Age I fish. Also collected concurrently with the age and growth sample were 77 Age 0 (YOY) fish. These fish represent

the fastest-growing individuals of the very abundant 1985 year-class. The overwhelming numbers of this year-class are readily apparent in both electrofishing and seine samples. A length-frequency histogram for redbreast sunfish collected in September and October 1985 (Figure 6.5-1) illustrates the size of the 1985 year-class (fish less than approximately 75 mm) relative to older year-classes. From this sample it appears that the 1985 year-class is about ten times more abundant than any other group. Seine samples indicated that the 1985 year-class of redbreast sunfish was at least twice as large as any previously studied year-class and many times larger than the relatively weak 1984 year-class.

It is thought that the relative scarcity of older redbreast sunfish may be related to the fish kill which occurred for several days after 31 July 1985. The kill appeared to be selective for older, larger fish. In addition, the dearth of older fish may also be related to low water levels that caused larger fish to seek deep water areas outside our sampling zones.

Comparison with Previous Findings

Greatest growth of redbreast sunfish continued to occur in the second year of life, a characteristic of all annual samples. The predominant 1983 year-class continued to be evident, although

it declined from 74.9% of the 1984 sample to 55.0% of the 1985 sample.

Modal length at capture for one-year-old redbreast sunfish had been previously examined with annual length-frequency histograms. This procedure, however, was not effective utilizing the 1985 sample because Age I fish were not numerous enough to generate a curve (Figure 6.5-1). The mode had varied from 75 to 95 in previous samples.

Back-calculated mean lengths for annual samples collected in 1973, 1975, 1981, 1983, 1984, and 1985 are shown in Table 6.5-5. Back-calculated lengths at annuli I, II, and III for fish collected in 1985 show slight decreases in length compared with previous years, notably length at annulus II (84 mm). These differences appear to be related to the previously discussed poor growth conditions in 1984.

Operation of LGS could have had, at most, a negligible effect on the growth and year-class strength of Schuylkill River redbreast sunfish. Hydrological conditions which affected these characteristics of the population were firmly in place many months prior to withdrawal of any substantial amounts of water from the river, which began in August 1985. Hydrological conditions which produced excellent reproduction and good growth in 1985 were related to extremely low, stable water levels and high

temperatures. Stable river flow and warm temperatures allowed early spawning (and thus a longer effective growing season for YOY redbreast), good parental care of nests, fast growth due to high metabolism of fish and high productivity of supporting trophic levels, and good survival of small redbreast sunfish due to cover provided by lush growth of aquatic vegetation. No differences in growth rates or age composition could be detected between control and downstream stations.

Table 6.5-1. Back-calculated mean lengths (mm) at annulus for Redbreast sunfish collected from the Schuylkill River during 1985.

			Mean Length at Annulus			
Year	Location	No. of Specimens	I	II	III	IV
1985	S79400	95	40	86	130	156
	S77240	58	39	85	123	145
	S76440	105	38	81	123	156
*		258	39	84	126	153

Table 6.5-2. Back-calculated mean lengths (mm) at annulus by age for Redbreast sunfish collected from the Schuylkill River during 1985.

			Mean Length at Annulus			
Year	Age	No. of Specimens	I	II	III	IV
1985	1	24	30	N/A	N/A	N/A
	2	142	40	79	N/A	N/A
	3	53	38	89	124	N/A
	4	32	45	95	131	155
	5	7	37	79	110	143
*		258	39	84	126	153

Table 6.5-3. Comparison of back-calculated mean lengths (mm) at annulus with observed mean lengths (mm) at capture of Redbreast sunfish collected from the Schuylkill River, October 1985.

		Back-calculated	Observed mean		
Annulus	No.	mean length	length at capture	No.	Age
I	258	39	65	77	0
II	234	84	89	24	I
III	92	126	132	142	II
IV	39	153	155	53	III
			172	32	IV

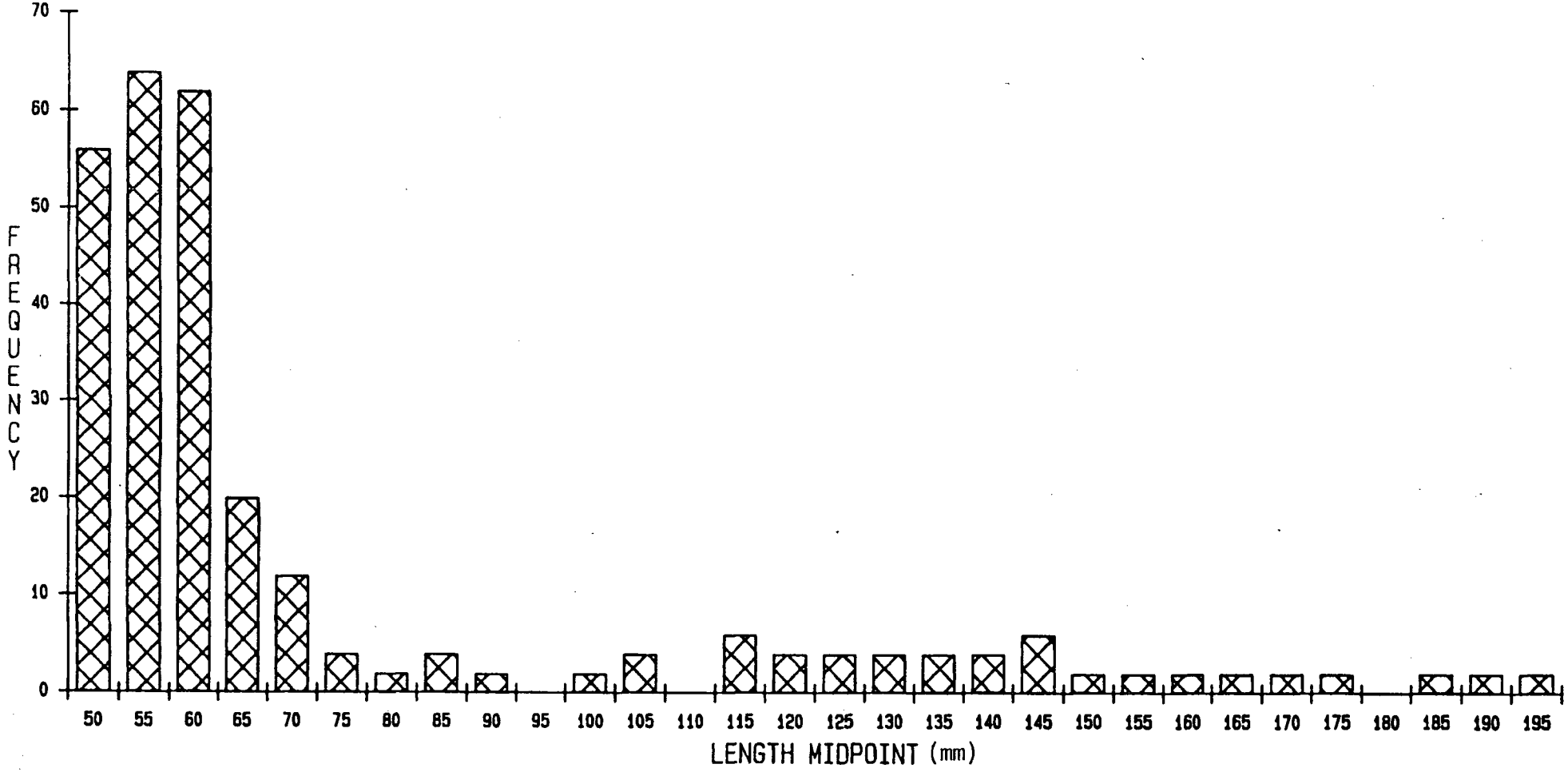
Table 6.5-4. Age composition of Redbreast sunfish collected from the Schuylkill River in 1985.

		Number of Specimens					
Year	Location	I	II	III	IV	V	TOTAL
1985	S79400	12	50	19	12	2	95
	S77240	4	36	8	6	4	58
	S76440	8	56	26	14	1	105
*		24	142	53	32	7	258

Table 6.5-5. Back-calculated mean lengths (mm) at annulus for Redbreast sunfish collected from the Schuylkill River 1973, 1975, 1981, 1983, 1984 and 1985.

		Mean Length at Annulus				
Year	No. of Specimens	I	II	III	IV	V
1973	521	38	92	130	144	153
1975	88	41	91	116	111	
1981	355	46	95	132	155	156
1983	318	43	95	133	162	
1984	398	41	89	128	153	163
1985	258	39	84	126	153	156

FIGURE 6.5-1. LENGTH FREQUENCY DISTRIBUTION OF REDBREAST SUNFISH COLLECTED FROM THE SCHUYLKILL RIVER, SEPTEMBER AND OCTOBER 1985.



6.6 Creel Survey

Summary

1. In 1985, fishing pressure on the Schuylkill River near LGS was estimated at 4,228 angler-hours, the lowest amount measured in 6 years. Lower fishing pressure may have been caused by poorer access to several shoreline fishing areas. Access to the stream was further restricted by posting of private land and the closing of a delapidated bridge within the study area.

2. Angler success in terms of fish caught per unit of fishing effort was moderate in 1985. The fishery is mostly a catch-and-release recreational fishery directed at sunfishes, smallmouth bass, carp, and catfishes.

3. An estimated 6,679 fish of 15 species or hybrids were caught but only 12% of this total (782 fish) were actually harvested. Total weight of harvest was estimated at 176.1 kg for the season, or about 4.1 kg/ha or 20.5 kg/km of stream.

4. Compared to past creel surveys, a higher proportion of anglers used boats to fish the Schuylkill River near LGS in 1985, but the age and sex composition of the angling population did not change substantially. The propor-

tional increase in boating activity probably resulted from the reduction in shoreline access mentioned previously.

5. Unlike the situations at several other power-plants in southeastern Pennsylvania, no winter fishery has developed near the LGS discharge. Poor access and the very limited degree of thermal enrichment are two factors that will likely preclude the development of any significant winter fishery.

Introduction and Methods

A survey of recreational fishing on an 8.6-km reach of the Schuylkill River near LGS began in 1980 and continued in 1985 for the sixth consecutive fishing season (April-September). Fishery characteristics that were investigated include: 1) monthly fishing pressure occurring between river meters 71860 and 80450; 2) locations frequented by anglers; 3) monthly catch and harvest by species; and 4) information about preferred fish species, access, and the age and sex composition of anglers. Creel survey data can augment studies of fish population dynamics and are useful in fisheries management. Fishing mortality provides a relative measure with which to place fish impingement losses in perspective, thus helping to evaluate the ecological significance of power-plant impacts (Mathur et al. 1977, Denoncourt 1984).

A roving creel survey based on a nonuniform probability sampling design was used to gather information on the recreational fishery near LGS. The design was similar to ones used by Pfieffer (1966), Malvestuto et al. (1978), Euston and Mathur (1979), and is described in detail in RMC (1984).

Results and Discussion

Fishing Pressure

Estimates of monthly fishing pressure with standard errors and coefficients of variation (CV) were calculated for the period April-September 1985 (Table 6.6-1). Estimated fishing pressure for the season was the lowest measured in any year since the survey was initiated in 1980, despite relatively stable weather and stream conditions throughout most of the spring and summer. It is probable that restricted access to several popular fishing locations within the survey reach has discouraged angler use of the Schuylkill River near LGS. Although a majority of anglers fished from the same shoreline access areas identified in past years (Table 6.6-2), there was an increase in the proportion of anglers using boats (Table 6.6-3), from 26% in 1984 to 40% in 1985. Over 50% of the boat angling activity took place between the Vincent Dam tailwater (river meter 71860) and Linfield (river meter 75400) in the lower half of the creel survey reach. Meanwhile, the proportion of angler use at two shoreline access

points upstream of LGS, Sanatoga Creek and Sprogles Run, collectively declined from 49% of total anglers in 1984 to 36% in 1985. The amount of fishing adjacent to the LGS site was again low in 1985. Only 10 anglers, or 7% of the total seen in 1985, fished between river meters 76840 and 77720, which is approximately the reach of the Schuylkill River bounded on one shore by LGS. Several of these sightings were of one gentleman, a PECo employee who regularly used the RMC boat ramp to gain access to this limited section of the Schuylkill River. Incidentally, there has been no observations of angler use below the cooling tower blowdown discharge structure in either the winter of 1984-1985 or 1985-1986, despite the start-up and testing of the Unit I reactor at LGS, which from time to time may have produced a slightly heated effluent. Winter-time fisheries have developed near some other generating stations with heated discharges in southeast Pennsylvania (Euston and Mathur 1979, Denoncourt 1984), but because of limited access and the slight degree of thermal enrichment, a similar fishery is not likely to develop at LGS.

Catch and Harvest

Total catch, effort, and catch-per-unit-effort (CPUE in fish/angler-hour) calculated from the results of angler interviews are presented in Table 6.6-4. Monthly CPUE ranged from 0.33 fish/angler-hour in July to 6.30 fish/angler-hour in

September. Overall CPUE for the year, 1.50 fish/angler-hour, was intermediate in the range of values observed since 1980. The projected angler catch of 6,679 fish of 15 species or hybrids (Table 6.6-5) was the lowest seasonal total yet observed but can be attributed more to the lesser amount of fishing pressure measured in 1985 than to below normal catch rates. Peak catches occurred in June, August, and September, while only an estimated 74 fish were caught by anglers in July. Redbreast sunfish was the most common species in the Lepomis sunfish group which dominated the projected catch, and probably was the species most often caught, although catches of smallmouth bass and rock bass exceeded the identifiable redbreast sunfish catch (Table 6.6-5).

The harvest rate for 1985 amounted to 0.18 fish/angler-hour (Table 6.6-4), yielding an estimated seasonal harvest of 782 fish of 12 species or hybrids (Table 6.6-6). Anglers released 88% of the fish they reportedly caught in 1985, including 96% of the recreationally important smallmouth bass. These release rates are similar to those found in the past. Although high release rates are caused in part by small fish size, there is considerable anecdotal evidence that harvestable-size fish are frequently released as well. Data are insufficient, however, to estimate the release rate of fish larger than the legal minimum. In contrast, Paragamian (1984) found it uncommon to hear of smallmouth bass being released from the Maquoketa River, Iowa. Austen

(1984) found that imposing a 305-mm minimum length limit increased the release rate of smallmouth bass in a Virginia section of the New River, compared to a similar section of the New River in West Virginia where there was no length limit. Through the 6-year course of this study, about 50% of smallmouth bass observed in anglers' creels were shorter than the 254-mm minimum legal length imposed in 1981 on Pennsylvania streams, while about 30% have been shorter than the previously imposed minimum length, 229 mm.

Estimates of harvested weight were calculated for species appearing in anglers' creels in 1985 (Table 6.6-7). Low sample size prevented making precise estimates of harvested weight in many cases, but for some species harvested weight was at least roughly estimated. Estimated total harvest amounted to 176.1 kg, or about 4.1 kg/ha or 20.5 kg/km for the survey reach. Four species, carp, smallmouth bass, goldfish, and redbreast sunfish, collectively comprised almost 75% of the total weight of fish harvested in 1985.

Characteristics of Anglers

There were no major changes in the age or sex composition of Schuylkill River anglers compared to information collected in previous creel surveys (Table 6.6-3). In 1985, 93% of anglers

interviewed were males, and nearly 75% were 16 years of age or older and hence required a fishing license.

As previously stated, there was an increase in the proportion of anglers accessing the stream in boats, possibly due to restricted shoreline access at several locations (Table 6.6-3). Most fishing effort was directed at "bass" or "anything"; catfishes and muskellunge were also preferred by many anglers (Table 6.6-8).

Table 6.6-1. Monthly fishing pressure estimates in angler-hours, with standard errors and coefficients of variation (in %) from the 1985 Schuylkill River creel survey.

Month	Number of survey trips	Fishing pressure	Standard error	Coefficient of variation
Apr	8	890	190	21
May	9	749	226	30
Jun	9	1341	337	25
Jul	9	225	161	71
Aug	9	555	155	28
Sep	8	468	205	44
Total	52	4228		

Table 6.6-2. Number of anglers interviewed at Schuylkill River access points during 1985.

Access Point	Meter Number	1985
Below Vincent Dam	71959	16
Vincent Dam	71960	11
State Game Lands	71980	6
Home Water Co. Dock	73880	12
Pigeon Creek	74870	3
Linfield RR Bridge	75250	4
Linfield Boat Ramp	75350	6
Linfield Auto Bridge	75400	24
Above Linfield	76839	3
Brooke Evans Run	76840	5
Lower Limerick Run	77239	1
Diffuser	77240	2
PEL Ramp	77720	2
Upper Limerick Run	79039	2
Sanatoga Bridge	79060	22
Sanatoga Creek	79110	10
Firestone Run	80099	2
Sprogles Run	80120	8
Firestone Gate Two	80450	10
		149

Table 6.6-3. Age and sex composition and mode of access for anglers interviewed on the Schuylkill River during 1985.

Sex	Number	%
Males	135	93
Females	10	7
	145	100
Age(Years)		
Child (<13)	19	13
Teen (13-19)	32	22
Adult (20-64)	94	65
	145	100
Mode of Access		
Boat	59	40
Bridge	6	4
Shore	83	56
Wading	1	1
	149	100

Table 6.6-4. Observed catch, effort (in angler-hrs) and catch-per-unit-effort (CPUE in fish/angler-hr) by month from the Schuylkill River in 1985.

Total Catch

Month	Catch	Effort	CPUE
April	37	69.3	0.53
May	44	73.1	0.60
June	57	51.7	1.10
July	10	30.5	0.33
August	94	41.5	2.27
September	206	32.7	6.30
Annual	448	298.8	1.50

Harvest
(Fish Kept)

Month	Catch	Effort	CPUE
April	7	69.3	0.10
May	4	73.1	0.05
June	4	51.7	0.08
July	0	30.5	0.00
August	23	41.5	0.55
September	17	32.7	0.52
Annual	55	298.8	0.18

Table 6.6-5. Species composition and estimated angler catch from the Schuylkill River in 1985.

Species	Apr Catch	May Catch	Jun Catch	Jul Catch	Aug Catch	Sep Catch	Total Catch
Brown trout	-	10	-	-	-	14	25
Carp	-	-	-	-	188	43	231
Goldfish	-	-	-	-	54	-	54
Yellow bullhead	-	-	-	-	-	14	14
Brown bullhead	13	10	-	-	13	-	36
Channel catfish	-	-	-	7	13	-	21
Unidentified catfish	51	10	-	-	161	86	308
Bluegill	-	-	-	-	-	29	29
Pumpkinseed	13	-	26	-	40	43	122
Green sunfish	-	-	-	-	-	14	14
Redbreast sunfish	26	20	52	-	-	200	298
Unidentified sunfish	268	143	776	15	509	1302	3014
Rock bass	13	61	26	-	161	472	733
White crappie	-	-	26	-	-	-	26
Black crappie	-	-	-	-	-	14	14
Unidentified crappie	-	51	-	-	-	72	123
Smallmouth bass	89	143	233	45	40	644	1194
Unidentified bass	-	-	336	-	80	-	417
Yellow perch	-	-	-	7	-	-	7
	472	449	1475	74	1260	2948	6679

Table 6.6-6. Species composition and estimated angler harvest from the Schuylkill River in 1985.

Species	Apr Harvest	May Harvest	Jun Harvest	Aug Harvest	Sep Harvest	Total Harvest
Brown trout	-	9	-	-	-	9
Carp	-	-	-	27	-	27
Goldfish	-	-	-	53	-	53
Brown bullhead	13	-	-	13	-	26
Bluegill	-	-	-	-	29	29
Pumpkinseed	13	-	27	40	-	79
Green sunfish	-	-	-	-	14	14
Redbreast sunfish	13	19	54	-	172	257
Unidentified sunfish	-	-	-	159	-	159
Rock bass	13	-	-	-	14	27
White crappie	-	-	27	-	-	27
Black crappie	-	-	-	-	14	14
Smallmouth bass	38	9	-	-	-	48
Unidentified bass	-	-	-	13	-	13
	89	37	107	305	243	782

Table 6.6-7. Estimated weights of projected angler harvest by species, and statistics used in their calculation, from the 43-ha, 8.6-km creel survey reach on the Schuylkill River in 1985. Total harvested weights are also expressed in kg/ha and kg/km of stream.

Species	Number in creel	Mean weight (g)	Number harvested	Harvested weight (kg)	Harvest per unit of stream (kg/ha)	(kg/km)
Brown trout	1	711	9	6.4	0.15	0.74
Carp	2	1616	27	43.7	1.02	5.08
Goldfish	4	533	53	28.2	0.66	3.28
Brown bullhead	2	508	26	13.2	0.31	1.53
Bluegill	2	110	29	3.2	0.07	0.37
Pumpkinseed	4	129	79	10.2	0.24	1.19
Green sunfish	1	64	14	0.9	0.02	0.10
Redbreast sunfish	17	104	257	26.7	0.62	3.10
Rock bass	2	128	27	3.5	0.08	0.41
White crappie	2	205	27	5.5	0.13	0.64
Black crappie	1	205	14	2.9	0.07	0.34
Smallmouth bass	4	519	61[1]	31.7	0.74	3.69
Total[2]				176.1	4.11	20.47

[1]Includes 13 unidentified bass harvested in September, assumed to be smallmouth bass.

[2]Total excludes weight of 159 unidentified sunfish harvested in August.

Table 6.6-8. Preferred fishes of Schuylkill River anglers during 1985.

Number of anglers identifying as:

Category	1st Choice	2nd Choice	Total
Anything	66	-	66
Bass	52	10	62
Catfish	13	6	19
Muskellunge	4	10	14
Carp	6	1	7
Sunfish	4	3	7
Walleye	-	2	2
Goldfish	1	-	1

6.7 Impingement

Summary

1. Fish impinged at the LGS Schuylkill River cooling water intake were surveyed on 16 dates in 1985.

2. A total of 135 fish representing seven species were impinged: Young-of-year (YOY) catfish (69%), sunfish (12%), and goldfish (10%) comprised 91% of impinged fish.

3. The greatest numbers of fish (79% of annual total) were impinged on 30 September during elevated Schuylkill River discharge resulting from rains associated with Hurricane Gloria.

Introduction and Methods

A postoperational impingement survey was initiated at the LGS Schuylkill River pump station (cooling water intake) on 29 April 1985 and continued to the end of the year. No prior survey had been conducted.

The objective of this program was to evaluate the level of fish mortality caused by impingement against the rotating debris collection screens at the pump station. An additional objective was to observe species and sizes of fish impinged by the screens.

The survey was conducted weekly, biweekly or at greater intervals of time depending upon river conditions and the expected level of impingement based on prior experience at other generating stations. A list of sampling dates is included in Table 6.7-1. Debris collected from the Schuylkill River by the rotating screens was deposited in a trash bin. Impinged fish were manually sorted from the debris and counted. Unless badly decomposed, each fish was identified and measured to the nearest mm fork length (FL). After processing, dead fish were returned to the trash bin. Live fish were processed and returned to the river.

Mixing of impinged fishes from different survey intervals was prevented by placing a clean plastic sheet over each mass of sorted debris. Fish that occasionally spilled onto the pump station floor were processed, returned to the trash bin, and covered by the new plastic sheet. The plastic sheet effectively separated fish from different survey intervals, and since the indoor location of the trash bin prevented scavenging of dead fish, both the number of fish impinged and the rate at which they accumulated were estimated closely. A few small fish were probably missed because they either decomposed or were lost amidst a large volume of debris, but the extent to which this occurred was considered small.

Results and Discussion

Throughout the survey period, a total of 135 fish of seven species was found (Table 6.7-1). YOY catfish comprised 69% of the annual total; sunfish and goldfish comprised 12% and 10%, respectively. The remainder consisted of minnows, rock bass, white suckers, and unidentifiable fish.

River discharge had an apparent effect on the level of impingement. Nearly 80% of the total number of fish impinged during the survey were collected on 30 September 1985, following a period of heavy rains and elevated river flow associated with Hurricane Gloria. During periods of high flow fish must seek shelter near shore and those moving near the water intake may be more susceptible to impingement at those times.

Most fish impinged were YOY. The 1985 year classes of most species were extremely strong (see Section 6.3-Fishes Collected by Seine) and these small fish are more susceptible to impingement than stronger-swimming larger individuals.

In conclusion, the survey provided a reasonable estimate of total fish impingement in 1985. The number of fish impinged was a very small percentage of the fish population present in the Schuylkill River in the vicinity of LGS (see Sections 6.3-Fishes Collected by Seine and 6.4-Fishes Collected by Electrofishing). Impingement appeared to be selective for YOY fish, particularly

young catfish. YOY brown bullhead and yellow bullhead together comprised a much larger fraction of the impingement sample than of seine or electrofishing samples. Nevertheless, the number impinged was only a negligible fraction of the population of young catfish in the vicinity. Compared to angling mortality (see Section 6.4-Creel Survey) the number of adult fishes lost to impingement was also quite small. Therefore, impingement of fishes on the LGS intake screens was of little ecological significance.

Table 6.7-1. Fish observed during impingement surveys at the Limerick Generating Station Schuylkill River cooling water intake screens.

Date	Total numbers found	Species	Number per species	Fork length (mm)
4-29-85	1	White sucker	1	321
5-06-85	2	Redbreast sunfish	2	114, 139
5-13-85	0	-	-	-
5-23-85	0	-	-	-
5-28-85	0	-	-	-
6-21-85	0	-	-	-
7-05-85	2	Redbreast sunfish	2	36, 41
7-19-85	3	Redbreast sunfish	2	31, 36
		minnow	1	73
7-29-85	0	-	-	-
8-26-85	5	Redbreast sunfish	2	53, 55
		Catfish sp.	3	72, 77, 79
9-16-85	7	Redbreast sunfish	4	41, 46, 53, 55
		Yellow bullhead	1	81
		Goldfish	2	99, 105
9-27-85	4	Redbreast sunfish[1]	1	33
		Yellow bullhead[1]	1	56
		Goldfish	1	75
		White sucker	1	83

Table 6.7-1. Fish observed during impingement surveys at the Limerick Generating Station Schuylkill River cooling water intake screens.

Date	Total numbers found	Species	Number per species	Fork length (mm)
9-30-85[2]	107	Redbreast sunfish	3	38, 116, 172
		Sunfish	1	47
		Yellow bullhead	13	69, 70, 75, 83, 86, 87, 89 92, 97, 99, 100, 101, 111
		Brown bullhead	9	72, 77, 86, 101, 101, 102 105, 110, 209
		Catfish	65	68, 73, 75, 76, 76, 76, 76 77, 78, 78, 79, 79, 81, 82 82, 83, 83, 84, 84, 85, 86 86, 87, 88, 89, 89, 90, 90 90, 91, 91, 92, 92, 92, 92 92, 93, 94, 94, 94, 95, 95 95, 96, 96, 97, 98, 99, 100 100, 100, 100, 101, 101, 105 105, 106, 110, 111, 111, 113 116, 120, 125, 145
		Rock bass	3	44, 146, 168
		Goldfish	7	102, 102, 108, 121, 134 142, 162
		Unidentified	6	-
10-7-85	3	Catfish sp.	1	210
		Goldfish	2	106, 127
10-16-85	1	Goldfish	1	133
11-14-85[3]	0	-	-	-

[1] - Fish found alive
[2] - After Hurricane Gloria
[3] - Survey area flooded out by clogged drain

7.0 Asiatic Clam

Summary

1. Field surveys for the presence of Corbicula were conducted in late summer and early fall at 2-4 mile intervals in the Delaware River, Schuylkill River, and Perkiomen Creek.

2. Corbicula was found in the Delaware River from near the Commodore Barry Bridge (river mile 81.8) to Washington Crossing State Park (river mile 146.0), only 11 miles downriver of the Delaware River intake for the proposed water diversion, and in the Schuylkill River from its mouth (river mile 0) to Black Rock Dam (river mile 36), only 3 miles and 11 miles downriver of Cromby Generating Station and LGS, respectively.

3. Corbicula was not found in the Perkiomen Creek, nor was it observed in benthic macroinvertebrate samples collected in the East Branch Perkiomen Creek.

Introduction and Methods

Studies of Asiatic clam (Corbicula fluminea) conducted in 1982-84, including both qualitative survey of the species' distribution in the Delaware and Schuylkill Rivers and Perkiomen

Creek and quantitative sampling conducted in the Schuylkill River at Norristown, were considered part of non-radiological environmental monitoring at Limerick Generating Station (LGS) and reported as such (RMC-Environmental Services 1984 and 1985). However, only the 1985 qualitative survey will be described in this report. The Corbicula studies have expanded in response to increased concern for biofouling at several additional generating stations and now are not considered to be part of LGS non-radiological monitoring. Consequently, the results of these studies will appear in a separate report.

In short, field surveys were conducted in late summer and early fall at approximately 2-4 mile intervals on the Delaware River from the Commodore Barry Bridge (river mile 81.8) to Pt. Pleasant, Pennsylvania (river mile 157.2); on the Schuylkill River from its mouth (river mile 0) to LGS (river mile 48); and on the Perkiomen Creek from its mouth (river mile 0) to the Schwenksville Road bridge (river mile 12.0). At locations where water depth permitted, the stream or river bottom was visually scanned for Corbicula shells. Samples of stream or river bottom materials were collected and washed through a 3.2 mm mesh sieve and inspected for Corbicula at all stations.

Results and Discussion

The results of 1985 qualitative sampling for the presence of Corbicula in the Delaware and Schuylkill Rivers and Perkiomen Creek are shown in Tables 7.0-1, 2, and 3, respectively. For ease of comparison, data obtained in 1982, 1983, and 1984 also are included in these tables.

Attention is drawn to the misidentification of Burlington Generating Station as Croydon Generating Station on Table 7.0-1 in the previous reports (RMC-Environmental Services 1984 and 1985). This location is at Delaware River mile 117.0.

Sampling in 1985 indicated continued presence of Corbicula in the Delaware River (Table 7.0-1). Distribution of the population in the lower study reach from near the Commodore Barry Bridge (river mile 81.8) to the Tacony Palmyra Bridge (river mile 107.1) appeared to be spotty in that living clams were collected at only a few sample stations. This may be a reflection of less than optimal habitat conditions in this part of the river.

In the upper end of the Delaware River study reach, Corbicula was found to be present at Washington Crossing State Park at river mile 146.0 (Table 7.0-1). This represents a range extension of 4 miles since 1984, reducing the distance to the Delaware River intake for the proposed water diversion to approximately 11 miles.

In 1985, living Corbicula were collected at only 1 of 8 sample stations within the tidal reach (river miles 0-8) of the Schuylkill River (Table 7.0-2). As in the Delaware River, Corbicula distribution probably was restricted by less than favorable habitat conditions. With one exception, Corbicula was found to be present at all sample stations from Fairmount Dam (river mile 8) to Black Rock Dam (river mile 36). Collection of Corbicula at Black Rock Dam represents a 7 mile upriver extension of the species' range and places it approximately 3 miles from Cromby Generating Station and approximately 11 miles from LGS.

Corbicula was not collected at any sample station in the Perkiomen Creek (Table 7.0-3). However, it is noteworthy that the range of Corbicula in the Schuylkill River includes the Perkiomen Creek confluence. Therefore, the appearance of Corbicula in Perkiomen Creek probably will occur shortly.

The East Branch Perkiomen Creek was not part of the 1985 Corbicula qualitative survey program. However, the species was not collected at the 6 sample stations that are part of the benthic macroinvertebrate sampling program (see Section 4.2 Benthic Macroinvertebrates).

Table 7.0-1. Results of qualitative sampling for *Corbicula* in the Delaware River, 1982-1985.

Location (River Mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985
Point Pleasant Canoe Livery (157.2)	0	0	0	0	0
Lumberville Canal Park Footbridge (155.4)	1.8	0	0	0	0
PA Rt. 263 Bridge, town of Center Bridge (151.9)	5.3	0	0	0	0
PA Rt. 179 Bridge, New Hope (148.7)	8.5	0	0	0	0
Washington Crossing State Park (146.0)	11.2		0	0	+
100 yds above PA Rt. 532 Bridge (142.0)	15.2	0	0	+	+
0.75 mi above I-95 Bridge (139.7)	17.5	0	0	+	
Under I-95 Bridge (139.0)	18.2		+	+	
Yardley Boat Ramp (138.4)	18.8	0	+	+	+
1.5 mi below Yardley Boat Ramp (136.9)	20.3	0			
Below 3-island archipelago, above Trenton Avenue and Calhoun Street Bridge (134.0)	23.2	+			+

Table 7.0-1. (Cont.)

Location (River Mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985
Below railroad bridge (mid-town Trenton) (133.0)	24.2	+		+	
Between buoys 105 and 106 (131.7)	25.5	0			
Biles Creek (131.2)	26.0	+			+
Buoy 97 (130.6)	26.6	+		+	
Buoy 92 (129.1)	28.1	+		+	
0.5 mi above Newbold Island (127.0)	30.2	+		+	
Southern tip of Newbold Island (124.9)	32.3	+		+	+
Florence Boat Ramp (122.6)	34.6	+			
Above I-276 Bridge (121.3)	35.9	+		+	
Burlington Island at Buoy 45 (118.9)	38.3	+			
Burlington Generating Station (117.0)	40.2	+		+	
1.5 mi below Neshaminy Creek (114.1)	43.1	+			
Mouth of Rancocas Creek (111.1)	46.1	+	+		+

Table 7.0-1. (Cont.)

Location (River Mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985
0.5 mi downstream of buoy 18 (109.3)	47.9		+	+	
0.5 mi downstream of buoy 15 (108.0)	49.2	0	+		
Under Tacony Palmyra Bridge (107.1)	50.1	0	+		0
Betsy Ross Bridge (104.8)	52.4	0	+	+	0
Richmond Generating Station (104.4)	52.8	0	0	0	
Northern tip of Petty Island (103.2)	54.0	0	0	+	0
Delaware Generating Station (101.1)	56.1		0	0	0
Benjamin Franklin Bridge (100.2)	57.0	0		+	0
Upstream of Walt Whitman Bridge (98.0)	59.2	0	0		
Southwark Generating Station (97.5)	59.7		0	0	0
Buoy 46A (95.0)	62.2	0			+
Mouth of Schuylkill River (92.5)	64.7	0	+	+	
Opposite Paulsboro, NJ (90.0)	67.2	0			

Table 7.0-1. (Cont.)

Location (River Mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985
Northern tip of Tinicum Island (87.5)	69.7	0		+	+
Northern tip of Mond's Island (85.6)	71.6	0			
Eddystone Generating Station (84.3)	72.9		+	+	
Just north of Commodore Barry Bridge (81.3)	75.4	0			0

A "0" indicates that no clams were present.
A "+" indicates that clams were present.
A blank indicates that no sample was collected.

Table 7.0-2. Results of qualitative sampling for *Corbicula* in the Schuylkill River, 1982-1985.

Location (River Mile)	Distance from LGS (miles)	1982	1983	1984	1985
Limerick Generating Station (S48)	0	0	0	0	0
Vincent Dam (S45)	3.5	0		0	0
Main Street, Spring City (S42)	6.0	0		0	0
0.25 mi above Cromby Generating Station (CGS) (S40)	8.25		0	0	0
Adjacent to CGS (S40)	8.5		0	0	0
0.25 mi below CGS (S39)	8.75		0	0	0
Phoenixville Water Treatment Plant (S38)	9.25		0	0	0
Black Rock Road, Rt. 113, Phoenixville (S37)	10.0	0	0	0	0
Public Picnic Area opposite Fish Commission boat ramp (S37)	10.5		0	0	0
Black Rock Dam (S36)	11.25		0	0	+
Bridge Street, Rt. 29, Phoenixville (S35)	13.0	0			+
Pawlings Road, Phoenixville (S31)	17.0	0		0	0

Table 7.0-2. (Cont.)

Location (River Mile)	Distance from LGS (miles)	1982	1983	1984	1985
1.0 mi above Betzwood Bridge (S29)	19			+	
0.5 mi above Betzwood Bridge (S28.5)	19.5			+	+
Betzwood Bridge (S28)	20.0	0	0	+	
0.75 mi above Abrams Creek (S27)	21.5		+	+	
Abrams Creek (S26)	22.25		+	+	
Tip of Barbadoes Island (S26)	22.5		+	+	+
Intake to Barbadoes Generating Station (S25)	23.25		+	+	
Under Rt. 202 Bridge (S25)	23.5		+	+	+
Norristown Dam (S24)	24.0	+	+	+	+
I-276 Bridge, Swedesburg (S22)	26.0	+			+
Plymouth Dam, West Conshohocken (S20)	28.0	+			+
Near Montgomery County/Philadelphia County line (S17)	31.0	+			+
West of Green Lane Bridge (S14)	34.0	+			+

Table 7.0-2. (Cont.)

Location (River Mile)	Distance from LGS (miles)	1982	1983	1984	1985
Pencoyd Bridge (S12)	36.0	+			+
Strawberry Bridge (S11)	37.0	+			+
Fairmount Dam (S8)	40	+	+		+
Under Park Drive Bridge (S8)	40.25		0	0	0
Under Market Street Bridge (S7)	40.75		0	+	+
Under South Street Bridge (S6)	41.5		0	0	0
Adjacent to Schuylkill Generating Station (SGS) (S5)	42.0	0	+	+	0
0.25 mi below SGS (S5)	42.25	0	0	+	0
Under Passyunk Avenue Bridge (S3)	44.0	0	0		0
South of I-95 Bridge (S1)	47.0	0		0	0
Mouth of Schuylkill River (S0)	48.0	0	0	+	0

A "0" indicates that no clams were present.
A "+" indicates that clams were present.
A blank indicates that no sample was collected.

Table 7.0-3. Results of qualitative sampling for *Corbicula* in the Perkiomen Creek, 1983-1985.

Location	Distance from Confluence w/ Schuylkill(mi)	1983	1984	1985
Below Wetherill's Dam	0.75	0	0	0
Egypt Road	1.5	0	0	0
Indian Road Dam	2.25	0	0	0
Yerkes Road Bridge	4.5	0	0	0
Collegeville Dam	6.5	0	0	0
Rahn's Bridge, Rt. 113	7.25	0	0	0
Graterford Road Bridge	9.25	0	0	0
Ott's Dam Bridge	10.5	0	0	0
Rt. 73 Bridge	11.25	0	0	0
Schwenksville Road Bridge	12.0	0	0	0

A "0" indicates that no clams were present.
A "+" indicates that clams were present.
A blank indicates that no sample was collected.

8.0 Cooling Tower Bird Mortality

Summary

1. Bird impaction at both LGS cooling towers was investigated during spring and fall migrations during 1985.

2. A total of 57 birds of 14 species was collected.

3. This total is considered insignificant when compared to the number that migrate through the area.

Introduction and Methods

The potential for migrating bird mortality due to impaction in the LGS cooling towers was identified early in the environmental impact review process. A fall survey of bird mortalities at a nearly completed cooling tower at Susquehanna Steam Electric Station produced a mortality count of 80 birds during a 2-month survey period.

A survey to document the extent of bird mortality, the time periods when most bird kills occur, and the bird species involved was initiated in spring 1981 and continued in subsequent years until the present. Regular, almost daily, checks of both cooling towers were made during the work week throughout the spring and fall migration periods.

Each inspection consisted of an early morning, usually between 0700-0900, search of the precast concrete deck which covers the fill structure of each cooling tower. Experience indicated that virtually all the birds which strike the LGS towers can be found on the concrete decking which overtops the fill structure.

Results and Discussion

A total of 57 birds of 14 species was found between 11 April and 29 October 1985. One of these specimens was not identifiable to species because of deteriorated condition (Table 8.0-1). Greatest apparent mortality occurred just prior to 7 October 1985. Seventeen dead birds were recovered on this day. Mortalities continue to be insignificant when compared to the large number of birds which migrate through the area.

Table 8.0-1. Birds collected at LGS cooling towers in 1985.

Common Name[1]	April 11	April 19	May 7	August 28	August 29	September 4	September 6	September 9	September 11	September 16	September 18	September 20
Golden-crowned kinglet												
Ruby-crowned kinglet	1											
Gray-cheeked thrush												
White-eyed vireo			1									
Solitary vireo		1										
Philadelphia vireo												
Red-eyed vireo				2	2		2	1	1	2	1	1
Chestnut-sided warbler				1								
Magnolia warbler												
Black-throated green warbler												
Blackburnian warbler				1								
Prairie warbler		1										
Bay-breasted warbler												
Common yellowthroat			1			1		1				
Unidentified specimen												

Common Name[1]	September 23	September 25	September 26	October 7	October 9	October 11	October 14	October 17	October 28	October 29	Totals
Golden-crowned kinglet								1		1	2
Ruby-crowned kinglet								2	1		4
Gray-cheeked thrush	1										1
White-eyed vireo											1
Solitary vireo			1	2			1			1	6
Philadelphia vireo				1							1
Red-eyed vireo	2	2		4	1	1		2			24
Chestnut-sided warbler											1
Magnolia warbler				4							4
Black-throated green warbler				2							2
Blackburnian warbler											1
Prairie warbler											1
Bay-breasted warbler				2							2
Common yellowthroat				2	1						6
Unidentified specimen								1			1

[1]Common names are from the American Ornithologist Union Checklist of North American Birds, Sixth edition, 1983.

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