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ECS-SR-72

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STEEL CREEK FISH: L LAKE/STEEL CREEK BIOLOGICAL MONITORING PROGRAM JANUARY 1986 - DECEMBER 1987

MARCH 1988

[redacted]

Prepared By: M. H. Paller, J. H. Heuer and L. A. Kissick
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Prepared For: Environmental Sciences Division
Savannah River Laboratory
E. I. du Pont de Nemours & Co.
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ACKNOWLEDGEMENTS

We thank Eric Ben, Gary Eargle, Sherry Flynn, Jim Geddes, and Greg Grunzel for collecting and processing data. We also extend appreciation to Roy Camp, Bob Helmers, Mark Giffin, Dan Magoulick, John Nagle, Chris Skelton, and Jeff Wollis for assisting in field collection. Lastly, we thank Dan Magoulick for reviewing an earlier version of this report.

PREFACE

The Savannah River Plant (SRP) encompasses 300 sq mi of the Atlantic Coastal Plain in west-central South Carolina. The Savannah River forms the western boundary of the site (Figure 1). Five major tributaries of the Savannah River -- Upper Three Runs Creek, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek -- drain the site. All but Upper Three Runs Creek receive, or in the past received, thermal effluents from nuclear production reactors. In 1985, L-Lake, a 400-hectare cooling reservoir, was built on the upper reaches of Steel Creek to receive effluent from the reactivation of L-Reactor, to protect the lower reaches of the stream from thermal impacts. The lake has an average width of approximately 600 m and extends along the Steel Creek valley approximately 7000 m from the dam to the headwaters. Water level is maintained at a normal pool elevation of 58 m above mean sea level by overflow into a vertical intake tower that has multilevel discharge gates. The intake tower is connected to a horizontal conduit that passes through the dam and releases water into Steel Creek.

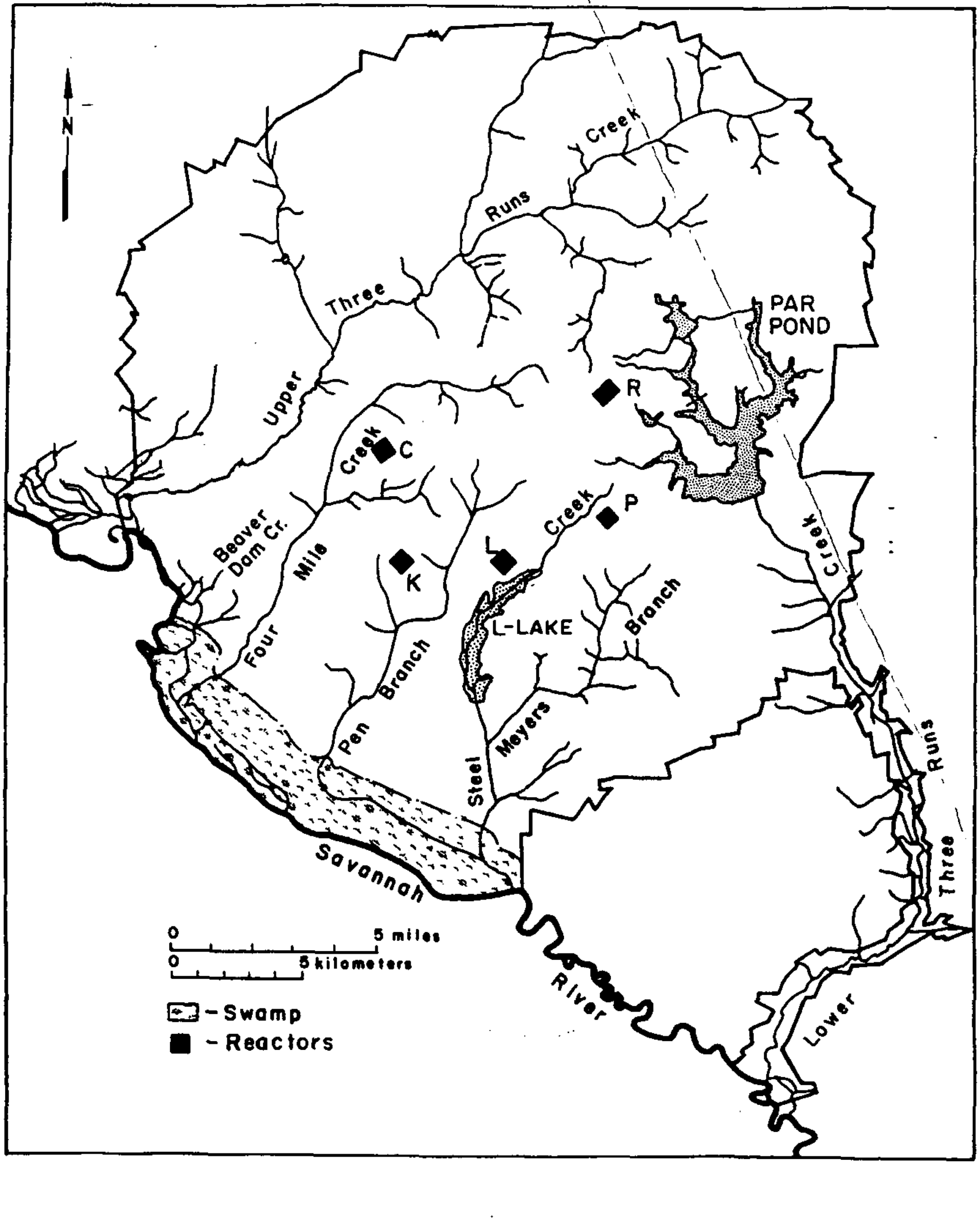


Figure 1. A map of the Savannah River Plant showing the major aquatic systems.

The Steel Creek Biological Monitoring Program was designed_ to meet environmental regulatory requirements associated with the re-start of L-Reactor and compliments the Biological Monitoring Program for L-Lake. This extensive program was implemented to address portions of Section 316(a) of the Clean Water Act. The Department of Energy (DOE) must demonstrate that the operation of L-Reactor has not significantly altered the established aquatic ecosystems.

Steel Creek Description

Steel Creek and its main tributary, Meyer's Branch (Figure 1), drain approximately 35 sq mi of the Aiken Plateau before descending to the Coastal Terrace. The headwaters of Steel Creek are located approximately 16 km from the Steel Creek delta and about 19 km from the Savannah River. L-Lake was created near L-Reactor by construction of a dam across Steel Creek about 5 km upstream the Steel Creek delta.

Steel Creek received thermal effluents directly from both P- and L-Reactors between 1954 and 1963 (maximum of 835 cfs; Smith et al. 1981; DOE 1984), and then from L-Reactor alone until 1968. The increased flow scoured the upper reaches of Steel Creek and deposited the sediments in a delta where the creek enters the river swamp. The increased sedimentation and the elevated water temperature destroyed all the in-stream vegetation along the upper reaches of the creek and the mature swamp forest at the site of the expanding delta. When thermal discharges ceased in the late 1960's, vegetation became reestablished and ecological succession began. The stream characteristics before the construction of L-Lake included shallow braided channels and scrub-shrub or emergent wetland (marsh) communities. Diverse floral and faunal communities existed (Smith et al. 1981 and references therein). Potential influences of L-Reactor on Steel Creek physical parameters include changes in depth, flow, velocity, channel morphology and water quality.

Biological Monitoring Program

The Steel Creek Biological Monitoring Program is designed to assess various components of the ecosystem and identify any changes due to the operation of L-Reactor or discharge from L-Lake, the once-through cooling reservoir for the reactor. An intensive ecological assessment program prior to the construction of the lake (Paller et al. 1986a, 1986b; Firth et al. 1986; and others) provided baseline data with which to compare data accumulated after the lake was filled and began discharging into the creek.

This report summarizes the results of two years' data from Steel Creek under the L-Lake/Steel Creek Monitoring

Program. L-Lake is discussed separately from Steel Creek in Volumes ECS-SR-61 through ECS-SR-67.

Each major component of the Steel Creek portion of the biological monitoring program is presented in a separate volume as follows:

ECS-SR-68	Primary Producers
ECS-SR-69	Habitat Formers
ECS-SR-70	Zooplankton
ECS-SR-71	Macroinvertebrates
ECS-SR-72	Fish
ECS-SR-73	Wildlife
ECS-SR-74	Water Quality

EXECUTIVE SUMMARY

1. Fish samples were collected from Steel Creek during 1986 and 1987 following the impoundment of the headwaters of the stream to form L-Lake, a cooling reservoir for L-Reactor which began operating late in 1985. Electrofishing and ichthyoplankton sample stations were located throughout the creek. Fykenetting sample stations were located in the creek mouth and just above the Steel Creek swamp. Larval fish and fish eggs were collected with 0.5 m plankton nets.

2. Multivariate analysis of the electrofishing data suggested that the fish assemblages in Steel Creek exhibited structural differences associated with proximity to L-Lake, and habitat gradients of current velocity, depth, and canopy cover. The Steel Creek corridor, a lotic reach beginning at the base of the L-Lake embankment was dominated by stream species and bluegill. The delta/swamp, formed where Steel Creek enters the Savannah River floodplain, was dominated by fishes characteristic of slow flowing waters and heavily vegetated habitats. The large channel draining the swamp supported many of the species found in the swamp plus riverine and anadromous forms.

3. The fish community in the corridor underwent prominent changes in species composition following the re-start of L-Reactor. These consisted of increases in the abundance of bluegill and reductions in the abundance of species typically associated with small streams and slow flowing waters. The reductions were probably due to habitat changes, including large increases in flow, erosion, and channel size. The increases in bluegill abundance, which were particularly prominent close to the L-Lake embankment, were due to the emigration of juvenile bluegill from L-Lake into Steel Creek.

4. Bluegill abundance in the Steel Creek corridor peaked in the fall of 1986, then declined substantially during 1987, indicating that bluegill were leaving the corridor and suggesting relatively little emigration of bluegill from L-Lake in 1987. The large influx of bluegill into Steel Creek from L-Lake during 1986 may have resulted from the development of an unusually strong bluegill year class in L-Lake during 1986. Less immigration of juvenile bluegill into the corridor during 1987 could also be a result of the withdrawal of water from the hypolimnion of L-Lake where fish were scarce or absent. The latter was probably responsible for the reduction in number of sunfish (Lepomis spp.) larvae discharged from L-Lake into Steel Creek during 1987.

5. Unlike the fish assemblages in the corridor, those in the delta/swamp and the channel draining the swamp were relatively stable. Comparisons between data collected before and after the re-start of L-Reactor and impoundment of L-Lake indicated possible, relatively minor alterations in species composition following these events but no species losses. The only change that could be strongly linked to the re-start was an increase in bluegill abundance which was more prominent during 1987 than 1986, reflecting the downstream dispersal of this species from the corridor. In summary, the only habitat suffering conspicuous and seemingly deleterious changes (in terms of large alterations in species composition) was the corridor.

6. To further assess environmental quality, the Steel Creek fish community was compared to fish communities in eight other southeastern streams. Steel Creek possessed more species (60 in 1986 and 59 in 1987) than the other streams because of its habitat diversity and proximity to the Savannah River, the latter resulting in incursions by riverine and anadromous species. Examination of the number of species in each family indicated that Steel Creek supports a particularly rich sunfish, catfish/bullhead, and minnow fauna. These comparisons, in addition to the pre/post-comparisons,

suggest that negative effects on the Steel Creek fish community due to the re-start of L-Reactor and impoundment of L-Lake are largely limited to the reaches closest to the lake and that the fish community in Steel Creek as a whole remains diverse and well-balanced.

1.0 INTRODUCTION

Steel Creek is a tributary of the Savannah River draining the central portion of the Savannah River Plant (SRP), a Department of Energy nuclear materials production facility near Aiken, South Carolina. From 1954 to 1968, Steel Creek received high temperature cooling water from L-Reactor, resulting in partial elimination of the cypress-tupelo (*Taxodium distichum* - *Nyssa aquatica*) canopy vegetation and sediment erosion from the mid-reaches and deposition in the lower reaches of the stream (Gladden et al. 1985). When L-Reactor was shut-down in 1968, reactor discharge to the creek ceased for the next 17 years (except for a brief period in the mid-1970s). In preparation for the re-start of L-Reactor in 1985; L-Lake, a 400 ha cooling reservoir was constructed by damming Steel Creek approximately 12 km from its confluence with the Savannah River. Cooling water from L-Reactor now enters at the upper end of L-Lake and discharges into Steel Creek through a controllable, multiple level outlet near the dam.

During the hiatus in reactor operation, ecological succession resulted in the development of a secondary growth of shrubs, bushes, and emergent and submerged macrophytes which subsequently attracted a variety of aquatic and terrestrial animals (Smith et al. 1981). The Steel Creek delta/swamp, a 94 ha marsh formed where Steel Creek enters the Savannah River floodplain, and the channel below the delta/swamp, developed into particularly important habitats supporting a diversity of organisms, including approximately 50 species of fish (McFarlane 1976; Aho et al. 1986).

The fish assemblages in the Steel Creek delta/swamp have been the subject of numerous studies. McFarlane (1976) reported that the recovery of the fish community from previous reactor operations was "almost complete" as of 1976, based on comparisons of species richness between Steel Creek and nearby unimpacted streams. More recent studies have indicated the stability of the Steel Creek swamp fish assemblage, and provided evidence of its diversity and spatial heterogeneity, the latter being due to variations in habitat, particularly canopy cover and macrophyte bed development (Aho et al. 1986). The macrophyte beds also support large numbers of larval fishes (Paller et al. 1986a) and may contribute to the reproductive success of some species by providing solid substrates for egg deposition, and shelter and forage for early life stages. The creek channel below the delta/swamp, while not supporting the high larval densities characteristic of sheltered areas in the delta, provides spawning areas for anadromous American shad and blueback herring entering from the river (Paller et al. 1986a).

The restart of L-Reactor has had several effects on habitat in the mid-and lower reaches of Steel Creek, the most prominent being large increases in flow and moderate alterations in temperature. Changes in flow can affect fish by altering habitat structure and detritus processing, the latter having repercussions through the food chain. Subtle temperature increases can alter the behavior, activity, phenology, and growth of fishes (Brown 1974). The subject of this report is the impact of L-Lake and L-Reactor operations on the fish communities in the mid-and lower reaches of Steel Creek during the first two years after the impoundment of L-Lake and re-start of L-Reactor. Data from the second year is emphasized, since data from the first year was published in a 1986 interpretive report. The specific objectives of the fisheries studies in Steel Creek are to:

1. describe and evaluate the fish assemblages occurring in the mid-and lower reaches of Steel Creek after the re-start of L-Reactor;
2. compare these assemblages with the fish assemblages present before reactor re-start;
3. distinguish seasonal and secondary successional changes resulting from prior impacts from those caused by L-Reactor operation and L-Lake impoundment;
4. assess the "quality" of the fish community in Steel Creek after the re-start of L-Reactor by comparing it to fish communities in other regional streams.

2.0 METHODS AND MATERIALS

Steel Creek below L-Lake can be divided into three basic habitats: the corridor, extending from the dam to the delta/swamp, which is characterized by relatively well-defined channels; the delta/swamp formed where Steel Creek enters the Savannah River floodplain, which is characterized by numerous braided channels and broad shallow sheet flows; and the relatively deep channel draining the delta/swamp into the Savannah River (Figure 2-1). The delta/swamp can be subdivided into an open-canopy portion, now dominated by a secondary growth of emergent, submergent, and herbaceous vegetation where thermal effluents killed the cypress and tupelo-gum overstory, and a closed-canopy portion dominated by a climax forest of cypress and tupelo gum.

2.1 SAMPLING STATIONS AND SCHEDULES

There were four sampling stations in the Steel Creek corridor (275, 280, 285, and 290; Figure 2-1), seven in the delta/swamp (300, 310, 320, 330, 340, 350, and 640) and two in the channel draining the swamp (360 and 370). One sample station (400) was located in the mouth of Meyer's Branch, a tributary of Steel Creek.

Adult/juvenile and larval fish samples were collected at each station. Adult/juvenile fish sampling consisted of electrofishing and fyke netting. Drifting larval fish and fish eggs (ichthyoplankton) were sampled with plankton nets.

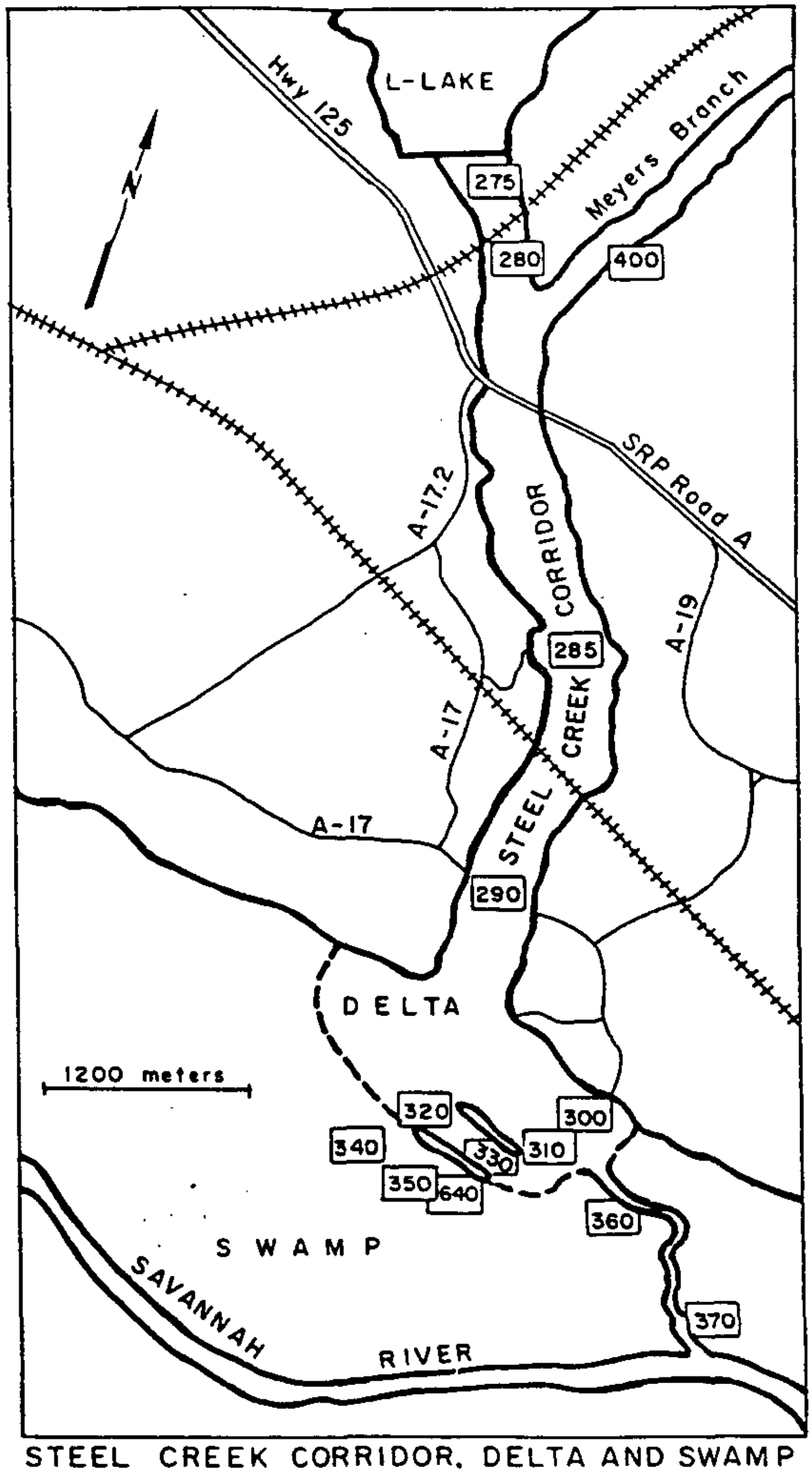


Figure 2-1. Location of fish sampling stations in Steel Creek. January 1986 - December 1987.

Temperature, dissolved oxygen, pH, conductivity, current velocity, and depth were measured in conjuction with all fish samples except the fyke net collections.

Electrofishing was conducted monthly at the nine sampling stations in the delta/swamp and channel and quarterly at the four stations in the corridor, and the station in Meyer's Branch (Table 2-1). Fyke netting was conducted at one sample station in the mouth of Steel Creek and at one sample station above the delta/swamp for two days each week during March, April, May, June, and July; the expected spawning period of anadromous species near the SRP (Paller et al. 1984); and for two days each month during the remainder of the year. Sampling for larvae and eggs was conducted weekly at 14 sampling stations during February through July, and monthly at Stations 275, 280, 290, 310, 330, 350, and 370 during the remainder of the year. Diel (24 h) ichthyoplankton sampling was conducted once monthly from February - July at Stations 275, 280, 290, 310, 330, 350, and 370.

2.2 ADULT FISH

2.2.1 Electrofishing

Electrofishing was conducted from an aluminum boat equipped with a 4500-watt, 230-v gasoline-powered generator. A four-electrode array was mounted on a boom and suspended in the water approximately 2 m in front of the boat; the metal hull of the boat served as the negative electrode. Current

Table 2-1. Fish sampling schedule for Steel Creek. January - December 1987.

	January					February				March				April					May				June			
Week	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4
<u>Adult fish</u>																										
Delta electrofishing				x				x				x					x				x				x	
Corridor electrofishing						x															x					
Fyke net				x					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<u>Ichthyoplankton</u>																										
Routine ichthyoplankton	x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Diel ichthyoplankton								x				x					x				x				x	

	July					August				September				October					November				December				
Week	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	5
<u>Adult fish</u>																											
Delta electrofishing				x				x					x					x				x					x
Corridor electrofishing											x												x				
Fyke net	x	x	x	x	x	x					x			x						x			x				
<u>Ichthyoplankton</u>																											
Routine ichthyoplankton	x	x	x	x	x			x				x						x			x				x		
Diel ichthyoplankton				x																							

to the electrodes was controlled by a Smith Root Model IV electrofisher set to deliver pulsed DC at a frequency of 60 Hz. Current to the electrodes was regulated by a foot switch operated by a netter at the bow.

Three consecutive 100 m transects were electrofished at each sampling station except Stations 300, 310, and 400, where lack of space necessitated the use of three 50 m, two 50 m, and three 50 m transects, respectively. Collections were made by slowly moving the boat upstream along the banks or, at sample stations where submerged vegetation was abundant, along the borders of the vegetation beds. Shock time at each 100 m transect generally ranged from 150 - 200 sec. Stunned fishes were lifted from the water with a wooden-handled dip net and placed in a holding tank until the transect was completely sampled. When dense aggregations of fish were encountered, efforts were made to randomly collect as many fish as possible. All collections were made during daylight for safety reasons and to facilitate comparisons with data collected during daylight in previous years.

All specimens were identified and those over 90 mm total length were measured (nearest mm total length), weighed (nearest g), and examined for parasites, disease, and deformities. Because many juvenile sunfish were occasionally collected at some of the transects, it was necessary to sub-sample specimens under 90 mm to expedite processing. Fifty individuals of each species were randomly selected from the holding tanks and measured for total length, the remaining animals were counted, and all were weighed in aggregate before being returned to the water. For minnows (Cyprinidae), which were occasionally present in large quantities but for which length information was not as important, ten specimens were measured, the remaining ones counted, and all weighed in aggregate. When minnows were collected in large numbers, approximately five specimens from each transect were preserved and returned to the laboratory for accurate species-level identifications.

Measurements of temperature, dissolved oxygen concentration, pH, and conductivity were made with a water quality analyzer at a depth of approximately 1 m at each sample station on each sampling date. Current velocity was measured with a General Oceanics Model 2030 current meter or General Oceanics remote reading flow meter. Depth was measured with a sounding pole calibrated in 10 cm intervals. All the preceding measurements were made in the center of the creek channel in the middle of the reach being sampled.

Because of the comparative shallowness and narrowness of Meyer's Branch, Station 400 was electrofished along three 50 m stream sections with a Smith-Root 700 v pulsed DC, 120 Hz backpack shocker instead of a boat shocker. Two 6.4 mm mesh nets were placed across the creek, one at the upstream end and one at the downstream end of the section being sampled, to prevent the escape of fish. The fish were processed as described for the Steel Creek electrofishing stations and released in the center of the section from which they were caught. The nets were then removed and placed at the upstream end and the downstream end of the next 50 m section which was sampled in the same manner as the first section. Temperature, dissolved oxygen, pH, conductivity, depth, and current velocity were measured in the center of each section as previously described.

2.2.2 Fyke Netting

The fyke nets were approximately 4 m in length, with a 1.4 x 1.6 m mouth and a single 7.6 x 1.8 m lead. Mesh size was 3.8 cm in the body of the net and 2.5 cm in the cod end. Two fyke nets were set parallel to the bank and facing downstream at Station 370 and approximately 600 m above Station 290 on each sample date. Each net was set for 48 h. Fish collected with the fyke nets were processed as described for Steel Creek electrofishing.

2.3 ICHTHYOPLANKTON

Ichthyoplankton sampling in Steel Creek consisted of two programs; a routine sampling program and a diel sampling program. For the routine sampling program, all stations were sampled between 0900 and 1600 h, with the order of sampling randomized to prevent systematic temporal biases. For the diel distribution program, four samples were taken at six hour intervals over a 24 h period at Stations 275, 280, 290, 310, 330, 350, and 370. The intervals were 0800 - 1359, 1400 - 1959, 2000 - 0159, and 0200 - 0759. Other aspects of sampling protocol were the same for both programs.

Ichthyoplankton samples were collected with paired 0.5 m 505 ìm mesh plankton nets mounted side by side in an aluminum frame. The nets were deployed by suspending them in the current until either 50 m^3 of water was filtered by each net or 20 min had elapsed. A digital-reading flowmeter mounted in the center of each net opening permitted calculation of the amount of water filtered. Near-surface (0.5 - 1.0 m from the surface) samples were taken at all stations. Near-bottom samples (0.5 - 1.0 m from the bottom) were taken at all stations where the depth exceeded 2.0 m. An 11.4 kg lead weight was attached to the bottom of the net frame to keep the nets at the desired depth when taking near-bottom samples.

Temperature, dissolved oxygen, pH, conductivity, depth, and current velocity were measured in the center of the channel in conjunction with each sample. The water quality parameters and current velocity were measured approximately 0.5 m below the surface at sample stations less than 2.0 m in depth, and 0.5 m below the surface and 0.5 m above the bottom at sample stations exceeding 2.0 m in depth. In addition, at Stations 275, 290, 400, 360, and 370, depth and current velocity were measured at 1 m intervals along a transect perpendicular to the stream banks. Current velocity was measured at 20% and 80% of the distance from the water's surface to the bottom where depth exceeded 0.5 m, and 60% of the distance from the surface where depth was less than 0.5 m. Other details of sample preservation, processing, and identification were as described for the L-Lake ichthyoplankton program (Paller et al. 1987).

Fish larvae collected in 1987 were organized into taxonomic groups different from those used in 1986. In general, larval identification was refined and extended to the species level. Revisions in the 1986 classifications include:

1. Resolution of species within the genus *Lepomis*. In 1987, larval bluegill, redbreast, warmouth, and spotted sunfish were segregated. However, bluegill were not distinguished prior to analysis of the June samples and were therefore grouped with other unidentifiable lepomids.

   Spotted sunfish identifications are tentative, pending confirmation by taxonomists at the Louisiana Fish and Wildlife Cooperative Research Unit (Baton Rouge). Identification of this species was based on preliminary descriptions by Conner (1979) and J. Aho (pers. comm.).

Larvae of this species have been collected in abundance from Steel Creek (Anderson et al. 1986).

2. Identification of bluespotted sunfish larvae. Prior to 1987, probable bluespotted sunfish larvae were identified as crappie larvae. Sample specimens have been sent to taxonomists at the Louisiana Fish and Wildlife Cooperative Research Unit for verification. In the present report, it has been assumed that bluespotted sunfish is the correct epithet, and the 1986 data have been revised accordingly.

3. All banded pygmy sunfish larvae were identified only to genus following the capture of an adult Everglades pygmy sunfish (Elassoma evergladei) from Steel Creek in 1987. Presently, it is impossible to separate the larvae of these two very similar species.

4. Larval Percina sp. were first recognized in 1987. These larvae were assumed to be blackbanded darters, since this is the only Percina species known to occur in Steel Creek. All darter larvae other than Percina were grouped as Etheostoma spp.

5. Restriction of study to egg-to-larval stages (sensu Auer 1982) of fish. Species lacking these stages (e.g., the viviparous mosquitofish, Gambusia affinis) were excluded

from analysis in 1987. (This did not affect comparisons between the 1986 - 1987 fish communities, as only 22 Gambusia were collected from Steel Creek in 1987).

2.4 Data Analyses

Catch per unit effort (CPUE) was calculated for adult/juvenile fish sampling methods (number fish/100 m for transect electrofishing and number fish/net day for fyke netting). Ichthyoplankton catches were expressed as number of organisms/1000 m^3 by dividing the number of larvae and eggs collected in each net by the volume of water filtered and multiplying by 1000. Percent composition was calculated by dividing the mean CPUE (adult/juvenile) or density (ichthyoplankton) by the total (i.e. sum of all taxa) CPUE or density and multiplying by 100.

Statistical analyses have emphasized principal component analysis (PCA) rather than analysis of variance (ANOVA), because of the ability of PCA to extract maximum information from species abundance matrices. In general, PCA has been used as an exploratory technique to illustrate basic spatial and temporal relationships within the data. Only taxa composing at least 1% of the total annual catch from at least one station were included in the analysis. Mean densities or CPUEs were used in all PCAs. All data were $\log_{10}(x + 1)$ transformed prior to statistical analysis to reduce correlations between means and variances. This transformation was chosen on the basis of Taylor's Power Law (Appendix Table 1; Green 1979). All statistical procedures were performed with SAS programs. More details on statistical procedures are provided later in the report as the methods are applied to data.

3.0 RESULTS

3.1 WATER QUALITY

Mean annual temperatures in Steel Creek during 1986 ranged from 19.1°C at Station 350 to 22.6°C at Station 275 (Table 3-1). During 1987, mean annual temperatures ranged from 18.6°C at Station 340 to 20.7°C at Station 320. Temperatures decreased with distance from L-Lake, reflecting the presence of a temperature gradient associated with L-Lake discharge. Mean dissolved oxygen concentrations were similar between years; the lowest average values were at Station 350 (6.2 mg/L and 6.1 mg/L in 1986 and 1987, respectively) and the highest average values were at Station 275 (8.5 mg/L in 1986 and 8.6 mg/L in 1987, respectively; Table 3-1). The lowest dissolved oxygen concentrations were in the delta/swamp during the summer, probably as a result of organic decay and low saturation levels due to relatively high summer water temperatures. Low oxygen concentrations in the Steel Creek delta/swamp were observed prior to the impoundment of L-Lake and re-start of L-Reactor (Paller and Saul 1986). Current velocities were much higher in the channel below the delta/swamp and the corridor than in the delta/swamp.

Table 3-1. Annual average and range of selected water quality parameters recorded during fish sampling in Steel Creek. January 1986 - December 1987.

Habitat	Station	Temp. °C Mean	Temp. °C (min - max)	Dissolved Oxygen Mean	Dissolved Oxygen (min - max)	pH Mean	pH (min - max)	Conductivity Mean	Conductivity (min - max)	Current Velocity Mean	Current Velocity (min - max)
					1986						
Corridor	275	22.6	(13.1 - 30.2)	8.5	(4.1 - 15.1)	7.4	(5.8 - 9.2)	76.8	(2.50 - 103.0)	0.82	(0.25 - 1.60)
	280	22.2	(12.4 - 31.6)	8.1	(4.9 - 12.0)	7.2	(5.5 - 9.0)	73.7	(21.0 - 96.0)	0.66	(0.11 - 1.20)
	285	22.1	(10.6 - 31.9)	7.5	(2.6 - 16.1)	6.8	(5.2 - 8.8)	66.9	(27.0 - 86.0)	0.65	(0.30 - 0.85)
	290	21.4	(7.6 - 29.9)	7.0	(4.0 - 11.8)	6.6	(3.0 - 8.9)	74.7	(24.0 - 108.0)	0.59	(0.03 - 0.94)
Meyer's Branch	400	17.7	(4.4 - 29.8)	8.5	(4.0 - 16.2)	6.7	(5.9 - 8.7)	59.7	(29.0 - 170.0)	0.23	(0.05 - 1.30)
Delta	300	20.2	(9.4 - 28.8)	7.6	(2.9 - 14.0)	6.4	(5.8 - 6.8)	76.0	(43.0 - 97.0)	0.23	(0.01 - 0.38)
	310	20.8	(5.5 - 29.6)	6.4	(1.3 - 13.8)	6.3	(5.4 - 6.8)	75.6	(32.0 - 116.0)	0.32	(0.01 - 0.80)
	320	21.3	(4.7 - 29.1)	6.6	(2.0 - 11.1)	6.3	(5.4 - 6.8)	75.7	(39.0 - 94.0)	0.20	(0.01 - 0.80)
	330	20.1	(5.2 - 28.5)	6.8	(1.8 - 12.3)	6.3	(5.1 - 8.0)	75.1	(31.0 - 101.0)	0.28	(0.03 - 0.51)
Swamp	340	19.8	(6.3 - 27.2)	6.8	(2.9 - 17.2)	6.3	(5.1 - 6.9)	79.7	(40.0 - 101.0)	0.14	(0.01 - 0.80)
	350	19.1	(5.0 - 27.9)	6.2	(2.8 - 11.2)	6.2	(5.0 - 6.7)	79.1	(28.0 - 104.0)	0.29	(0.10 - 1.50)
	640	19.2	(5.5 - 27.7)	6.5	(3.0 - 11.5)	6.3	(5.0 - 6.7)	80.9	(37.0 - 100.0)	0.40	(0.20 - 0.65)
Channel	360	20.4	(6.9 - 28.0)	6.8	(3.2 - 14.3)	6.3	(5.9 - 6.8)	78.9	(43.0 - 96.0)	0.74	(0.25 - 1.40)
	370	19.9	(6.4 - 28.2)	6.4	(2.4 - 13.2)	6.3	(4.8 - 9.2)	79.4	(27.0 - 116.0)	0.46	(0.05 - 1.60)
					1987						
Corridor	275	20.6	(12.0 - 29.7)	8.6	(5.0 - 10.8)	6.9	(5.6 - 8.6)	76.8	(25.0 - 103.0)	1.04	(0.35 - 1.70)
	280	20.5	(11.8 - 29.2)	8.3	(4.1 - 11.1)	6.7	(5.7 - 7.9)	73.7	(21.0 - 96.0)	0.71	(0.32 - 1.26)
	285	19.1	(9.7 - 28.2)	8.4	(5.0 - 12.0)	6.7	(4.8 - 7.8)	66.9	(27.0 - 86.0)	0.60	(0.20 - 0.98)
	290	20.1	(10.4 - 28.3)	7.7	(4.8 - 12.4)	6.6	(4.6 - 7.8)	74.7	(24.0 - 108.0)	0.54	(0.17 - 1.10)
Meyer's Branch	400	17.3	(8.0 - 27.6)	8.8	(6.5 - 11.2)	6.5	(5.5 - 7.4)	59.7	(29.0 - 170.0)	0.26	(0.01 - 0.40)

Table 3-1 (continued). Annual average and range of selected water quality parameters recorded during fish sampling in Steel Creek. January 1986 - December 1987.

		1987									
		Temp. °C		Dissolved Oxygen		pH		Conductivity		Current Velocity	
Habitat	Station	Mean	(min - max)	Mean	(min - max)	Mean	(min - max)	Mean	(min - max)	Mean	(min - max)
Delta	300	19.7	(8.6 - 30.5)	8.0	(2.8 - 11.4)	6.6	(5.7 - 7.5)	76.0	(43.0 - 97.0)	0.17	(0.00 - 0.34)
	310	20.2	(6.9 - 34.0)	7.0	(1.6 - 12.7)	6.6	(5.6 - 8.6)	75.6	(32.0 - 116.0)	0.23	(0.00 - 0.44)
	320	20.7	(9.0 - 29.1)	7.8	(1.6 - 11.8)	6.7	(5.6 - 7.8)	75.7	(39.0 - 94.0)	0.19	(0.05 - 0.42)
	330	19.4	(6.0 - 27.9)	6.8	(2.4 - 12.2)	6.5	(5.7 - 7.3)	75.0	(31.0 - 101.0)	0.27	(0.08 - 1.00)
Swamp	340	18.6	(5.0 - 29.1)	6.3	(3.3 - 12.1)	6.3	(5.4 - 7.6)	79.7	(40.0 - 101.0)	0.12	(0.02 - 0.24)
	350	18.9	(4.8 - 27.0)	6.1	(1.6 - 11.9)	6.4	(5.3 - 7.2)	79.1	(28.0 - 104.0)	0.22	(0.03 - 1.70)
	640	19.1	(4.5 - 27.3)	6.3	(1.2 - 11.2)	6.4	(5.4 - 7.4)	80.9	(37.0 - 100.0)	0.28	(0.08 - 0.52)
Channel	360	18.7	(4.6 - 28.5)	7.2	(3.0 - 12.0)	6.4	(5.3 - 7.3)	78.9	(43.0 - 96.0)	0.65	(0.07 - 1.20)
	370	18.7	(5.2 - 28.6)	6.7	(2.0 - 11.6)	6.4	(3.3 - 7.1)	79.4	(27.0 - 116.0)	0.45	(0.08 - 1.00)

3.2 ADULT/JUVENILE FISH

3.2.1 Electrofishing

Electrofishing catches differed among sample stations in Steel Creek (Tables 3-2 and 3-3). To summarize these differences, principal component analysis (PCA) was used to ordinate the 1986 and 1987 catch per unit effort (CPUE; no./100 m) data from each station. Principal components 1 and 2 accounted for 46.6% and 30.3%, respectively, of the variance in the 1986 data and 43.3% and 33.9%, respectively, of the variance in the 1987 data (Appendix Tables 3 and 4).

A plot of the first two principal components of the 1986 data indicated that Station 275 (just below the L-Lake embankment) was distinctly separated from the other stations, primarily because of extremely high bluegill catches (Figure 3-1; Table 3-2). Two corridor stations (280 and 285) and the Meyer's Branch station (400) yielded relatively high catches of bluegill, relatively low catches of shiners, and high catches of redbreast sunfish, causing them to separate from the stations in the delta/swamp. Fish assemblages in the lowermost corridor station (290), however, were similar to those in the delta/swamp. The sample stations within the delta/swamp separated into open-canopy (Stations 300, 310, 320, and 330) and closed-canopy (Stations 340 and 350) groups, with the open-canopy stations characterized by higher catches of shiners and largemouth

Table 3-2. Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at stations in Steel Creek. January - December 1986.

Species	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
	275	280	285	290	400	300	310	320
longnose gar	0.08 (0.03)	[a]		0.11 (0.3)			0.17 (0.6)	0.06 (0.2)
bowfin	0.08 (0.03)			0.11 (0.3)	0.17 (0.6)	0.10 (0.4)	0.25 (0.7)	0.42 (0.6)
American eel	1.42 (2.2)			0.33 (0.5)	2.67 (2.6)	0.29 (1.0)	0.50 (1.4)	0.17 (0.4)
blueback herring								
American shad								
herring/shad								
gizzard shad								
redfin pickerel					0.50 (0.9)	0.48 (0.9)	0.17 (0.6)	0.03 (0.2)
chain pickerel	0.08 (0.03)	0.07 (0.3)		0.44 (0.5)		0.29 (0.7)	0.25 (0.7)	0.22 (0.5)
minnow[b]	0.50 (1.4)		0.11 (0.3)	3.00 (6.7)	9.33 (12.1)	56.67 (93.9)	7.66 (19.4)	1.97 (5.0)
golden shiner						0.86 (1.4)	1.42 (4.1)	0.53 (1.0)
creek chubsucker	0.75 (2.0)	1.20 (3.4)	0.22 (0.4)	0.22 (0.4)	1.17 (2.8)	0.48 (1.1)	0.67 (2.1)	0.39 (0.6)
lake chubsucker		0.20 (0.6)				0.19 (0.6)		2.00 (4.4)
northern hog sucker	1.00 (2.1)	0.27 (0.5)	0.33 (0.5)	0.11 (0.3)	0.67 (1.3)			
spotted sucker		0.27 (1.0)	0.33 (0.7)	0.44 (0.9)		0.29 (0.7)	1.83 (2.4)	0.44 (0.8)
yellow bullhead	0.17 (0.4)				0.33 (0.8)	0.10 (0.6)	0.08 (0.4)	0.06 (0.2)
brown bullhead								
flat bullhead		0.13 (0.4)				0.10 (0.6)	0.25 (0.9)	0.03 (0.2)
madtom					0.83 (1.8)			0.08 (0.3)
pirate perch	0.50 (1.2)			0.11 (0.3)	1.50 (2.1)	0.19 (0.6)	1.25 (2.2)	0.53 (1.2)
mosquitofish						0.57 (2.2)		1.14 (3.9)
brook silverside						1.33 (2.0)	1.00 (3.4)	0.36 (1.0)
bluespotted sunfish						0.19 (0.6)	0.08 (0.4)	0.03 (0.2)
redbreast sunfish	6.50 (11.0)	1.20 (1.7)	0.33 (0.7)	1.33 (1.2)	1.50 (2.1)	0.86 (1.6)	1.33 (2.9)	0.42 (0.8)
warmouth					0.17 (0.6)		0.17 (0.6)	0.06 (0.2)
bluegill	88.92 (203.2)	3.20 (9.4)	3.33 (7.6)		8.17 (18.5)	0.29 (1.0)	0.50 (2.1)	0.39 (1.2)
dollar sunfish	0.08 (0.3)						0.08 (0.4)	
redear sunfish						0.19 (0.6)	0.17 (0.6)	0.03 (0.2)
spotted sunfish	0.67 (1.0)	0.13 (0.4)		0.33 (0.7)	2.50 (2.3)		3.67 (6.0)	1.61 (2.2)

[a] Blank indicates no fish collected.
[b] Includes various combinations of minnows and shiners (*Notropis* spp.).

Table 3-2 (continued). Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at stations in Steel Creek. January - December 1986.

	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
Species	275	280	285	290	400	300	310	320
largemouth bass	11.75 (22.3)	0.87 (1.7)	0.33 (0.7)	0.67 (1.1)	0.50 (1.2)	13.90 (46.1)[c]	3.75 (4.0)	2.53 (2.4)
black crappie	0.08 (0.3)						0.08 (0.4)	
darter	0.25 (0.6)			0.11 (0.3)	1.00 (1.6)			
blackbanded darter	0.17 (0.4)	0.07 (0.3)		0.11 (0.3)	0.83 (2.3)		0.42 (1.3)	0.14 (0.5)
tesselated darter	0.25 (0.6)				1.17 (2.0)	0.10 (0.4)		0.03 (0.2)
yellow perch					0.17 (0.6)		0.67 (2.5)	
other (including rare taxa)	0.08 (0.3)			0.11 (0.3)		0.19 (0.8)	0.17 (0.8)	0.17 (0.4)
Total	113.33	7.60	5.00	7.55	33.17	77.62	26.58	13.81

[c] Primarily juveniles.

Table 3-2 (continued). Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at stations in Steel Creek. January - December 1986.

Species	Steel Creek Swamp				Steel Creek Channel	
	330	340	350	640	360	370
longnose gar	0.28 (0.9)	0.42 (0.9)	0.08 (0.5)	0.28 (0.7)	0.11 (0.4)	0.06 (0.2)
bowfin	0.67 (0.9)	0.53 (0.9)	0.31 (0.5)	0.61 (1.4)	0.03 (0.2)	0.22 (0.5)
American eel	0.17 (0.4)	0.22 (0.6)	0.17 (0.4)	0.08 (0.3)	0.17 (0.4)	0.03 (0.2)
blueback herring					0.03 (0.2)	0.03 (0.2)
American shad				0.03 (0.2)	0.03 (0.2)	0.06 (0.3)
herring/shad						0.17 (0.7)
gizzard shad		0.11 (0.5)		0.06 (0.3)		0.11 (0.4)
redfin pickerel					0.03 (0.2)	0.14 (0.4)
chain pickerel	0.56 (1.0)	0.36 (0.7)	0.14 (0.5)	0.08 (0.3)		0.28 (0.6)
minnow[b]	5.36 (14.9)	1.55 (3.1)	2.50 (7.2)	1.03 (2.6)	1.78 (6.5)	2.14 (4.3)
golden shiner	0.36 (1.0)	0.39 (0.9)	0.75 (4.3)			
creek chubsucker	0.42 (0.8)	0.28 (0.6)	0.11 (0.3)	0.06 (0.2)		0.06 (0.2)
lake chubsucker	0.36 (0.8)	0.19 (0.5)	0.08 (0.4)	0.06 (0.3)		
northern hog sucker			0.03 (0.2)		0.03 (0.2)	
spotted sucker	1.00 (1.1)	1.61 (1.7)	0.86 (1.7)	2.33 (3.2)	0.25 (0.5)	0.36 (0.6)
yellow bullhead	0.03 (0.2)	0.08 (0.4)	0.03 (0.2)	0.06 (0.2)	0.06 (0.3)	
brown bullhead	0.03 (0.2)	0.06 (0.2)				0.03 (0.2)
flat bullhead		0.03 (0.2)		0.06 (0.2)	0.06 (0.3)	0.06 (0.2)
madtom	0.03 (0.2)		0.06 (0.2)	0.03 (0.2)	0.03 (0.2)	0.03 (0.2)
pirate perch	0.08 (0.4)	0.25 (0.9)	0.06 (0.2)	0.06 (0.2)		0.19 (0.6)
mosquitofish	0.11 (0.4)		0.03 (0.2)	0.06 (0.3)	0.06 (0.2)	0.06 (0.2)
brook silverside	0.39 (0.8)	0.47 (0.9)	0.31 (0.9)	0.22 (0.8)	0.06 (0.2)	0.61 (1.5)
bluespotted sunfish		0.03 (0.2)				0.14 (0.5)
redbreast sunfish	0.22 (0.6)	0.06 (0.2)	0.06 (0.2)	0.14 (0.4)	0.69 (1.3)	0.56 (1.0)
warmouth	0.03 (0.2)					0.03 (0.2)
bluegill	0.17 (0.4)	0.03 (0.2)			0.03 (0.2)	0.06 (0.2)
dollar sunfish	0.03 (0.2)					0.03 (0.2)
redear sunfish	0.06 (0.2)	0.33 (1.4)		0.11 (0.3)	0.03 (0.2)	0.03 (0.2)
spotted sunfish	2.39 (2.7)	0.17 (0.4)	0.47 (0.8)	0.61 (0.9)	0.47 (0.7)	1.14 (1.6)
largemouth bass	4.33 (12.2)	2.25 (4.2)	1.00 (0.9)	0.78 (0.9)	0.72 (1.0)	0.67 (0.8)
black crappie	0.03 (0.2)	0.06 (0.2)				0.06 (0.2)
darter	0.11 (0.5)		0.03 (0.2)			0.06 (0.2)

[b] Includes various combinations of minnows and shiners (Notropis spp.).

Table 3-2 (continued). Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at stations in Steel Creek. January - December 1986.

	Steel Creek Swamp				Steel Creek Channel	
Species	330	340	350	640	360	370
blackbanded darter	0.33 (0.6)		0.19 (0.5)	0.08 (0.3)	0.17 (0.4)	0.19 (0.7)
tesselated darter						0.19 (0.9)
yellow perch	0.19 (0.5)	1.06 (1.8)	0.83 (1.4)	0.50 (1.0)	0.08 (0.3)	0.06 (0.2)
other (including rare taxa)		0.14 (0.4)	0.14 (0.7)	0.11 (0.3)	0.19 (0.5)	0.03 (0.2)
Total	17.72	10.67	8.22	7.42	5.08	7.83

Table 3-3. Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at sample stations in Steel Creek. January - December 1987.

Taxon	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
	275	280	285	290	400	300	310	320
longnose gar	[a]	0.08 (0.3)	0.09 (0.3)					0.14 (0.5)
Florida gar							0.08 (0.4)	0.06 (0.12)
bowfin				0.08 (0.3)		0.59 (0.9)	0.25 (0.7)	0.14 (0.4)
American eel	1.42 (1.8)		0.18 (0.6)	0.08 (0.3)	3.83 (4.0)	0.07 (0.4)	0.08 (0.4)	0.08 (0.4)
American shad								
gizzard shad			0.09 (0.3)	0.25 (0.6)				
eastern mud minnow						0.15 (0.5)		
redfin pickerel						0.44 (1.4)	0.17 (0.6)	0.22 (0.5)
chain pickerel	0.08 (0.3)		0.18 (0.4)			0.74 (1.7)	0.50 (1.0)	0.19 (0.5)
minnow[b]	2.00 (4.5)	39.17 (92.7)	0.91 (1.8)	1.33 (3.4)	2.17 (3.3)	12.59 (32.8)	16.17 (40.6)	18.97 (40.9)
golden shiner	0.17 (0.4)	1.08 (3.4)		0.25 (0.9)		2.22 (5.2)	5.33 (10.2)	1.06 (1.5)
chubsucker	0.08 (0.3)					0.07 (0.4)	0.25 (1.2)	0.03 (0.2)
creek chubsucker	0.67 (1.4)	0.92 (2.6)	0.36 (0.5)		0.83 (1.3)	0.67 (1.1)	0.83 (2.6)	0.56 (0.9)
lake chubsucker						0.81 (2.3)	0.50 (1.1)	0.94 (2.3)
northern hog sucker	0.17 (0.6)	0.08 (0.3)	0.50 (0.9)		0.17 (0.6)			
spotted sucker	0.17 (0.4)		0.55 (0.9)	0.67 (1.2)		0.22 (1.2)	1.75 (3.3)	0.83 (2.0)
bullhead catfishes		0.17 (0.6)						
snail bullhead								0.03 (0.2)
yellow bullhead		0.50 (1.2)			1.17 (1.6)	0.37 (1.0)	0.42 (1.0)	0.06 (0.2)
brown bullhead						0.15 (0.5)	0.08 (0.4)	0.03 (0.2)
flat bullhead		1.83 (5.1)	0.09 (0.3)		0.83 (2.3)		0.08 (0.4)	
channel catfish								
madtom					0.17 (0.6)			
tadpole madtom								
speckled madtom	0.08 (0.3)							
swampfish						0.15 (0.5)		
pirate perch					0.83 (1.6)	2.07 (5.7)	1.17 (2.5)	0.50 (1.1)
mosquitofish						3.33 (14.3)	1.25 (4.3)	0.53 (1.5)
brook silverside		0.08 (0.3)				0.74 (3.1)	0.33 (1.0)	0.19 (0.5)
mud sunfish								
pygmy sunfish						0.15 (0.5)		0.06 (0.2)
Everglades pygmy sunfish						0.07 (0.4)		

[a] A blank indicates no fish collected.
[b] Includes various combinations of minnows and shiners (*Notropis* spp.).

Table 3-3 (continued). Mean electrofishing catch per unit of effort (no./100 m [standard deviation]) at sample stations in Steel Creek. January - December 1987.

	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
Taxon	275	280	285	290	400	300	310	320
banded pygmy sunfish						0.07 (0.4)		
bluespotted sunfish						0.30 (0.7)	0.08 (0.4)	
unid. sunfish							0.50 (1.8)	0.06 (0.2)
hybrid sunfish		0.08 (0.3)						
redbreast sunfish	2.83 (3.8)	3.58 (5.2)	1.27 (1.5)	0.75 (0.9)	2.17 (2.3)	1.19 (2.2)	0.25 (0.7)	0.22 (0.5)
warmouth						0.22 (0.6)	0.16 (0.8)	
bluegill	94.67 (98.4)	12.00 (12.4)	1.09 (2.6)	1.33 (1.9)	3.83 (4.1)	3.26 (7.1)	3.25 (5.1)	0.94 (1.0)
dollar sunfish					0.17 (0.6)			
redear sunfish							0.08 (0.4)	0.06 (0.2)
spotted sunfish		0.17 (0.4)	0.18 (0.4)		1.33 (1.3)	0.30 (0.7)	3.92 (6.1)	1.00 (1.6)
largemouth bass	1.83 (1.9)	0.67 (0.9)	0.68 (0.9)	1.42 (3.8)		0.89 (1.4)	3.75 (4.0)	1.69 (1.5)
black crappie							0.17 (0.6)	0.06 (0.2)
tesselated darter					0.17 (0.6)			
yellow perch	0.08 (0.3)	0.08 (0.3)			0.17 (0.6)		0.33 (0.8)	
blackbanded darter	0.08 (0.3)	1.50 (2.3)	0.50 (0.8)	0.67 (1.2)	0.17 (0.6)		0.17 (0.6)	0.08 (0.4)
darters				0.08 (0.3)				0.11 (0.7)
striped mullet							0.08 (0.4)	
unknown								
Total	104.33 (102.9)	62.00 (117.7)	6.68 (4.4)	6.92 (9.1)	18.0 (6.8)	31.85 (52.0)	42.0 (44.2)	28.83 (34.8)

Table 3-3 (continued). Mean electrofishing catch per unit of effort (no./100m [standard deviation]) at sample stations in Steel Creek. January - December 1987.

Taxon	Steel Creek Swamp 330	Steel Creek Swamp 340	Steel Creek Swamp 350	Steel Creek Channel 360	Steel Creek Channel 370
longnose gar		0.42 (1.1)		0.08 (0.3)	
Florida gar					0.03 (0.2)
bowfin	0.56 (0.9)	0.17 (0.4)	0.22 (0.6)	0.03 (0.2)	0.08 (0.3)
American eel	0.06 (0.2)	0.03 (0.2)	0.11 (0.3)	0.08 (0.3)	0.06 (0.2)
American shad				0.69 (1.7)	0.11 (0.4)
gizzard shad		0.14 (0.4)			0.03 (0.2)
eastern mud minnow					0.03 (0.2)
redfin pickerel	0.06 (0.2)		0.06 (0.2)	0.03 (0.2)	
chain pickerel	0.36 (0.8)	0.06 (0.2)	0.36 (0.8)		0.11 (0.3)
minnow[b]	8.69 (21.2)	1.86 (5.6)	3.08 (8.4)	2.75 (5.8)	5.44 (15.1)
golden shiner	1.00 (2.1)	0.25 (0.9)	0.36 (1.3)		
chubsucker			0.03 (0.2)	0.03 (0.2)	
creek chubsucker	0.33 (0.9)	0.22 (0.5)	0.17 (0.4)		
lake chubsucker	0.36 (0.8)	0.08 (0.3)	0.19 (0.4)		
northern hog sucker					0.03 (0.2)
spotted sucker	0.94 (1.3)	0.86 (1.4)	0.44 (0.7)	0.39 (1.0)	0.42 (0.8)
bullhead catfishes	0.03 (0.2)	0.03 (0.2)	0.03 (0.2)	0.03 (0.2)	
snail bullhead					
yellow bullhead	0.14 (0.4)	0.11 (0.4)	0.03 (0.2)		
brown bullhead					
flat bullhead				0.06 (0.3)	
channel catfish				0.03 (0.2)	0.06 (0.2)
madtom					
tadpole madtom		0.03 (0.2)			
speckled madtom				0.03 (0.2)	
swampfish			0.08 (0.3)		
pirate perch	0.17 (0.4)	0.03 (0.2)	0.19 (0.6)	0.03 (0.2)	0.08 (0.4)
mosquitofish	0.42 (1.2)	0.06 (0.3)	0.31 (0.8)	0.06 (0.3)	
brook silverside	0.14 (0.4)	0.19 (0.6)	0.42 (0.8)		0.72 (2.3)
mud sunfish					0.03 (0.2)
pygmy sunfish				0.03 (0.2)	
Everglades pygmy sunfish					

[b] Includes various combinations of minnows and shiners (Notropis spp.).

Table 3-3 (continued). Mean electrofishing catch per unit of effort (no./100m [standard deviation]) at sample stations in Steel Creek. January - December 1987.

Taxon	Steel Creek Swamp			Steel Creek Channel	
	330	340	350	360	370
banded pygmy sunfish					
bluespotted sunfish					0.03 (0.2)
unid. sunfish	0.06 (0.3)	0.03 (0.2)	0.03 (0.2)		
hybrid sunfish					
redbreast sunfish	0.08 (0.3)		0.03 (0.2)	0.53 (0.7)	0.36 (0.9)
warmouth	0.03 (0.2)				
bluegill	0.50 (0.8)	0.06 (0.2)	0.11 (0.3)	0.78 (3.4)	0.78 (1.6)
dollar sunfish					
redear sunfish	0.06 (0.2)			0.03 (0.2)	
spotted sunfish	1.58 (1.8)	0.17 (0.5)	0.56 (1.0)	0.31 (0.7)	0.44 (0.8)
largemouth bass	2.11 (1.8)	1.25 (1.9)	0.81 (1.1)	0.78 (1.2)	0.47 (0.8)
black crappie	0.06 (0.2)				
tesselated darter					0.03 (0.2)
yellow perch	0.17 (0.4)	0.44 (0.7)	0.53 (1.0)	0.11 (0.3)	0.06 (0.2)
blackbanded darter	0.39 (0.6)	0.06 (0.2)	0.17 (0.7)	0.17 (0.4)	0.17 (0.6)
darters					
striped mullet				0.06 (0.3)	0.14 (0.4)
unknown					0.03 (0.2)
Total	18.30 (20.4)	6.53 (6.0)	8.31 (10.0)	7.08 (8.7)	9.72 (13.0)

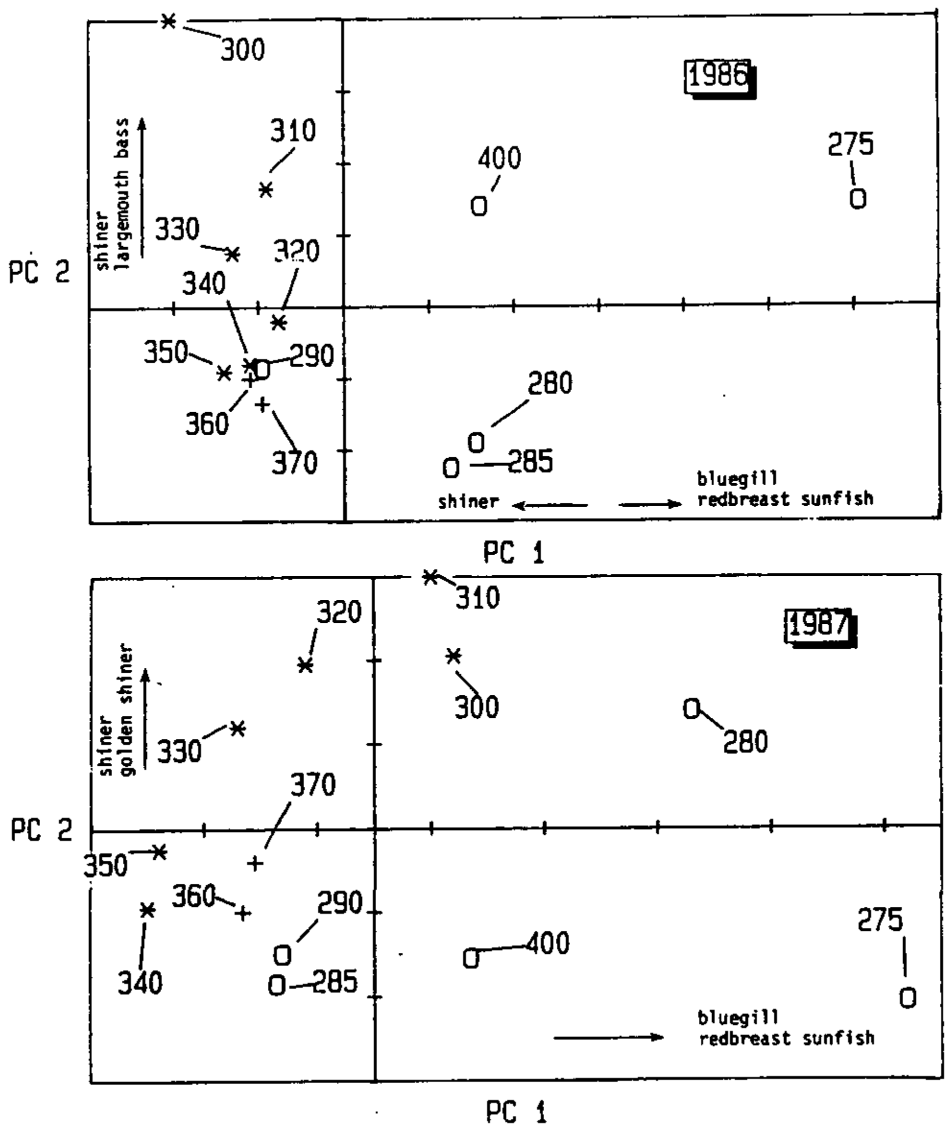


Figure 3-1. Principal component analysis of mean yearly electrofishing catch per unit effort (CPUE; no. fish/100 m) at stations in Steel Creek. Taxa primarily responsible for separation along each axis are indicated with arrows showing direction of increasing abundance. (* = delta/swamp, + = channel, and 0 = corridor). January 1986 - December 1987.

bass. Station 300, which was located in an exceptionally shallow, heavily vegetated area at the northeastern edge of the delta, produced the highest average shiner and largemouth bass catches, although all of the largemouth bass were small juveniles collected from a single school. The structure of the adult/juvenile fish assemblage in the channel (Stations 360 and 370) was fairly similar to that in the closed-canopy swamp.

The relationship among stations during 1987 was generally similar to that during 1986 (Figure 3-1; Table 3-3). Station 275 separated from the other stations along principal component 1, primarily due to high catches of bluegill. Station 280, 285, and 290 fell between Station 275 and the swamp sample stations, reflecting a downstream decline in bluegill abundance in the corridor. As in 1986, there was some separation among open-canopy, closed-canopy, and channel stations, with the open-canopy stations characterized by higher catches of shiners and golden shiners.

The presence of large numbers of bluegill in the corridor is of considerable interest since these fishes originated in L-Lake, hence represent an impact of the restart of L-Reactor. Young-of-year bluegill were first observed during the summer of 1986 in and around the L-Lake discharge culvert, after actively or passively emigrating from L-Lake where they were present in large numbers. By the winter of 1986, bluegill were the dominant species in the corridor (Figure 3-2), especially at Stations 275 (because of its proximity to L-Lake). Concurrent with the increase in bluegill abundance during 1986 was a decrease in the abundance of other taxa. Bluegill remained the dominant taxa in the corridor during early 1987 but declined later in the year. By late 1987, bluegill no longer dominated the catches from the corridor and other taxa, especially darters and minnows, were being collected in relatively large numbers.

While the immigration of bluegill into the corridor caused major changes in the corridor fish assemblages, relatively subtle changes were occurring prior to this. Certain species collected early in 1986 (eastern mudminnow, mud sunfish, banded pygmy sunfish, and Christmas darter) were not observed in later months (Table 3-4). All of these species are generally associated with smaller streams or slow flowing waters (Pflieger 1975; Trautman 1981), and their disappearance may reflect the effects of increased flow and changes in channel morphometry resulting from the discharge of L-Lake water into Steel Creek.

Unlike the fish assemblage in the corridor, which was characterized by large temporal changes in community structure due to the emigration of bluegill from L-Lake,

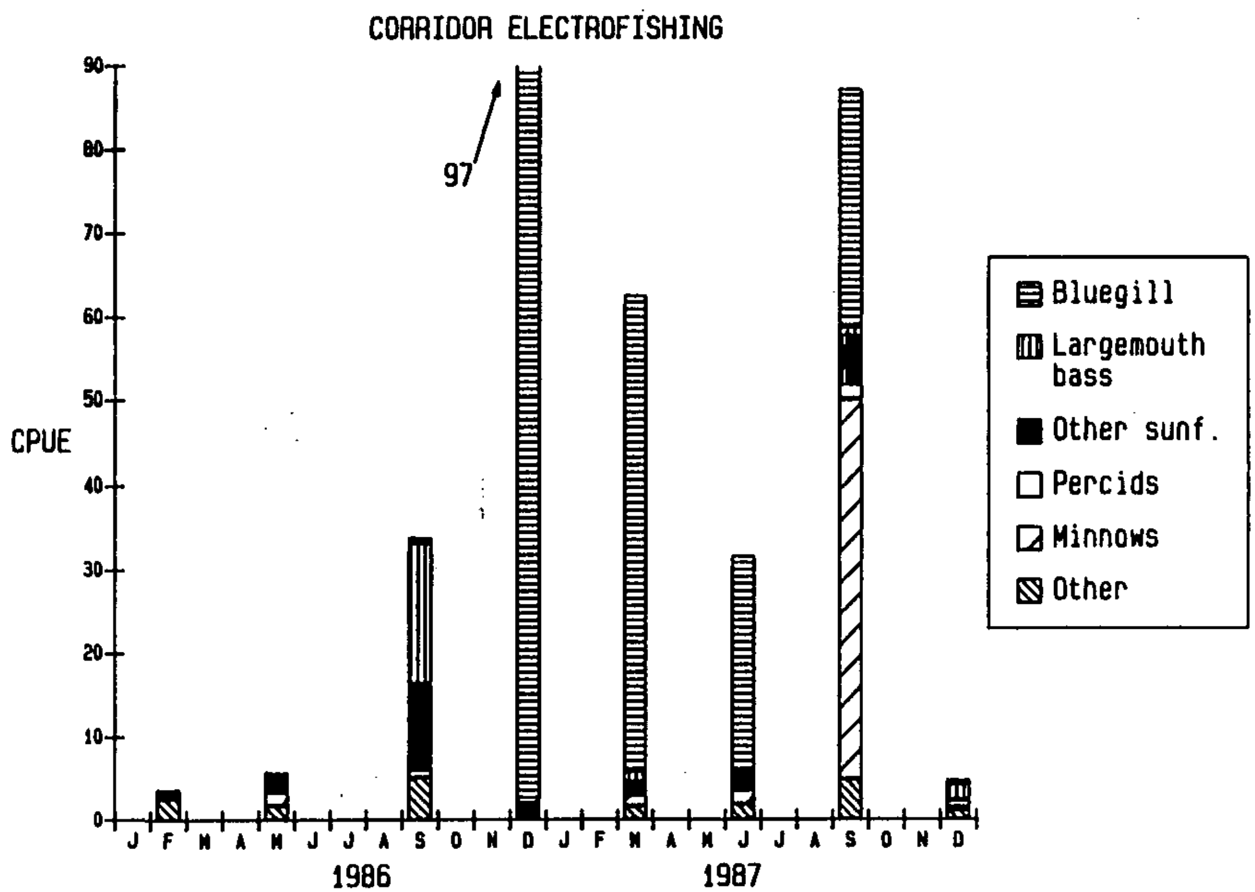


Figure 3-2. Temporal changes in mean seasonal catch per unit effort (CPUE; no./100 m) in the Steel Creek corridor (Stations 275, 280, 285, and 290). January 1986 - December 1987.

Table 3-4. Occurrence of fishes in the Steel Creek corridor observed in quarterly electrofishing samples during 1986 - 1987.

–	1986				1987			
	Feb	May	Sept	Dec	Feb - Apr	June	Sept	Dec
longnose gar		X				X		
Florida gar		X						
bowfin	X		X					X
American eel	X	X	X	X	X	X	X	X
gizzard shad					X	X		
eastern mudminnow	X							
redfin pickerel		X	X					
chain pickerel		X	X		X	X		
bluehead chub	X	X	X	X	X			
golden shiner						X	X	
dusky shiner		X	X	X	X		X	
spottail shiner						X		
yellowfin shiner	X		X	X	X	X	X	
coastal shiner	X	X	X	X	X		X	X
carpsucker		X						
creek chubsucker	X	X	X	X	X	X	X	X
lake chubsucker			X		X			
northern hog sucker	X	X	X	X	X		X	X
spotted sucker	X	X		X	X	X	X	X
yellow bullhead		X	X			X	X	X
flat bullhead			X	X		X	X	X
madtom		X					X	
tadpole madtom								
speckled madtom	X		X		X			
pirate perch	X	X	X				X	X
brook silverside							X	
mud sunfish	X							
banded pygmy sunfish	X							
hybrid sunfish							X	
redbreast sunfish	X	X	X	X	X	X	X	X
warmouth		X		X				
bluegill			X	X	X	X	X	X
dollar sunfish	X							X
spotted sunfish	X	X	X	X	X	X	X	X
largemouth bass	X	X	X	X	X	X	X	X
black crappie		X						
Christmas darter	X							
tesselated darter	X	X		X		X		
yellow perch		X				X	X	
blackbanded darter	X	X	X	X	X	X	X	X

important temporal changes in fish community structure were generally absent from the delta/swamp. Species number and catch per unit effort (Figures 3-3 and 3-4) were variable, probably a result of changes in water level (that affected fish distribution and electrofishing efficiency), occasional encounters with large schools of shiners, and changes in fish abundance associated with natural recruitment and mortality patterns. The strongest indication of environmental impact in the Steel Creek swamp was the occurrence of bluegill in relatively low numbers during 1987 and, to a lesser extent, 1986. These fish probably emigrated down the Steel Creek corridor from L-Lake.

In the Steel Creek channel, electrofishing catch per unit effort and species number varied over time, but exhibited few patterns of substantive interest (Figures 3-4 and 3-5). Shiners (the primary minnow taxon in Figure 3-5) exhibited a general increase over 1986 - 1987. Bluegill were collected in appreciable numbers for the first time in May and June 1987, possibly reflecting downstream dispersal from the Steel Creek corridor where they were decreasing in abundance at this time (Figure 3-2).

Changes in fish assemblage structures in Steel Creek were examined on a larger time scale by comparing 1986 and 1987 data with data collected prior to the re-start of L-

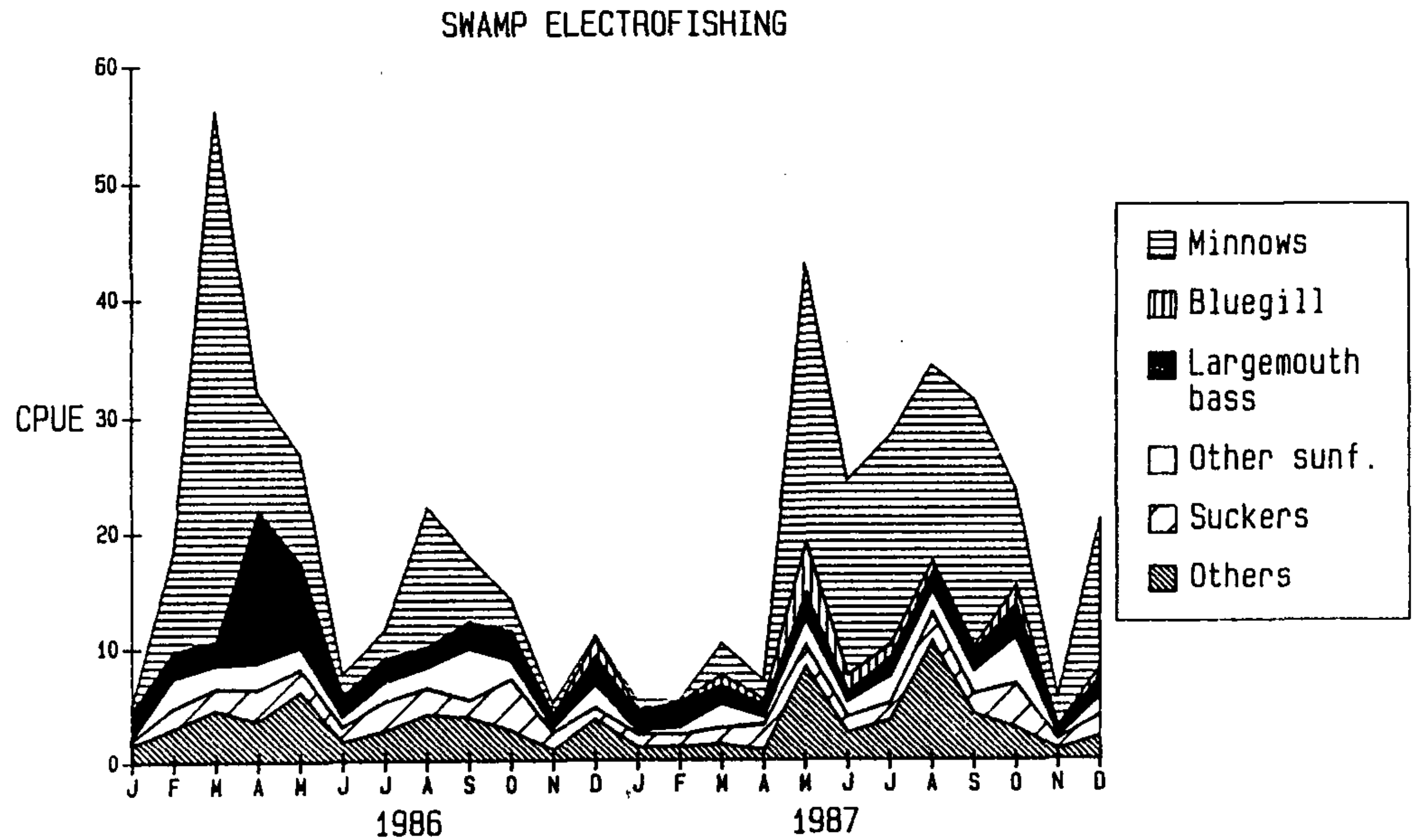


Figure 3-3. Temporal changes in mean monthly catch per unit effort (CPUE; no./100 m) in the Steel Creek swamp (Stations 300, 310, 320, 330, 340, and 350). January 1986 - December 1987.

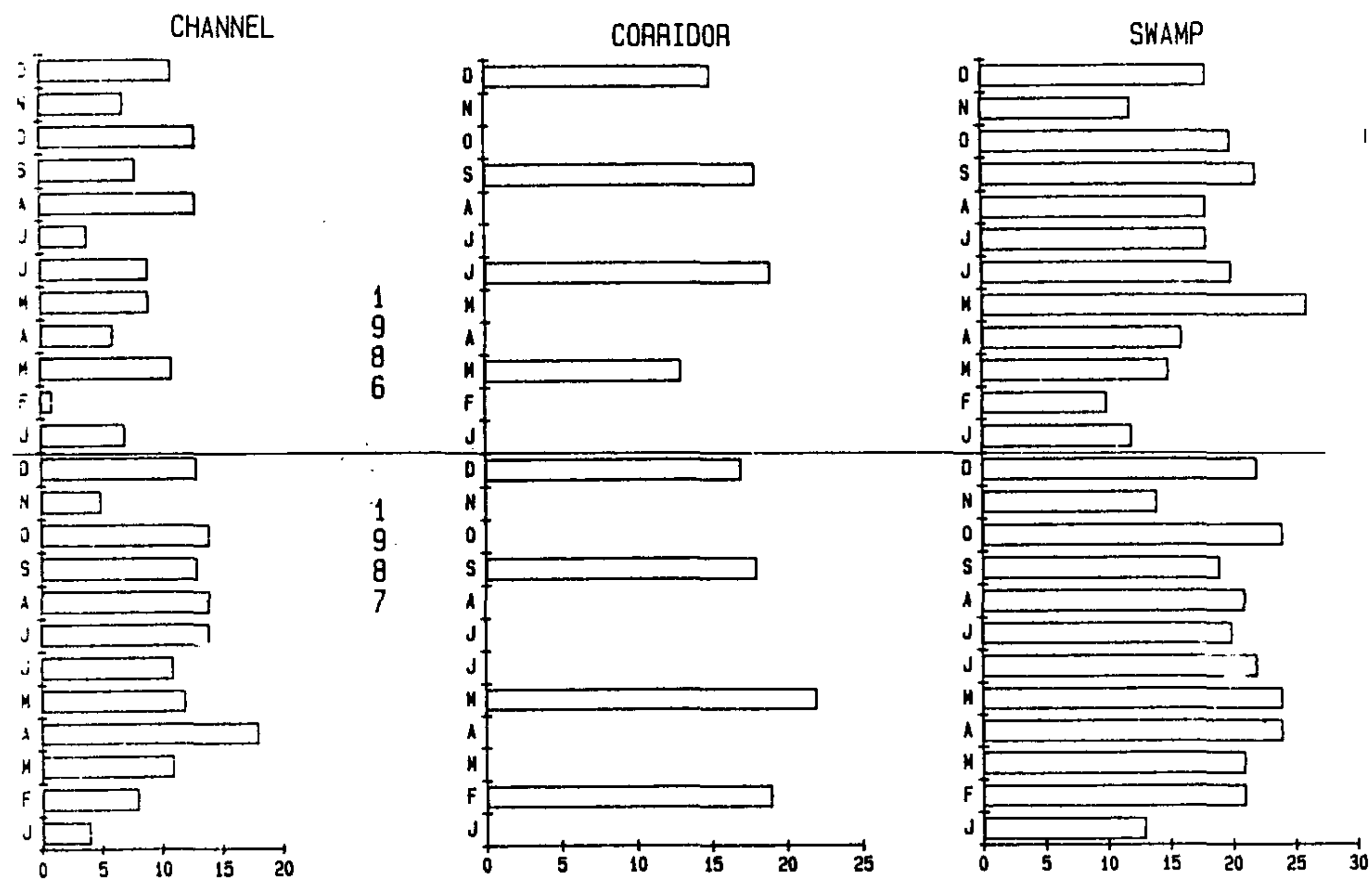


Figure 3-4. Temporal changes in number of species collected by electrofishing from the Steel Creek channel (Stations 360 and 370), corridor (Stations 275, 280, 285, and 290), and swamp/delta (Stations 300, 310, 320, 330, 340, and 350). January 1986 - December 1987.

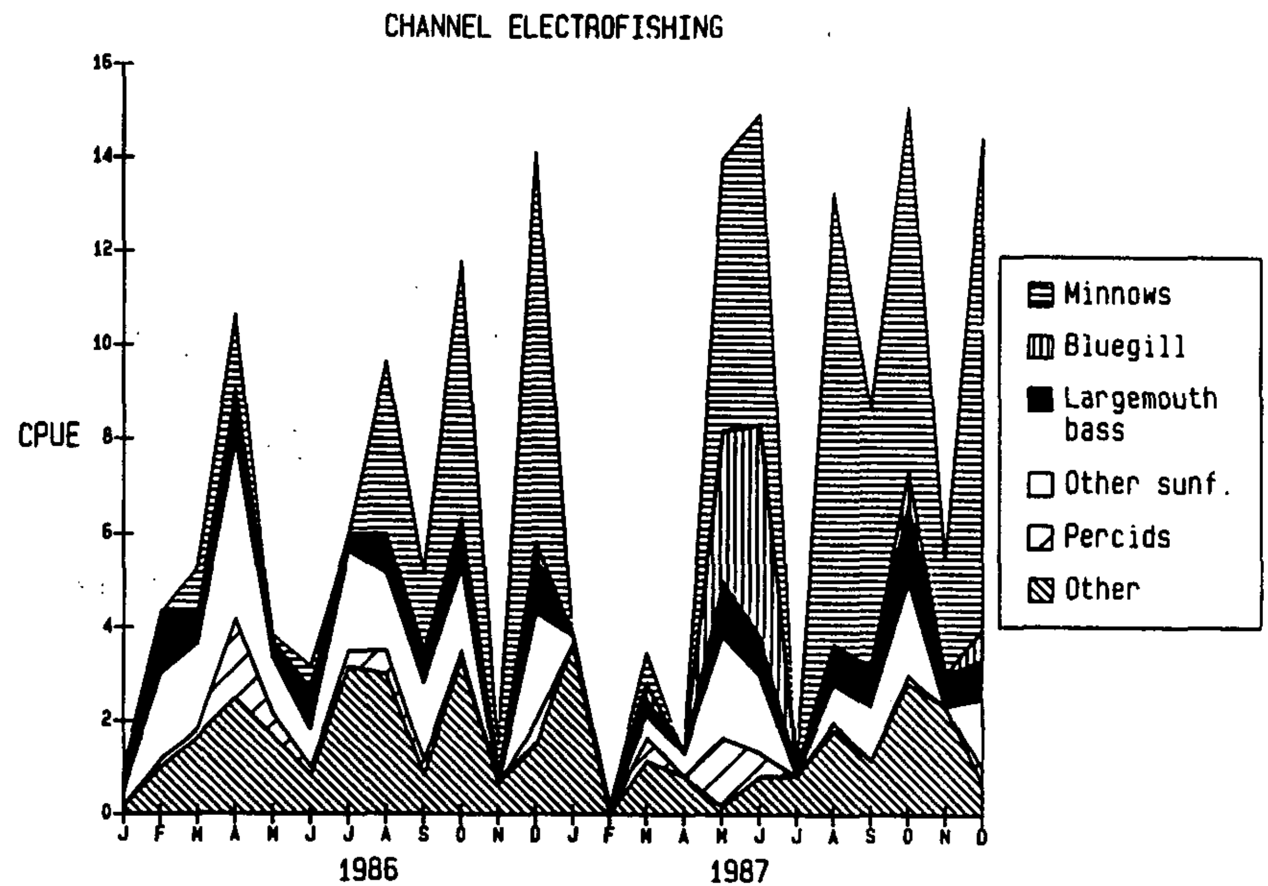


Figure 3-5. Temporal changes in mean monthly catch per unit effort (CPUE; no./100 m) in the Steel Creek channel (Stations 360 and 370). January 1986 - December 1987.

Reactor and impoundment of L-Lake. Aho et al. (1986 and unpublished data) collected electrofishing data from Steel Creek during 1983, 1984, and 1985. Their methods were generally similar to methods used in this study at the sample stations in the delta/swamp (i.e., single pass boat electrofishing) but differed at the sample stations in the corridor, where they used block nets and repeated passes with a backpack electroshocker while this study used single pass boat electrofishing. (The use of backpack electrofishing equipment and block nets was not feasible in the corridor following the ten-fold increase in flow caused by the re-start of L-Reactor). The locations of the sample stations in the prior study were not identical with this study but were in the same general habitats. Aho et al. (1986) generally sampled quarterly in the corridor and monthly in the delta/swamp.

Pre-impoundment (1983, 1984, and 1985) and post-impoundment (1986 and 1987) electrofishing data from the Steel Creek corridor are presented in Table 3-5. These data were collected from Aho et al.'s (1986) stations "Steel Creek 2" and "Steel Creek 3" and ECS Stations 280 and 290, which occupied generally similar locations. Only the relative abundance of major taxonomic groups is shown since catch per unit effort was not comparable between this study and Aho et al. (1986) due to changes in methodology.

Table 3-5. Percent abundance of major taxonomic groups of fishes collected by electrofishing in Steel Creek corridor and Meyers Branch before (1983, 1984 and 1985) and after (1986 and 1987) the impoundment of L-Lake and re-start of L-Reactor.

	Steel Creek			Meyer's Branch		
TAXON	Pre-[a]	Post-		Pre-[a]	Post-	
		1986	1987		1986	1987
suckers	3.54	19.76	2.41	1.33	5.52	5.55
minnows	45.83	14.89	60.71	44.71	28.14	12.05
catfishes	6.00	1.08	3.63	6.20	3.53	12.05
sunfishes	15.43	55.99	29.02	6.72	38.69	41.64
darters	10.76	1.71	3.40	11.66	9.56	2.78
other	18.44	6.59	0.84	29.38	14.57	25.93
Total	100.00	100.02	100.01	100.00	100.01	100.00

[a]From Aho et al. 1986.

Prior to 1986, electrofishing catches from the corridor were dominated by minnows (45.8%) and percids (mostly darters, 10.8%; Table 3-5), which are taxa typically associated with small streams (Pflieger 1975; Becker 1983). During 1986 community structure changed, with small fishes such as shiners decreasing in relative abundance and dominance shifting to sunfishes (56.0%) and suckers (19.8%). Most of the sunfishes collected from the corridor during 1986 were bluegill that probably originated in L-Lake. Further changes occurred in 1987, with sunfishes decreasing in relative abundance as a result of the downstream dispersal and/or mortality of many of the bluegill that entered the corridor in 1986. While some of these differences between pre- and post-impoundment years are undoubtedly partly due to differences in methodology, they suggest large initial changes in assemblage structure due to the invasion of bluegill from L-Lake and a later reduction in the abundance of these lake emigrants.

In the years preceding the re-start of L-Reactor, the Meyer's Branch fish assemblage was dominated by minnows (44.7%) and darters (11.7%; Table 3-5). Following the re-start, dominance shifted towards sunfishes (principally bluegill) as it did in the Steel Creek corridor (from 6.7% in 1984 and 1985 to 38.7% in 1986). Unlike the corridor fish assemblage, however, there was no indication of reduced domination by sunfish in 1987 (41.6%).

Because sampling methods were fairly consistent in the Steel Creek swamp, both CPUEs and percent composition have been included in the assessments of fish community structure for this habitat. Comparisons have been restricted to three habitats sampled by both Aho et al. (1986) and this study: the closed-canopy swamp (Aho et al. Site 3, this study Stations 340, 350), the open-canopy delta between the islands (Aho et al. Site 2, ECS Stations 320 and 330), and the open-canopy delta below the islands (Aho et al. Site 1, ECS Station 310). Only taxa that composed 1% or more of the catch from at least one year are included in these comparisons to facilitate comparison with Aho et al. (1986).

Community structure in the closed-canopy swamp was fairly constant during the three years (1983, 1984, and 1985) preceding the re-start of L-Reactor (Table 3-6). The shiners, brook silverside, and spotted suckers were among the most abundant fishes during all years. Other numerically important species were the largemouth bass and yellow perch. In 1986, the year following the re-start of L-Reactor, the shiners (21.5%), spotted suckers (13.2%), largemouth bass (17.3%), and yellow perch (10.0%) remained dominant, but the brook silverside declined to minor

Table 3-6. Mean electrofishing catch per unit effort (no./100 m) and relative abundance (% composition) of common species in a closed-canopy habitat (Stations 340 and 350) in the Steel Creek swamp before and after the impoundment of L-Lake and restart of L-Reactor. 1983 - 1987.

	Before						After			
	1983[a]		1984[a]		1985[a]		1986		1987	
Taxa	CPUE	%	CPUE	%	CPUE	%	CPUE	%	CPUE	%
longnose gar	0.42	4.3	0.94	4.7	2.29	15.1	0.25	2.7	0.21	2.8
bowfin	0.47	4.8	1.36	6.8	0.39	2.6	0.42	4.5	0.19	2.6
American eel	0.14	1.4	0.36	1.8	-		0.20	2.1	0.07	0.9
gizzard shad	0.08	0.8	0.44	2.2	0.28	1.8	0.06	0.6	0.07	0.9
chain pickerel	-		-		-		0.25	2.7	0.21	2.8
golden shiner	0.06	0.6	1.11	5.6	0.50	3.3	0.57	6.1	0.31	4.1
minnow	1.75	17.9	6.66	33.3	4.34	28.7	2.03	21.5	2.47	33.3
chubsucker	0.14	1.4	0.25	1.2	0.17	1.1	0.35	3.7	0.35	4.7
spotted sucker	0.73	7.5	1.42	7.1	1.95	12.9	1.24	13.2	0.65	8.8
pirate perch	-		0.34	1.7	0.28	1.8	0.15	1.6	0.11	1.5
lined topminnow	-		-		-		0.01	0.1	-	
mosquitofish	0.11	1.1	0.11	0.6	-		0.01	0.1	0.18	2.4
brook silverside	3.84	39.3	2.74	13.7	2.06	13.6	0.39	4.1	0.31	4.1
redbreast sunfish	0.08	0.8	0.22	1.1	0.06	0.4	0.06	0.6	0.01	0.2
bluegill	-		-		-		0.01	0.1	0.08	1.1
redear sunfish	-		-		-		0.17	1.8	-	
spotted sunfish	0.28	2.9	0.59	3.0	0.72	4.8	0.32	3.4	0.36	4.9
largemouth bass	1.00	10.2	1.23	6.2	1.05	6.9	1.63	17.3	1.03	13.9
yellow perch	0.50	5.1	1.27	6.4	0.66	4.4	0.94	10.0	0.49	6.6
blackbanded darter	0.06	0.6	0.39	2.0	0.28	1.8	0.10	1.1	0.11	1.5
striped mullet	0.11	1.1	0.56	2.8	0.11	0.7	0.01	0.1	-	
other	-		-		-		0.25	2.5	0.17	2.4
Total[b]	9.77	99.8	19.99	100.2	15.14	99.9	9.42	99.9	7.42	99.5

[a] Adapted from Aho et al. 1986.
[b] Deviations between arithmetic sum of the column and the indicated total for CPUE and the differences from 100.0 for percent composition are due to rounding error.

importance (4.1%). This pattern persisted in 1987 with shiners (33.3%), largemouth bass (13.9%), spotted sucker (8.8%), and yellow perch (6.6%) the domimant taxa. Total (all species combined) CPUE following the re-start of L-Reactor (7.42 - 9.42/100 m) was slightly below that in the years preceding the re-start (9.77 - 19.99/100 m). The bluegill, a species that emigrated from L-Lake in large numbers, was first observed in the closed-canopy swamp during 1986. CPUE for this species increased during 1987 (from 0.02 - 0.1/100 m), suggesting that bluegill entered the swamp in greater numbers during 1987.

The taxa assemblage in the open-canopy delta between the islands changed little during the three years preceding the re-start of L-Reactor, with shiners, brook silverside, spotted sunfish, and largemouth bass predominating during all years (Table 3-7). In the year following the re-start of L-Reactor (1986), shiners (23.2%), spotted sunfish (12.7%), and largemouth bass (21.8%) remained relatively abundant but, as in the closed-canopy swamp, brook silverside declined to a minor component of the total catch (2.4% in contrast to 9.0 - 14.3%). Primarily because of decreased brook silverside and shiner catches, total CPUE during 1986 (15.71/100 m) was lower than during previous years (23.57 - 44.74/100 m). In 1987, mean total CPUE increased somewhat (23.57/100 m) because of the collection of large numbers of shiners (mean CPUE of 13.83/100 m).

Table 3-7. Mean electrofishing catch per unit effort (no./100 m) and relative abundance (% composition) of common species in an open-canopy habitat (Stations 320 and 330) in the Steel Creek swamp. Samples were collected from between the islands before and after the impoundment of L-Lake and restart of L-Reactor. 1983 - 1987.

	Before						After			
	1983[a]		1984[a]		1985[a]		1986		1987	
Taxa	CPUE	%	CPUE	%	CPUE	%	CPUE	%	CPUE	%
longnose gar	-				-		0.17	1.1	0.07	0.3
bowfin	0.36	1.5	0.59	1.3	0.72	1.8	0.54	3.4	0.35	1.5
American eel	0.10	0.4	0.12	0.3	1.66	4.1	0.16	1.1	0.07	0.3
redfin pickerel	0.39	1.7	0.68	1.5	0.22	0.5	0.01	0.1	0.14	0.6
chain pickerel	-		-		-		0.39	2.5	0.28	1.2
golden shiner	1.50	6.4	1.80	4.0	1.01	2.5	0.44	2.8	1.03	4.4
minnow	12.34	52.4	24.22	54.1	10.80	26.4	3.66	23.2	13.83	58.7
chubsucker	1.05	4.5	3.02	6.8	2.72	6.7	1.61	10.2	1.11	4.7
spotted sucker	0.59	2.5	0.69	1.5	0.67	1.6	0.72	4.6	0.89	3.8
pirate perch	0.44	1.9	2.02	4.5	1.96	4.8	0.31	2.0	0.33	1.4
mosquitofish	0.78	3.3	0.67	1.5	0.11	0.3	0.62	3.9	0.47	2.0
brook silverside	2.11	9.0	4.50	10.0	5.85	14.3	0.38	2.4	0.17	0.7
redbreast sunfish	-		-		-		0.32	2.0	0.15	0.6
bluegill	-		-		-		0.27	1.7	0.72	3.1
spotted sunfish	1.80	7.6	3.08	6.9	10.50	25.7	2.00	12.7	1.29	5.5
largemouth bass	2.11	9.0	3.35	7.5	4.71	11.5	3.43	21.8	1.90	8.1
black banded darter	-		-		-		0.24	1.5	0.24	1.0
other	-		-		-		0.44	3.1	0.53	2.1
Total[b]	23.57	100.2	44.74	99.9	40.93	100.2	15.71	100.1	23.57	100.0

[a]From Aho et al. 1986.
[b]Deviations between arithmetic sum of the column and the indicated total for CPUE and the differences from 100.0 for percent composition are due to rounding error.

Taxonomic composition and total CPUE in 1987 were very similar to that in 1983.

Seventeen taxa were collected from the open-canopy delta between the islands in 1986 and in 1987, more than the 12 taxa collected in each sampled year preceding the re-start of L-Reactor (Table 3-7). While taxa number comparisons are weakened by greater sampling effort during 1986 and 1987 than during earlier years (i.e., Aho et al. [1986] sampled 50 m transects while this study sampled 100 m transects), they at least suggest that the diversity of the fish assemblage has not decreased since the re-start of L-Reactor. Perhaps the most significant addition to the fauna was bluegill (1.7% of the catch between the islands in 1986 and 3.1% in 1987), since this taxa probably entered the swamp after actively or passively emigrating from L-Lake.

Assemblage structure in the open-canopy delta below the islands varied prior to the re-start of L-Reactor. While shiners and, to a lesser extent, largemouth bass were abundant during all years, the abundance of other taxa such as the spotted sunfish, spotted sucker, and brook silverside fluctuated widely (Table 3-8). The dominant taxa following the re-start of L-Reactor were shiners (29.1%), largemouth bass (14.3%), spotted sunfish (13.8%), and spotted sucker

Table 3-8. Mean electrofishing catch per unit effort (no./100 m) and relative abundance (% composition) of common species in an open-canopy habitat (Station 310) in the Steel Creek delta before and after the impoundment of L-Lake and restart of L-Reactor. Samples were collected from below the islands. 1983 - 1987.

	Before						After			
	1983[a]		1984[a]		1985[a]		1986		1987	
Taxa	CPUE	%	CPUE	%	CPUE	%	CPUE	%	CPUE	%
longnose gar	0.06	0.4	0.28	1.2	0.21	1.3	0.17	0.6	-	
bowfin	0.64	4.5	1.27	5.4	0.88	5.5	0.25	1.0	0.25	0.6
American eel	0.36	2.5	0.33	1.4	0.10	0.6	0.50	1.9	0.08	0.2
redfin pickerel	6.43	3.0	0.38	1.6	0.10	0.6	0.17	0.6	0.17	0.4
chain pickerel	-		-		-		0.25	1.0	0.50	1.1
golden shiner	0.72	5.0	0.12	0.5	-		1.42	5.4	5.33	12.8
minnow	5.62	39.4	11.93	50.6	5.97	37.1	7.66	29.1	16.17	39.0
chubsucker	0.22	1.5	0.23	1.0	0.21	1.3	0.67	2.5	1.58	3.8
spotted sucker	2.05	14.4	0.78	3.3	1.10	6.8	1.83	7.0	1.75	4.2
yellow bullhead	-		-		-		0.08	0.3	0.42	1.0
flat bullhead	-		-		-		0.25	1.0	0.08	0.2
pirate perch	0.17	1.2	1.11	4.7	1.00	6.2	1.25	4.8	1.17	2.8
mosquitofish	-		0.28	1.2	0.22	1.4	-		1.25	3.0
brook silverside	0.67	4.7	1.22	5.2	-		1.00	3.8	0.33	0.7
unid. sunfish	-		-		-		-		0.50	1.2
redbreast sunfish	-		-		-		1.33	5.1	0.25	0.6
bluegill	-		-		-		0.50	1.1	3.25	7.7
redear sunfish	-		0.40	1.7	0.11	0.7	0.17	0.6	0.08	0.2
spotted sunfish	0.28	2.0	2.50	10.6	2.66	16.5	3.67	13.8	3.92	9.4
largemouth bass	2.27	15.9	1.84	7.8	2.77	17.2	3.75	14.3	3.75	8.2
yellow perch	0.28	2.0	0.28	1.2	-		0.67	2.5	0.33	0.8
blackbanded darter	0.17	1.2	0.45	1.9	0.77	4.8	0.42	1.4	0.17	0.4
striped mullet	0.33	2.3	0.17	0.7	-		-		0.08	0.2
other							0.58	2.1	0.54	1.3
Total[b]	20.27	100.0	23.57	100.0	16.10	100.0	26.58	99.9	42.00	99.8

[a] From Aho et al. 1986.
[b] Deviations between arithmetic sums of the column and the indicated total for CPUE and the differences from 100.0 for percent composition are due to rounding error.

(7.0%) in 1986. Shiners (39.0%), golden shiner (12.8%), spotted sunfish (9.4%), and largemouth bass (8.2%) were dominant in 1987. These patterns of dominance were not unlike those preceding the reactor re-start.

In 1986 total CPUE (26.29/100 m) in the open canopy area below the islands was similar to that before reactor re-start (16.10 - 23.57/100 m) but in 1987 was higher (41.50/100 m), due to the collection of large numbers of shiners. The total number of taxa collected was 20 during 1986 and 22 during 1987 in contrast to 13 - 17 in the years preceding reactor re-start. As previously described, this comparison is weakened by greater sampling effort during 1986 and 1987. Bluegill, which composed 1.1% of the catch in 1986 and 7.7% of the catch in 1987, were not collected prior to the re-start of L-Reactor. In summary, fish assemblage changes observed in the delta/swamp were minor compared to those observed in the corridor.

Comparisons between the pre- and post-impoundment fish assemblages in the lower channel have been based solely on data collected near the creek mouth, since this was the only location sampled prior to 1986. Samples were taken from the creek mouth on a quarterly schedule during 1983, 1984, and 1985 by Paller et al. (1984), Paller and Osteen (1985), and Paller and Saul (1986). Each study employed the same type of equipment, although the methods were slightly different during 1983 and 1984, when multiple passes were used for the purpose of mark/recapture population estimates. Because catch rates tended to decline with each pass, only data from the first pass have been used in the following comparisons.

Mean CPUE during 1986 and 1987 (7.83 and 9.72/100 m, respectively) was somewhat greater than during the years preceding the re-start of L-Reactor and impoundment of L-Lake (2.56 - 6.66/100 m; Table 3-9) due primarily to the collection of greater numbers of minnows. Mean bluegill CPUE was also relatively high during 1987, reflecting the dispersal of this species throughout Steel Creek. Largemouth bass and sunfishes, particularly the spotted sunfish, were relatively abundant during all years. Taxa numbers were higher during 1986 (31) and 1987 (23) than during pre-re-start years (10 - 15) although, again, this difference should be viewed cautiously since sampling effort was considerably greater during 1986 and 1987 (monthly sampling) than during earlier years (quarterly sampling). Within the limitations imposed by differences in sampling frequency between pre- and post- impoundment years, these data suggest an absence of deleterious effects at the mouth of Steel Creek following the re-start of L-Reactor.

3.2.2 Fykenetting

The fyke net collections made at Stations 290 (i.e., downstream end of the corridor; Figure 2-1) and 370 (Steel

Table 3-9. Mean electrofishing catch per unit effort (CPUE; no./100 m) at a sample station in the mouth of Steel Creek before (1983, 1984, and 1985) and after (1986 and 1987) the impoundment of L-Lake and re-start of L-Reactor. 1983 - 1987.

Taxa	1983[a]	1984[b]	1985[c]	1986	1987
longnose gar				0.06	
Florida gar		0.08			0.03
bowfin	0.63	0.33	0.22	0.22	0.08
American eel				0.03	0.06
herring/shad				0.17	
blueback herring				0.03	
American shad				0.06	0.11
gizzard shad	0.13			0.11	0.03
eastern mudminnow					0.03
redfin pickerel		0.83		0.14	
chain pickerel		0.08	0.11	0.28	0.11
minnow			0.44	2.14	5.44
creek chubsucker				0.06	
northern hogsucker					0.03
spotted sucker	0.75	0.17	0.11	0.36	0.42
silver redhorse	0.13				
snail bullhead			0.11		
brown bullhead				0.03	
flat bullhead				0.06	
channel catfish	0.13		0.11		0.06
madtom				0.03	
pirate perch	0.13		0.11	0.19	0.08
Atlantic needlefish				0.03	
mosquitofish				0.06	
brook silverside	0.25	0.08	0.11	0.61	0.72
mud sunfish					0.03
bluespotted sunfish			0.11	0.14	0.03
redbreast sunfish	0.50	0.17	1.22	0.56	0.36
warmouth			0.11	0.03	
bluegill	0.25			0.06	0.78
dollar sunfish				0.03	
redear sunfish	0.13			0.03	
spotted sunfish	2.00	0.33	1.44	1.14	0.44
largemouth bass	1.25	0.33	0.44	0.67	0.47
black crappie				0.06	
darter				0.06	
tesselated darter				0.19	0.03
yellow perch	0.38	0.08	0.22	0.06	0.06
blackbanded darter			0.11	0.19	0.17
striped mullet					0.14
other		0.08	0.33		0.03
Total[d]	6.66	2.56	5.30	7.83	9.72

[a] Paller et al. 1984.
[b] Paller and Osteen 1985.
[c] Paller and Saul 1986.
[d] Any deviations between arithmetic sum of the column and the indicated total for CPUE are due to rounding error.

Creek mouth) during 1987 differed in species composition (Table 3-10). The collections at Station 290 were dominated by longnose gar (28.5%), bluegill (26.9%), creek chubsuckers (13.8%), and sunfishes (flier, redbreast sunfish, warmouth, and spotted sunfish, 9.2%). The collections at Station 370 were dominated by longnose gar (35.7%), American shad (25.0%), and channel catfish (9.3%). Bluegill, which were prominent at Station 290, were absent from the collections at Station 370. These differences reflect habitat and proximity to the Savannah River with riverine (channel catfish) and anadromous (American shad) fishes strongly represented in the creek mouth and stream species (creek chubsuckers and sunfishes) strongly represented at Station 290.

Far more bluegill were collected at Station 290 during 1987 (mean of 0.3 fish/net/day) than during 1986 (mean of 0.01 fish/net/day; Table 3-10). This change indicates that bluegill are dispersing down the Steel Creek corridor from the area below the L-Lake dam. The dispersal of bluegill down the Steel Creek corridor and into the delta/swamp was also indicated by the electrofishing data (Section 3.2.1). Concurrent with the increase in bluegill catch was a decrease in the catch of other sunfishes (flier, redbreast sunfish, warmouth, and spotted sunfish; Table 3-10, Figure 3-6) suggesting possible competition and displacement of resident species. Another difference between 1986 and 1987

Table 3-10. Mean fykenetting catch per unit of effort (CPUE; no./net/day [standard deviation]) and relative abundance (% composition) at sample stations in Steel Creek. CPUE columns may not sum to totals owing to rounding effects. January 1986 - December 1987.

Taxa	Station 290						Station 370					
	1986			1987			1986			1987		
	CPUE		%	CPUE		%	CPUE		%	CPUE		%
longnose gar	0.19	(0.81)	15.33	0.32	(1.19)	28.46	0.38	(1.02)	32.29	0.43	(1.11)	35.71
Florida gar	0.08	(0.27)	6.64	0.06	(0.23)	5.38	0.02	(0.09)	1.46	0.05	(0.15)	4.29
bowfin	0.04	(0.15)	3.20	0.02	(0.09)	1.54	0.07	(0.20)	6.31	0.07	(0.46)	5.71
American eel	0.01	(0.04)	0.46	0.02	(0.13)	1.54	0.01	(0.07)	0.73	0.01	(0.07)	0.71
Alosa spp.	-			-			0.02	(0.12)	1.94	-		
blueback herring	-			-			0.02	(0.12)	1.94	-		
American shad	-			-			0.07	(0.24)	6.06	0.30	(0.96)	25.00
gizzard shad	0.01	(0.04)	0.46	0.01	(0.07)	0.77	-			0.08	(0.28)	6.43
redfin pickerel	0.01	(0.04)	0.46	0.01	(0.07)	0.77	-			-		
chain pickerel	0.01	(0.04)	0.46	-			-			-		
bluehead chub	0.01	(0.04)	0.46	-			-			-		
golden shiner	0.08	(0.23)	6.41	0.03	(0.11)	2.31	0.01	(0.07)	0.73	-		
chubsucker	0.04	(0.19)	3.19	-			0.01	(0.07)	0.97	-		
creek chubsucker	0.13	(0.31)	10.53	0.16	(0.57)	13.85	-			-		
lake chubsucker	0.04	(0.23)	3.43	0.02	(0.09)	1.54	-			-		
northern hogsucker	-			0.01	(0.07)	0.77	-			-		
spotted sucker	0.01	(0.07)	0.69	-			0.02	(0.09)	1.46	0.02	(0.09)	1.43
bullhead catfishes	0.01	(0.04)	0.46	-			-			-		
snail bullhead	-			-			0.01	(0.07)	0.73	-		
white catfish	-			-			0.09	(0.42)	7.53	0.02	(0.09)	1.43
yellow bullhead	0.03	(0.13)	2.29	0.01	(0.07)	0.77	0.01	(0.08)	1.21	-		
brown bullhead	0.01	(0.04)	0.46	-			0.01	(0.04)	0.49	-		
flat bullhead	0.05	(0.18)	4.12	0.04	(0.22)	3.85	0.05	(0.15)	4.13	0.03	(0.15)	2.14
channel catfish	-			-			0.28	(0.97)	23.30	0.11	(0.30)	9.29
striped bass	-			-			-			0.01	(0.07)	0.71
sunfishes	-			0.02	(0.09)	1.54	-			-		
flier	0.05	(0.24)	4.35	0.01	(0.07)	0.77	-			-		
sunfish	-			-			0.01	(0.04)	0.48	-		
redbreast sunfish	0.06	(0.21)	5.04	0.03	(0.16)	3.08	0.04	(0.16)	3.40	0.04	(0.17)	3.57
warmouth	0.15	(0.34)	12.13	0.02	(0.09)	1.54	-			-		
bluegill	0.01	(0.06)	0.91	0.30	(0.68)	26.92	0.01	(0.07)	0.73	-		
redear sunfish	0.01	(0.04)	0.46	-			0.01	(0.08)	1.21	0.02	(0.13)	1.43
spotted sunfish	0.18	(0.43)	14.42	0.04	(0.14)	3.85	0.01	(0.07)	0.73	-		
largemouth bass	0.01	(0.07)	0.69	0.01	(0.07)	0.77	-			-		
black crappie	0.03	(0.10)	2.06	-			0.03	(0.12)	2.18	0.02	(0.09)	1.43
unknown	0.01	(0.06)	0.91	-			-			0.01	(0.07)	0.71
Total	1.26	(1.47)	100.00	1.12	(2.01)	100.02	1.18	(1.46)	100.01	1.21	(1.76)	99.99

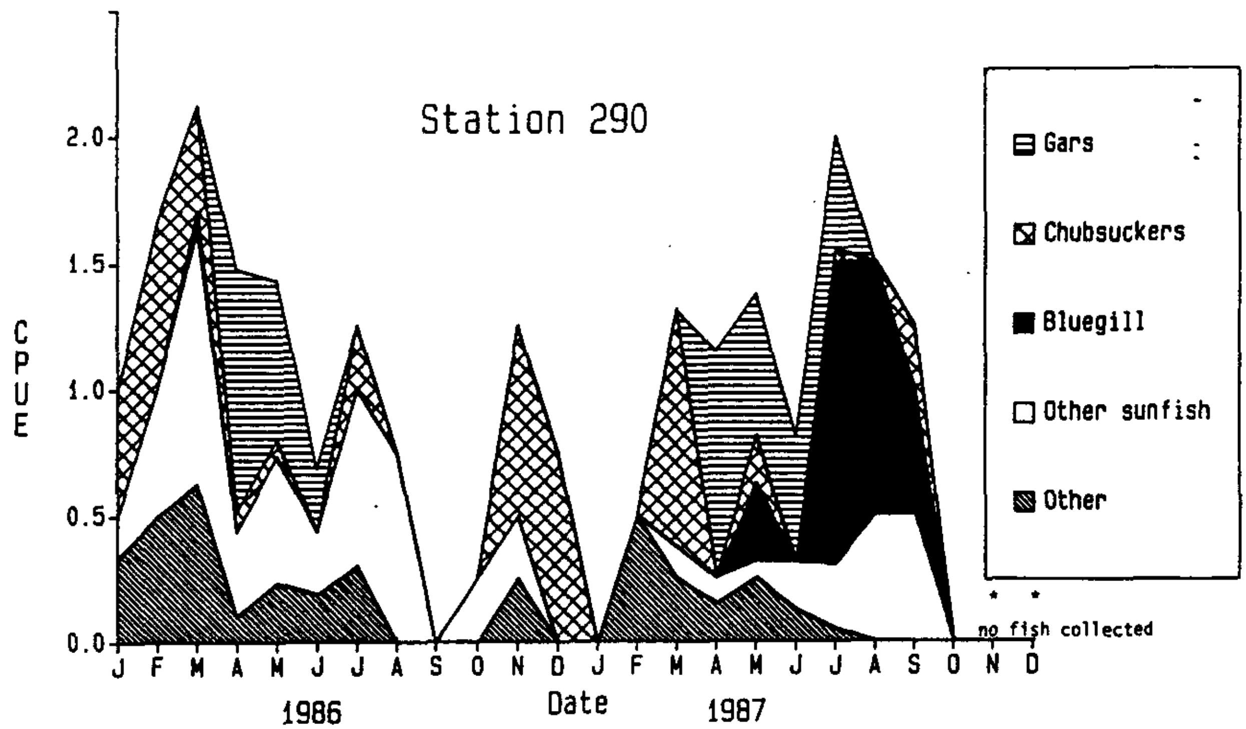


Figure 3-6. Temporal changes in mean monthly fykenetting catch per unit effort (CPUE; no./net/day) near Station 290 in the Steel Creek corridor. January 1986 - December 1987.

was higher catch rates of American shad at Station 370 during 1987 than during 1986. However, temporal trends in species number should be evaluated cautiously since fyke net collections were made more frequently during February - July (weekly) than during other months (monthly).

American shad were collected primarily from March - June in 1987 and from February - May in 1986 (Figure 3-7). These periods of occurrence correspond quite well with the occurrence of American shad eggs in Steel Creek (Section 3.3.1), although shad egg densities were fairly similar between years despite the higher catch of adult shad during 1987. Most other taxa, such as the creek chubsucker and channel catfish, were collected throughout the year. While the mean number of species collected fluctuated widely (Figure 3-8), more species were generally collected during 1987 than during 1986.

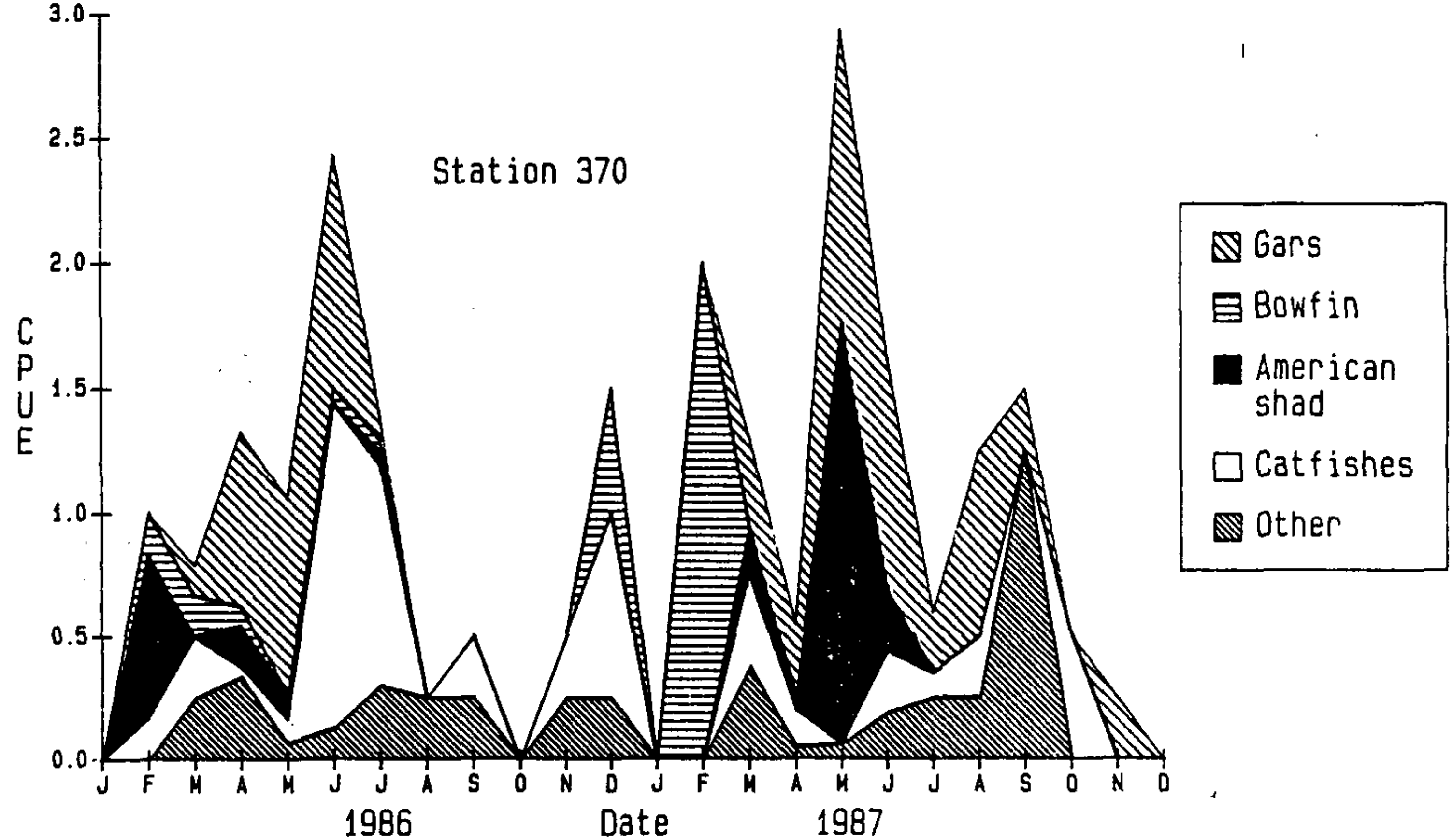


Figure 3-7. Temporal changes in mean monthly fykenetting catch per unit effort (CPUE; no./net/day) at Station 370 in the mouth of Steel Creek. January 1986 - December 1987.

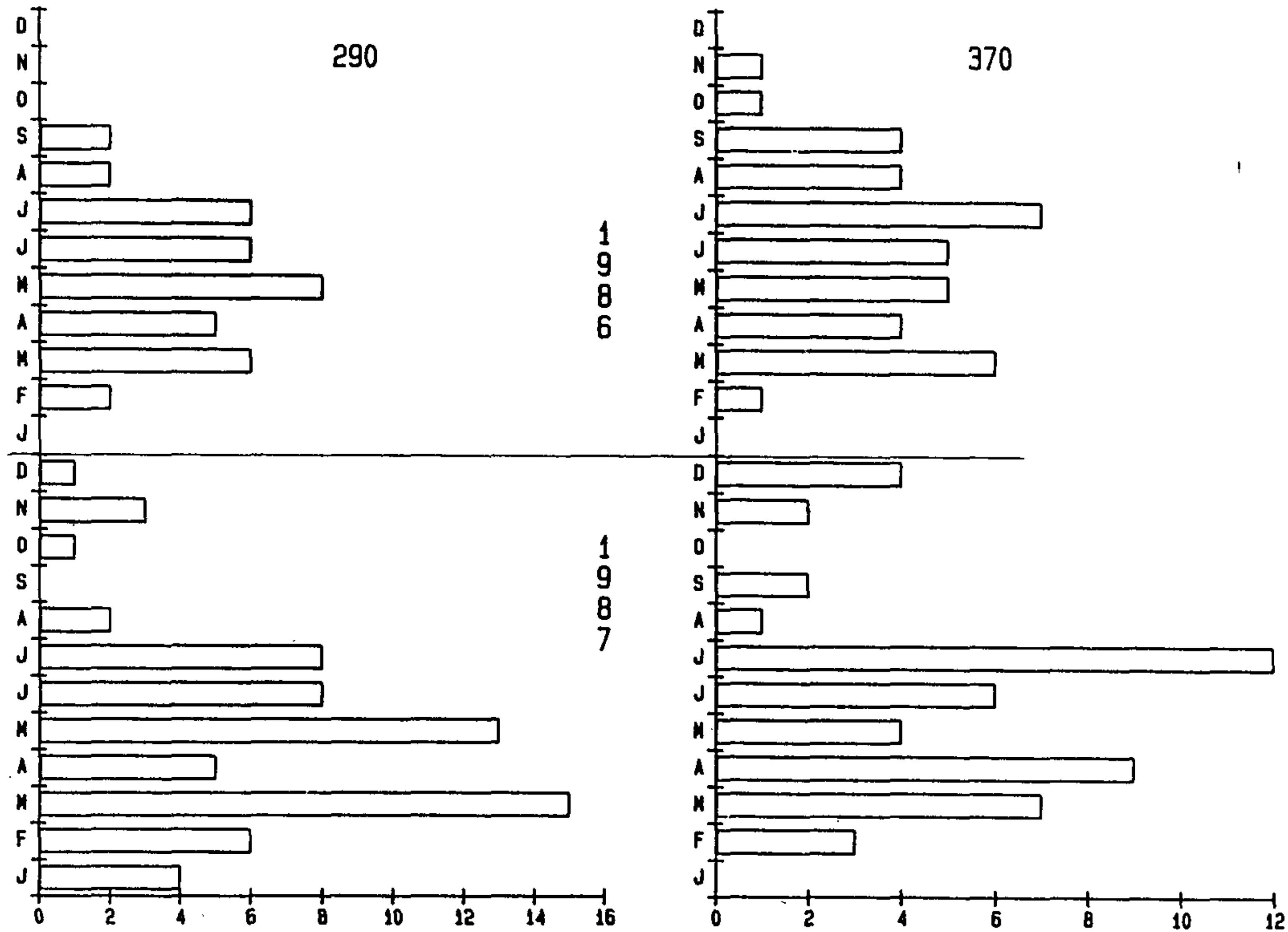


Figure 3-8. Temporal changes in number of species collected by fykenetting near Station 290 in the Steel Creek corridor and at Station 370 in the mouth of Steel Creek. January 1986 - December 1987.

3.3 ICHTHYOPLANKTON

3.3.1 Routine Sampling

The number and kinds of larval fish collected from Steel Creek differed among sample stations. To summarize these differences, PCA was performed on the mean densities of the dominant taxa at each sample station during the February - July spawning periods in 1986 and 1987. The first and second principal components accounted for 46.6% and 23.1%, respectively, of the variance in the 1986 ichthyoplankton density data (Appendix Table 5). A plot of principal component 1 versus principal component 2 indicated several distinct groupings corresponding to habitats in Steel Creek (Figure 3-9).

During 1986, Stations 300 and 310 were separated from the other sample stations on principal component 1 because of high densities of bluespotted sunfish and banded pygmy sunfish larvae (Table 3-11). Both stations are located in the open-canopy delta in relatively shallow water (especially Station 300) supporting heavy macrophyte growth. Another group included Stations 290, 320, 330, 340, 350, and 640; all except Station 290 are located in somewhat deeper water within the delta/swamp. These stations were generally characterized by lower densities than at Stations 300 and 310, and domination by various combinations of taxa,

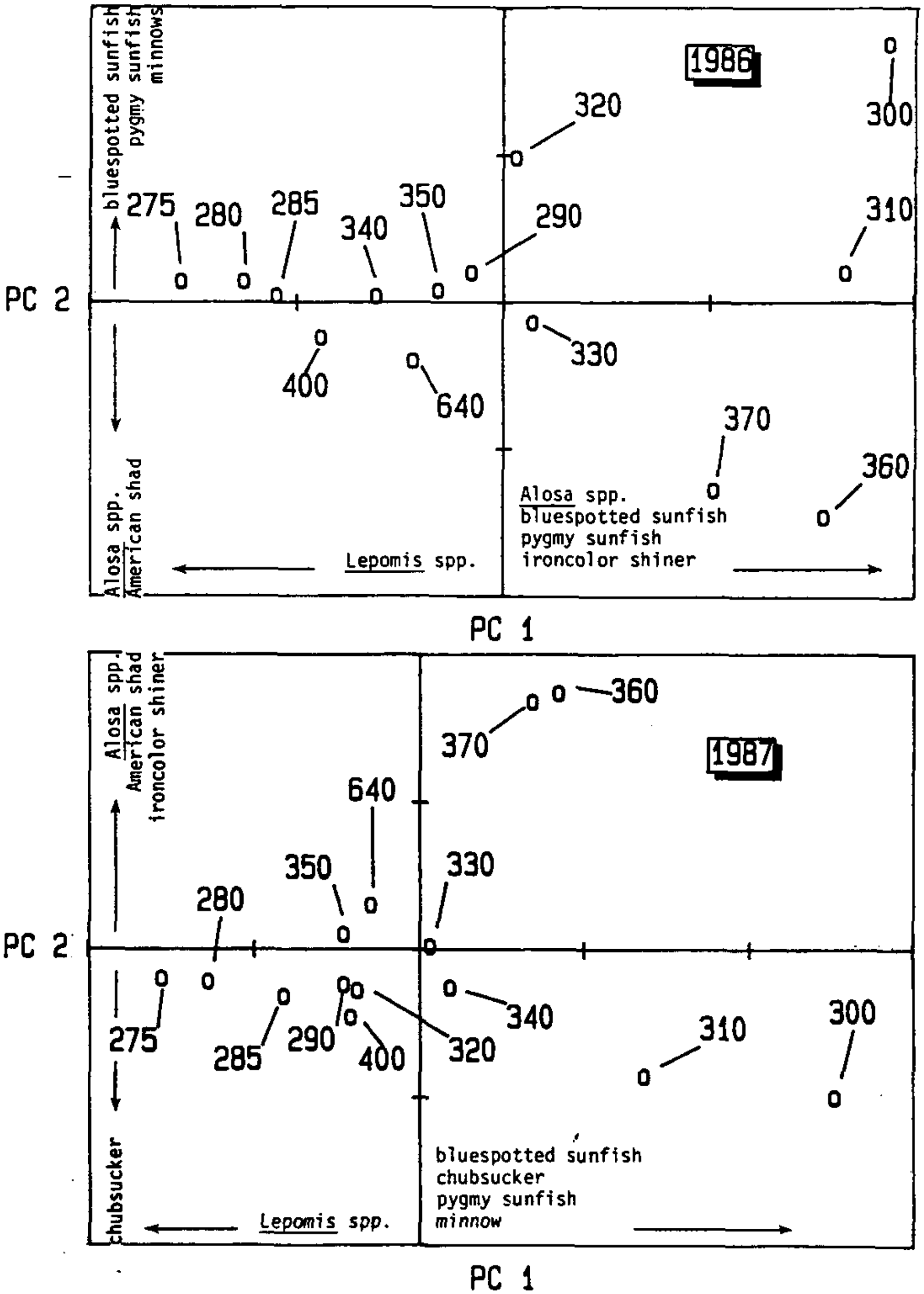


Figure 3-9. Principle component analysis of mean ichthyoplankton density (no./1000 m^3 for February - July only) at stations in Steel Creek. Taxa primarily responsible for separation along each axis are indicated with arrows showing direction of increasing abundance. February - July 1986 and 1987.

Table 3-11. Mean ichthyoplankton density (no./1000 m^3 [standard deviation]) at sample stations at Steel Creek. February - July 1986.

	Corridor				Swamp			
Taxa	275	280	285	290	300	310	320	330
unid. herring/shad								
blueback herring					1.9 (7.8)	9.5 (34.6)		2.0 (10.9)
American shad								
pickerel				0.3 (2.3)	3.0 (17.9)	0.4 (2.6)		0.3 (2.0)
other minnow	2.0 (11.1)	2.7 (11.4)	3.4 (11.3)	4.2 (13.2)	5.9 (12.7)	2.5 (10.1)	6.2 (17.0)	0.3 (2.3)
ironcolor shiner			0.3 (2.0)	0.3 (2.5)	11.6 (29.7)	5.6 (28.8)	0.4 (2.6)	2.7 (7.0)
chubsucker			0.3 (2.4)	1.3 (5.2)	5.8 (25.3)	0.7 (3.8)		0.2 (1.8)
spotted sucker			0.3 (2.4)					
redhorse					1.6 (9.2)			
pirate perch								
mosquitofish	1.6 (4.6)	0.9 (3.8)	0.2 (1.8)		3.3 (12.5)	0.4 (2.6)		
brook silverside		1.0 (5.6)			0.5 (3.7)	1.6 (5.8)		2.9 (10.5)
pygmy sunfish				0.5 (2.5)	20.5 (33.8)	19.1 (59.2)	4.6 (23.7)	1.0 (4.2)
bluespotted sunfish		0.7 (3.5)	0.3 (2.1)	4.7 (12.3)	84.2 (123.7)	12.8 (27.6)	16.7 (28.6)	4.7 (14.0)
sunfish (<u>Lepomis</u> spp.)	77.2 (148.5)	27.6 (53.1)	8.6 (21.9)	3.8 (10.5)	5.4 (14.8)	3.0 (8.2)	9.4 (40.8)	4.0 (12.0)
redbreast sunfish[a]								
warmouth[a]								
spotted sunfish[a]								
largemouth bass				0.4 (2.6)				
darter (<u>Etheostoma</u> spp.)			0.8 (4.0)	1.9 (7.5)	1.1 (4.3)	10.6 (41.7)	2.2 (6.8)	0.4 (2.9)
unknown	0.2 (1.5)	3.3 (8.0)	0.7 (3.7)	1.4 (4.3)	3.9 (16.8)	1.4 (6.0)	0.7 (3.5)	0.4 (3.2)
Total[b]	81.0 (148.2)	36.1 (62.0)	15.0 (24.0)	18.8 (25.9)	148.7 (179.1)	67.7 (86.6)	40.2 (59.9)	19.1 (26.2)

[a]These taxa grouped under sunfish in 1986.
[b]Any deviations between arithmetic sum of the columns and the indicated totals are due to rounding error.

Table 3-11 (continued). Mean ichthyoplankton density (no./1000 m^3 [standard deviation]) at sample stations at Steel Creek. February - July 1986.

	Swamp (continued)			Channel		Meyer's Branch
Taxa	340	350	640	360	370	400
unid. herring/shad				0.5 (3.4)	0.9 (8.9)	
blueback herring		0.4 (2.7)	1.1 (5.6)	83.1 (213.2)	32.1 (111.9)	
American shad				2.3 (10.8)	5.2 (10.5)	
pickerel						
ironcolor shiner	0.5 (3.9)	2.3 (8.4)	0.6 (3.0)	3.3 (8.2)	3.3 (10.3)	
other minnow	1.6 (6.6)	1.2 (6.3)	0.2 (1.6)	0.1 (1.1)	1.4 (5.3)	6.0 (19.4)
chubsucker				0.9 (5.3)	0.4 (2.7)	
spotted sucker					0.2 (2.1)	
redhorse					0.3 (2.3)	
pirate perch					0.2 (1.7)	
mosquitofish		0.8 (5.4)				
brook silverside	5.7 (15.5)	2.5 (7.4)	2.7 (7.4)	2.8 (9.1)	1.0 (5.2)	
pygmy sunfish	2.6 (13.4)	0.3 (1.9)		1.4 (5.7)	0.8 (5.2)	
bluespotted sunfish	0.7 (4.8)	3.6 (16.8)	2.4 (10.4)	7.2 (21.1)	3.4 (8.9)	
sunfish (<u>Lepomis</u> spp.)	16.3 (45.4)	5.5 (14.6)	4.4 (10.0)	4.2 (10.0)	6.1 (24.0)	0.2 (1.6)
redbreast sunfish[a]						
warmouth[a]						
spotted sunfish[a]						
largemouth bass				0.4 (3.6)		
darter (<u>Etheostoma</u> spp.)	3.3 (9.7)	0.8 (3.9)	1.1 (5.0)	3.5 (10.5)	5.4 (13.8)	6.2 (16.9)
unknown		0.7 (3.5)	1.5 (5.6)	4.0 (13.7)	3.0 (7.4)	0.4 (2.8)
Total	30.7 (51.7)	17.9 (32.3)	14.0 (20.8)	113.8 (220.1)	63.8 (127.7)	12.9 (25.1)

[a]These taxa grouped under sunfishes in 1986.
[b]Any deviations between arithmetic sum of the columns and the indicated totals are due to rounding error.

particularly sunfishes (Lepomis spp.), bluespotted sunfish, and banded pygmy sunfish. Stations 370 and 360 in the creek mouth and creek channel, respectively, constituted another distinct group characterized by high densities of blueback herring eggs (Table 3-11), indicating the importance of the lower portion of the creek to spawning anadromous fishes. The final group consisted of the remaining corridor stations (275, 280, and 285), all strongly dominated by sunfish larvae, with relatively poor representation by other taxa. Sunfish larvae densities were highest at Station 275 (77.2 larvae/1000 m^3) and declined downstream (27.6 larvae/1000 m^3 at Station 280 and 8.6 larvae/1000 m^3 at Station 285; Table 3-11) reflecting the discharge of sunfish larvae into Steel Creek from L-Lake. Such releases are also suggested by total species composition at Station 275, which was similar to that in L-Lake (Paller et al. 1988).

The first and second principal components accounted for 41.7% and 23.0%, respectively, of the variance in the 1987 ichthyoplankton data (Appendix Table 6). The patterns exhibited during 1987 were generally similar to those during 1986 (Figure 3-9). The shallow, open-canopy delta stations (300 and 310) separated from the other stations due to high densities of chubsucker, bluespotted sunfish, and banded pygmy sunfish larvae (Table 3-12). Station 275, located just below the L-Lake dam, separated from the other stations due to high densities of larval Lepomis (principally

Table 3-12. Mean ichthyoplankton density (no./1000 m^3 [standard deviation]) at sample stations at Steel Creek. February - July 1987.

Taxa	Corridor				Swamp			
	275	280	285	290	300	310	320	330
longnose gar						0.4 (2.6)		
unid. herring/shad								
blueback herring					0.9 (6.2)			
American shad								
shad (Dorosoma spp.)	1.3 (4.5)							
pickerel						0.5 (3.9)		
ironcolor shiner			0.4 (2.9)	2.2 (6.6)	1.2 (6.6)	1.5 (5.1)		2.8 (10.7)
other minnow	0.2 (1.5)	0.3 (1.9)	0.3 (2.3)		19.9 (102.6)	6.3 (27.0)		0.6 (4.6)
chubsucker			1.0 (4.2)	3.2 (10.3)	47.4 (182.3)	34.8 (114.8)	1.6 (8.7)	1.0 (5.3)
spotted sucker								
pirate perch					1.1 (7.3)	0.4 (3.1)		
brook silverside				0.7 (3.7)		0.4 (2.7)		3.4 (10.7)
pygmy sunfish					19.1 (59.9)	1.5 (6.1)		0.6 (4.3)
bluespotted sunfish				0.6 (4.6)	35.2 (115.2)	5.6 (18.0)	2.1 (6.5)	4.0 (9.6)
sunfish (Lepomis spp.)	28.6 (48.2)	4.7 (10.3)		0.9 (4.6)				
redbreast sunfish		0.5 (2.6)						
warmouth			0.4 (3.0)	0.7 (3.4)				
spotted sunfish			0.4 (2.9)				1.0 (5.1)	
other sunfishes	0.4 (2.1)	0.3 (2.3)		0.4 (2.6)	5.5 (28.1)	1.7 (8.3)	0.4 (2.8)	
crappie	4.3 (14.6)	0.6 (4.5)			0.4 (2.9)			
darter (Etheostoma spp.)		0.5 (3.5)	1.8 (5.7)	1.4 (5.0)	0.7 (3.6)	3.2 (11.4)	1.9 (7.3)	0.9 (4.6)
blackside darter		2.3 (6.1)	13.2 (21.4)	3.5 (8.7)	1.1 (7.3)		0.8 (5.7)	
unknown	1.1 (4.6)	4.9 (8.6)	5.0 (10.4)	6.0 (14.8)	5.3 (16.1)	9.2 (26.4)	8.5 (39.6)	6.7 (38.3)
Total[a]	35.9 (51.0)	14.1 (17.4)	22.5 (25.6)	19.6 (30.0)	137.6 (380.2)	65.3 (152.6)	16.4 (43.4)	20.1 (49.5)

[a] Any deviations between arithmetic sum of the columns and the indicated totals are due to rounding error.

Table 3-12 (continued). Mean ichthyoplankton density (no./1000 m^3 [standard deviation]) at sample stations at Steel Creek. February - July 1987.

	Swamp (continued)			Lower Channel		Meyer's Branch
Taxa	340	350	640	360	370	400
longnose gar						
unid. herring/shad					0.9 (5.2)	
blueback herring			0.4 (2.8)	39.6 (131.3)	19.8 (60.7)	
American shad				0.9 (4.0)	6.4 (13.2)	
shad (<u>Dorosoma</u> spp.)					0.5 (3.1)	
pickerel						
ironcolor shiner		0.6 (4.1)	1.3 (7.0)	3.2 (9.8)	4.3 (11.5)	
other minnow		0.4 (2.6)	0.4 (2.8)	0.8 (4.1)	2.0 (7.5)	6.1 (20.5)
chubsucker	4.1 (20.9)		0.3 (2.5)	1.6 (6.4)	0.6 (3.3)	1.0 (3.9)
spotted sucker				0.2 (2.1)		0.5 (3.5)
redhorse						
pirate perch						
brook silverside			0.3 (1.9)	1.9 (6.6)	0.4 (2.8)	
pygmy sunfish	1.7 (9.3)	1.4 (4.9)	1.7 (5.2)	1.8 (8.2)	2.7 (9.5)	
bluespotted sunfish	2.9 (10.4)	1.5 (6.5)	0.7 (3.3)	4.0 (12.5)	2.8 (9.1)	
sunfish (<u>Lepomis</u> spp.)		0.5 (3.9)		0.2 (1.9)	0.5 (3.2)	
redbreast sunfish						
warmouth		3.0 (11.4)	1.5 (5.4)	0.2 (2.0)	0.2 (2.1)	
spotted sunfish						
other sunfishes	1.1 (5.5)		0.3 (2.3)	0.8 (3.9)		
crappie						
darter (<u>Etheostoma</u> spp.)	6.1 (14.4)	2.8 (7.6)	6.6 (17.6)	7.2 (15.5)	4.1 (15.0)	2.1 (6.8)
blackside darter			0.6 (2.9)	0.2 (1.4)	0.5 (2.6)	4.1 (10.2)
unknown		2.4 (11.4)	9.1 (35.4)	1.0 (4.1)	1.6 (5.8)	0.7 (3.4)
Total	15.8 (33.2)	12.6 (20.8)	23.1 (53.1)	63.6 (145.5)	47.4 (94.0)	14.4 (25.7)

[a] Any deviations between arithmetic sum of the columns and the indicated totals are due to rounding error.

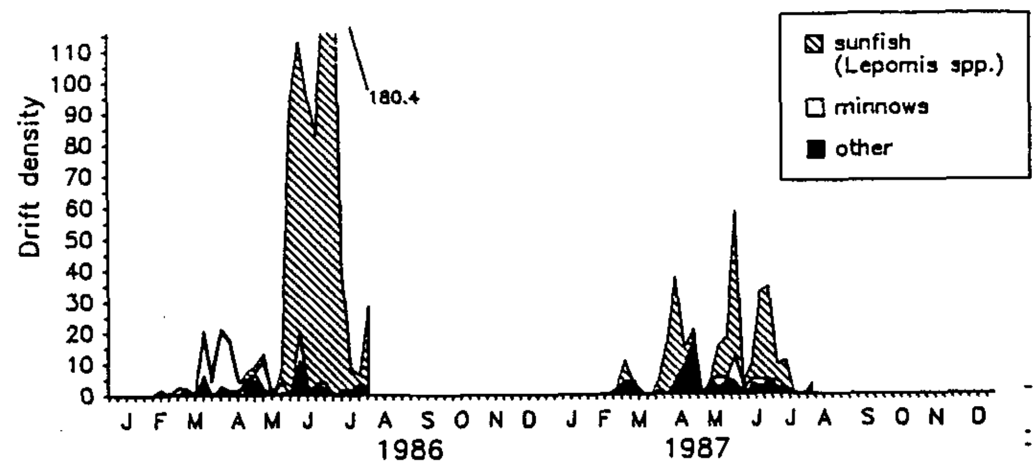
bluegill). The other corridor sample stations (280, 285, and 290) grouped more closely to the swamp sample stations, reflecting a progressive reduction in bluegill densities in the Steel Creek corridor with distance from L-Lake (Table 3-12). As in 1986, the creek mouth and channel stations were distinguished by high densities of blueback herring eggs (categorized as "Alosa spp." in Figure 3-9).

The only difference of importance between 1986 and 1987 was a reduction in sunfish densities in the corridor in 1987 (from 77.2 to 28.6/1000 m^3 at Station 275; Tables 3-11 and 3-12). Since most of the sunfish larvae in the corridor during 1986 probably originated in L-Lake, lower sunfish densities in the corridor may indicate less transport of these organisms from L-Lake during 1987, possibly as a result of withdrawing more water from L-Lake's hypolimnion (Starkel et al. 1988) where sunfish larvae were scarce or absent (Paller et al. 1988). It is unlikely that bluegill larvae were produced in the corridor in large numbers because of the lack of suitable spawning habitat.

Spawning chronology in Steel Creek was investigated by grouping the sample stations into habitats (Stations 300 and 310 are shallow delta; 320, 330, 340, 350, and 640 are delta/swamp; 275, 280, 285, and 290 are corridor; and 360 and 370 are channel) and examining temporal changes in density in each habitat. Drifting larval fish were not observed in the corridor until February and March 1986 when relatively low densities of minnows, darters, and sunfishes were collected (Figure 3-10). In May, June, and July 1986 sunfish (probably bluegill) larvae were collected in high densities, reflecting their discharge from L-Lake where they were concurrently present in high densities (Paller et al. 1988). In 1987 sunfish larvae occurred from late February through July but never attained the high densities reached during 1986. Darter larvae occurred from February through early July.

The larvae of a number of taxa were collected from the Steel Creek delta/swamp (Tables 3-11 and 3-12). Among the earliest spawners were pygmy sunfish whose larvae were collected from February through April in 1986 and from March through early May in 1987 (Figure 3-11). Sunfishes in the genus Lepomis and bluespotted sunfish spawned later in the year (from March through July in 1986 and from April through July in 1987). All sunfishes were collected in lower densities during 1987 than during 1986. Brook silverside were collected from April through July in 1986 and April - June in 1987, and chubsuckers were collected primarily during April and May in 1987 only. Minnow larvae occurred sporadically from mid- to late March through July during both 1986 and 1987. Darter larvae were collected from early March through mid-May in 1986 and from mid-February through mid-June in 1987 (except for one date in early August).

Steel Creek corridor



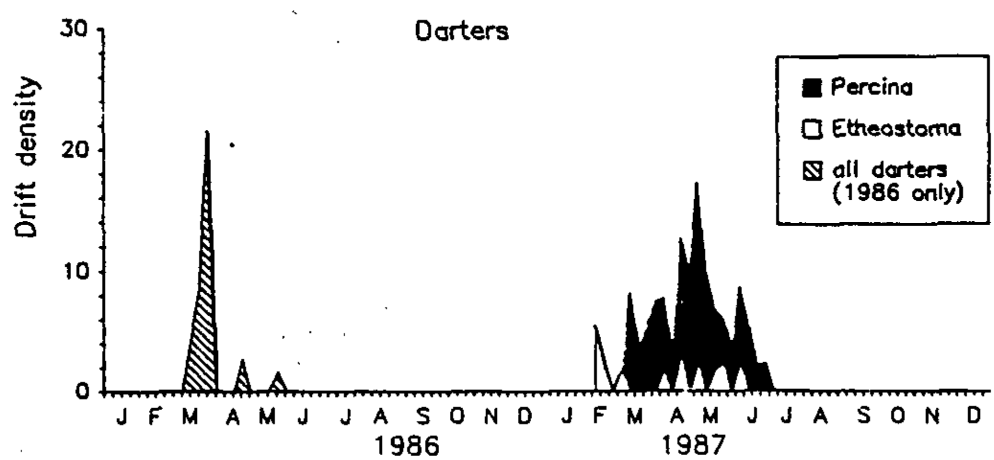
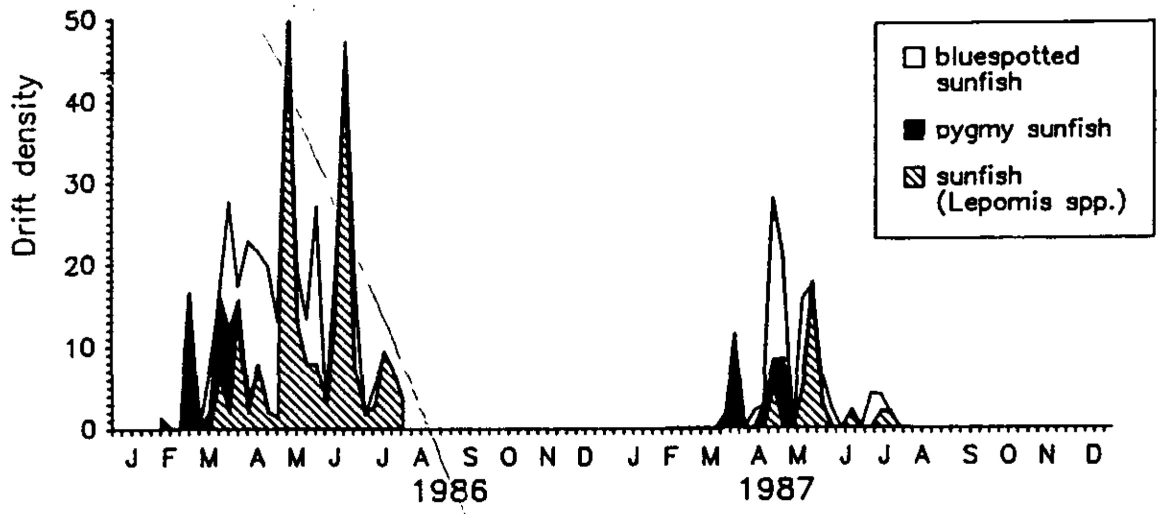


Figure 3-10. Temporal changes in the density (no./1000 m^3) of larval fish in the Steel Creek corridor (Stations 275, 280, 285, and 290). January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.

Sunfishes



Brook silverside & chubsuckers

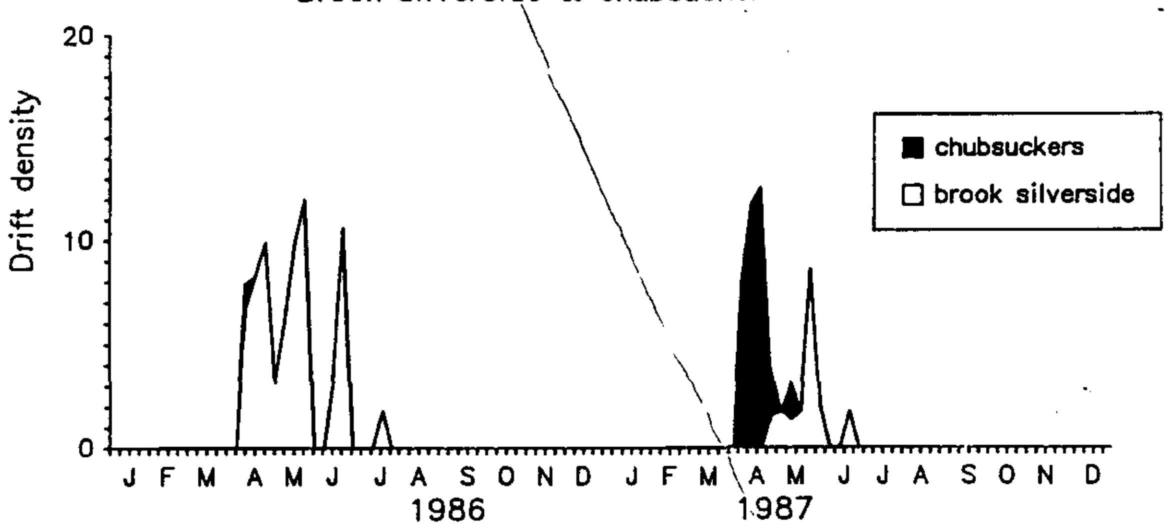
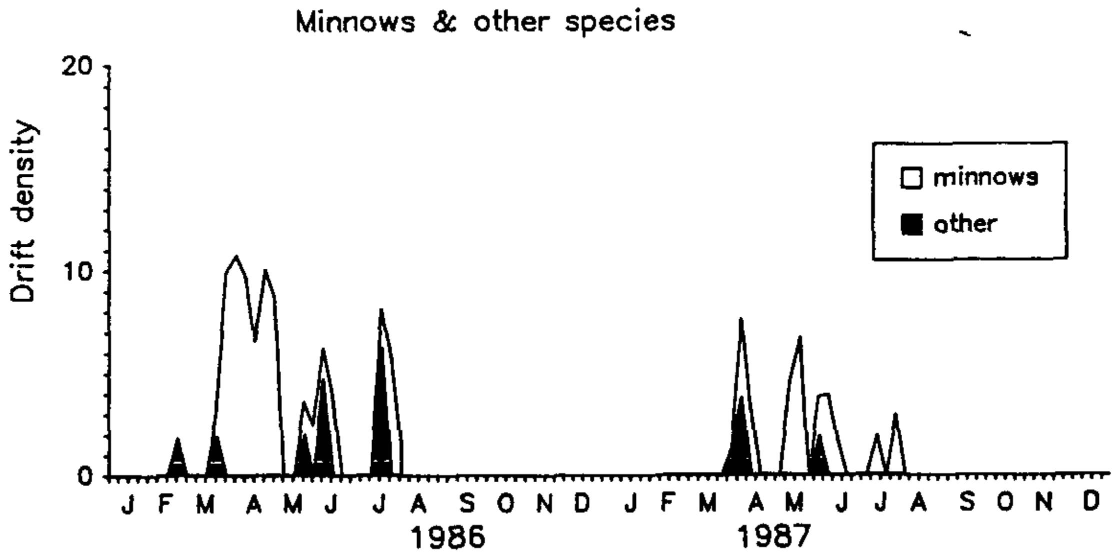


Figure 3-11. Temporal changes in the density (no./1000 m^3) of drifting larval fish at relatively deep stations (320, 330, 340, 350, 640) in the Steel Creek swamp/delta. January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.



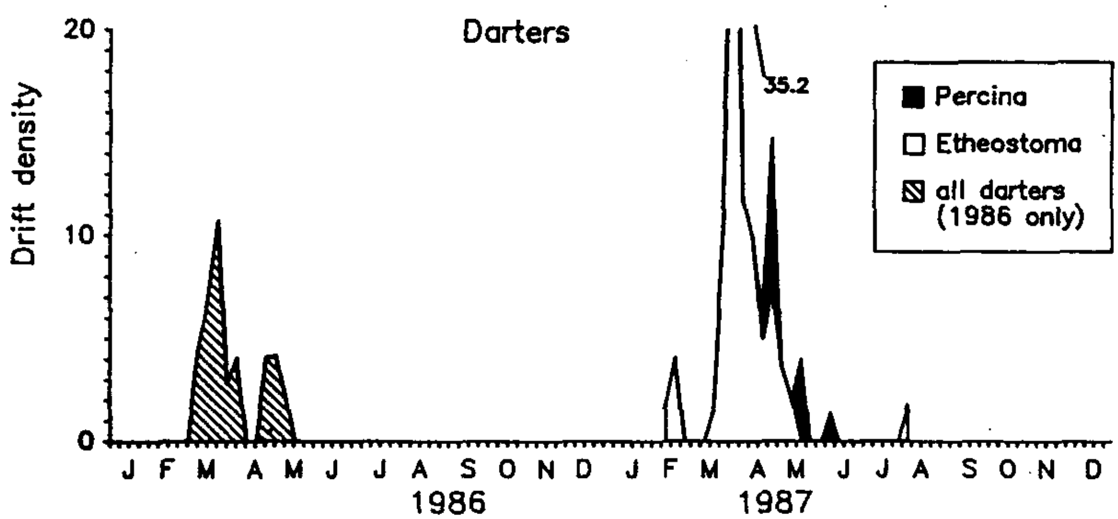
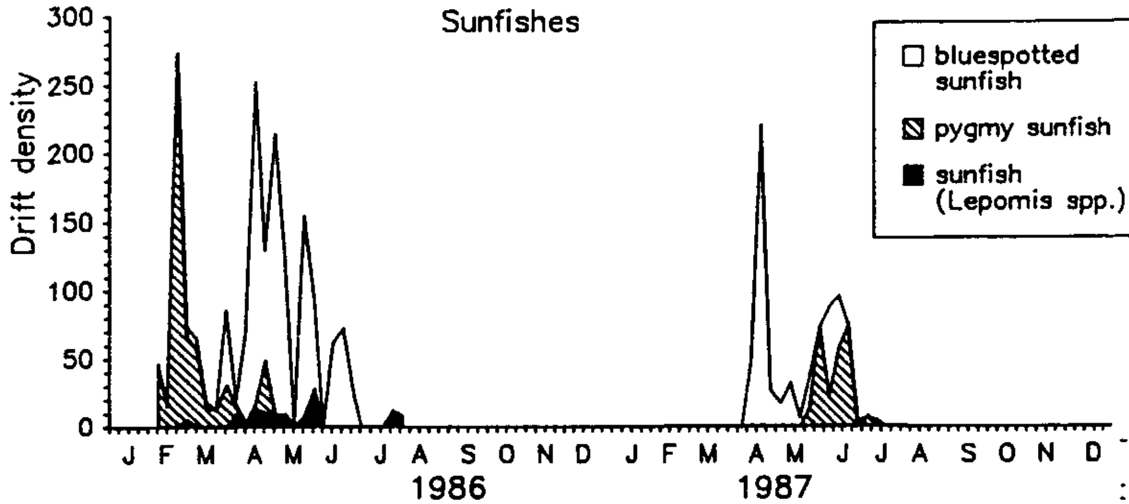


Figure 3-11 (continued). Temporal changes in the density (no./1000 m^3) of drifting larval fish at relatively deep stations (320, 330, 340, 350, 640) in the Steel Creek swamp/delta. January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.

Blackbanded darter (Percina) was the dominant darter in the corridor (Figure 3-10) while Etheostoma spp. was the dominant darter taxon in other habitats (Figures 3-11, 3-12, and 3-13), possibly reflecting the relatively high current velocities in the corridor. Percina spp. are typically more prevalent than Etheostoma spp. in larger streams and rivers (Page 1983; Paine 1984).

Most of the species collected from the deeper sample stations in the delta/swamp were also collected from the relatively shallow delta stations (300 and 310), although in different densities (Tables 3-11 and 3-12). Pygmy sunfish were collected in high densities in the shallow delta stations, first appearing in February during 1986 and in May during 1987 (Figure 3-12). Bluespotted sunfish were also abundant, being collected from late March though June in 1986 and from April through June in 1987. Chubsuckers exhibited relatively brief peaks in April during both years, with the 1987 density peak reaching as high as 647.6 larvae/1000 m^3. Brook silverside larvae were collected from April through mid-June in 1986 and during a brief two week period in early June 1987. Darter larvae (along with pygmy sunfish larvae) appeared early, being collected from February through early April during both years.



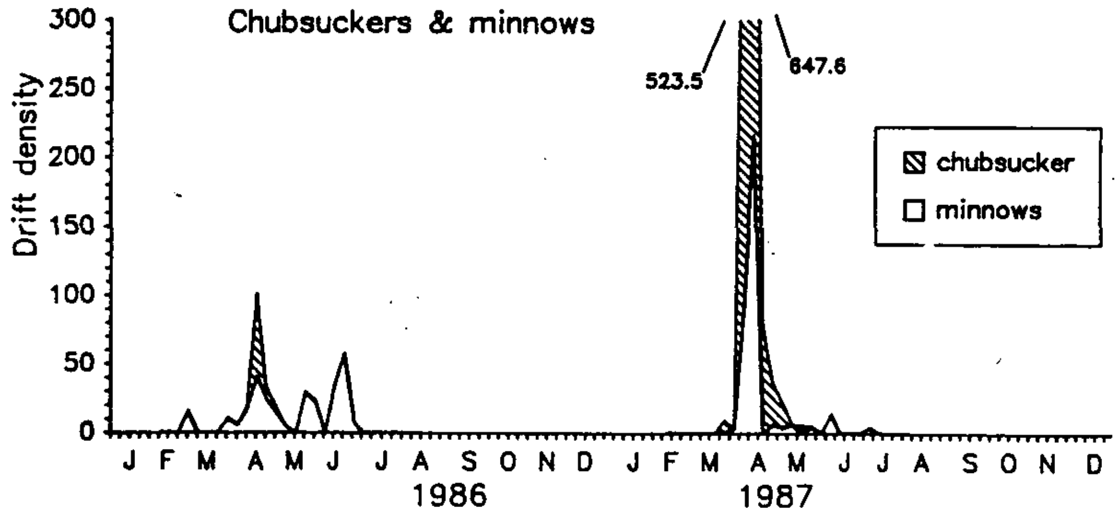
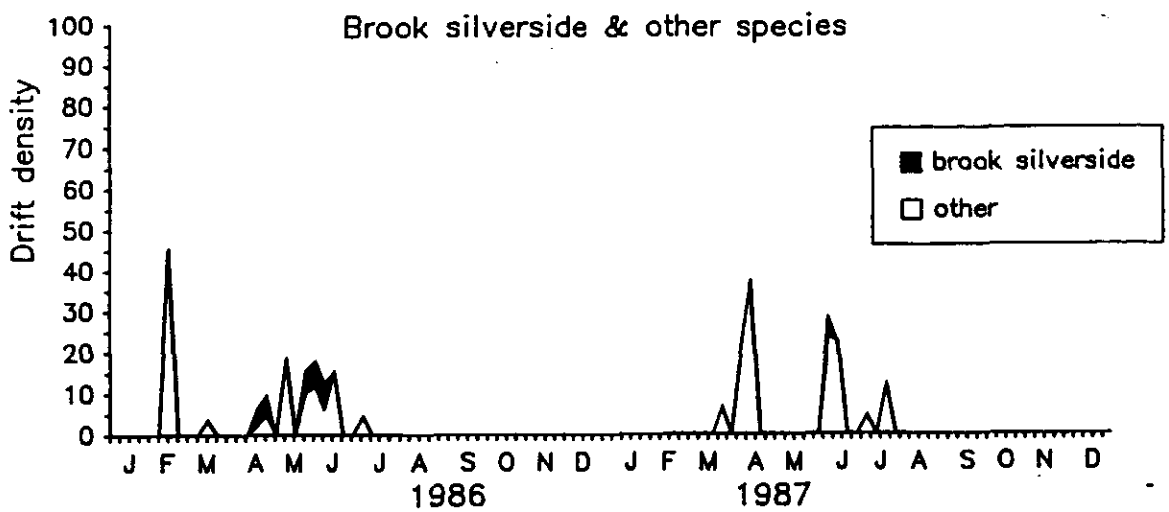


Figure 3-12. Temporal changes in the density (no./1000 m^3) of drifting larval fish at relatively shallow stations (300 and 310) in the Steel Creek delta. January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.



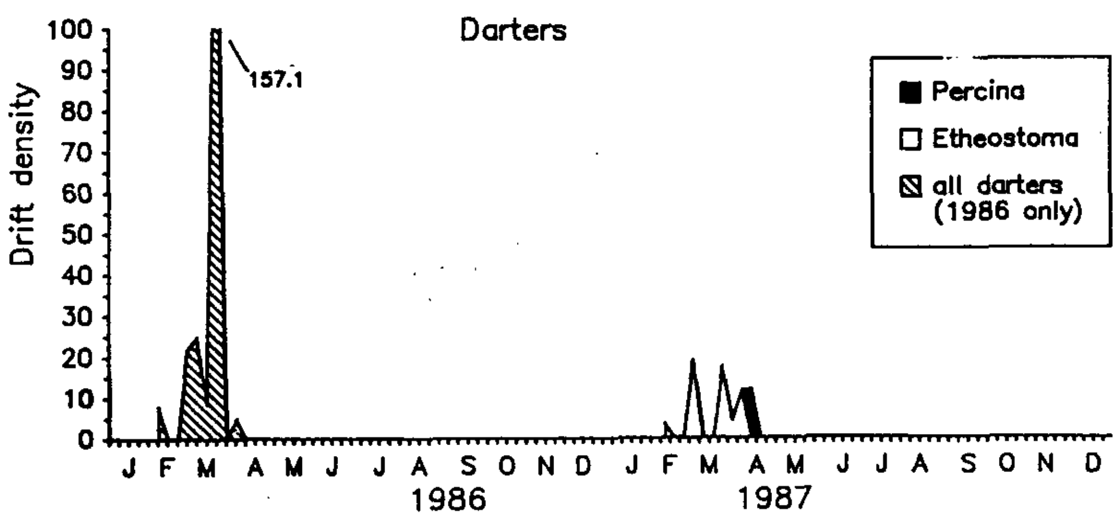


Figure 3-12 (continued). Temporal changes in the density (no./1000 m^3) of drifting larval fish at relatively shallow stations (300 and 310) in the Steel Creek delta. January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.

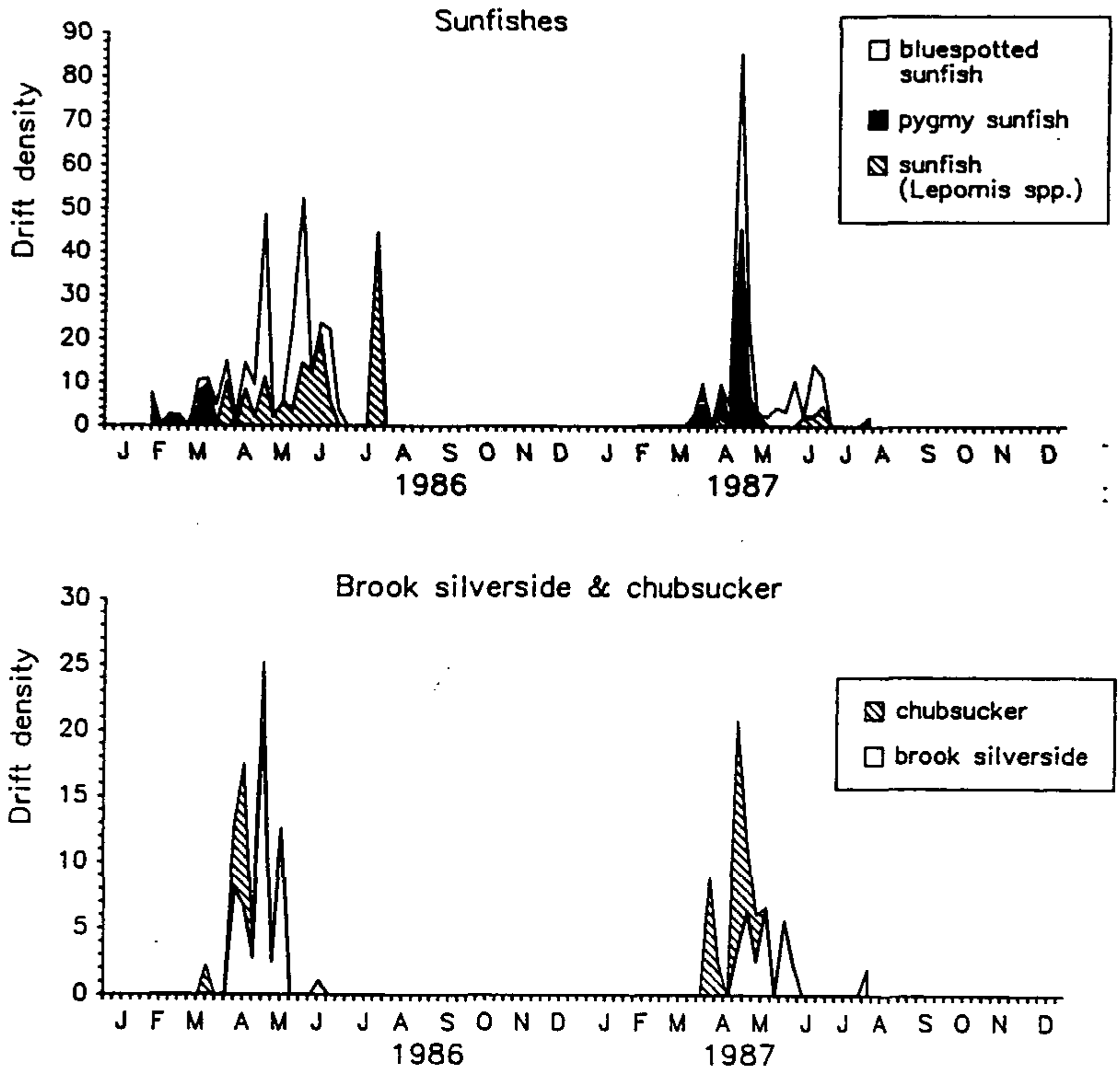
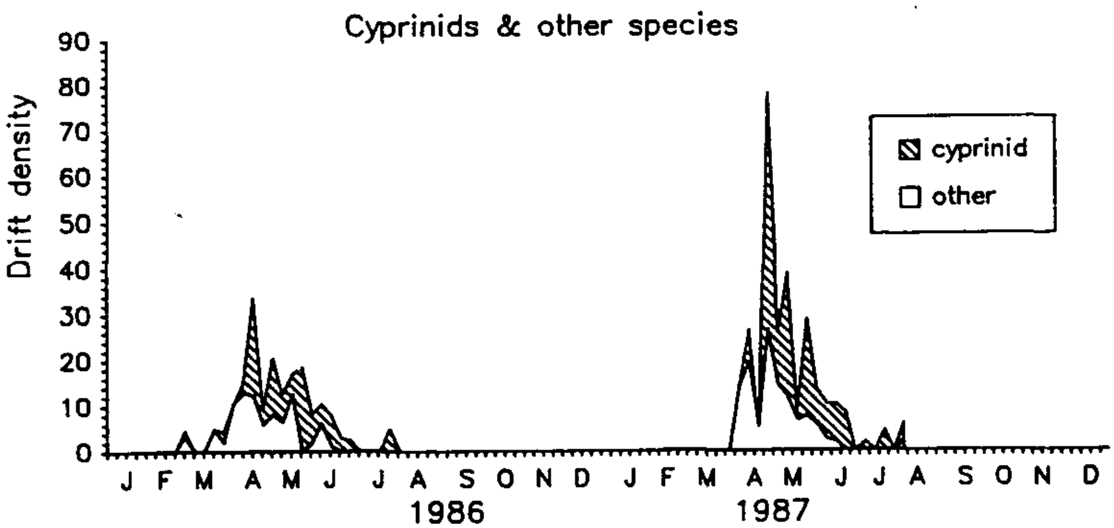


Figure 3-13. Temporal changes in the density (no./1000 m^3) of drifting larval fish and fish eggs in the Steel Creek channel (Stations 360 and 370). January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.



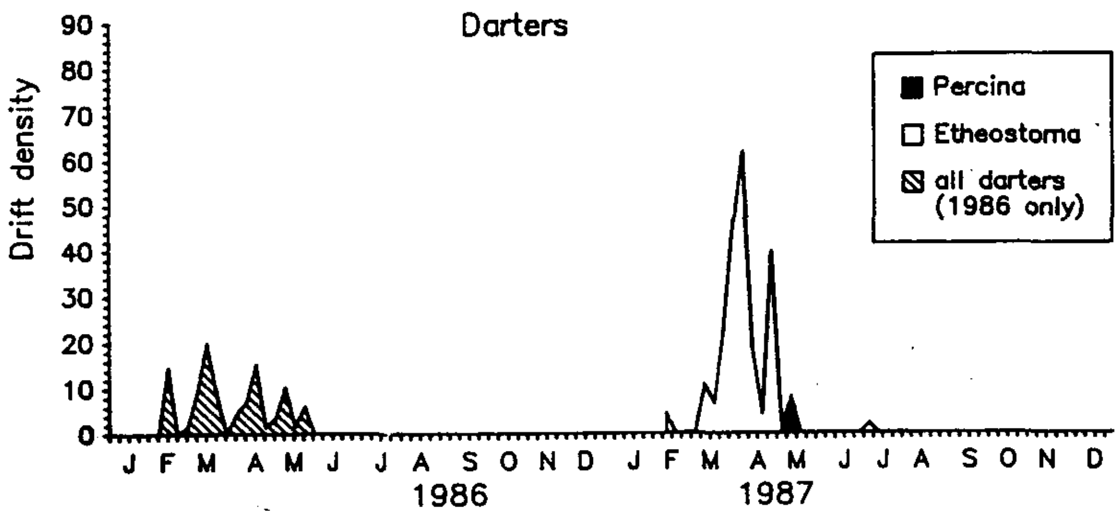


Figure 3-13 (continued). Temporal changes in the density (no./1000 m^3) of drifting larval fish and fish eggs in the Steel Creek channel (Stations 360 and 370). January 1986 - December 1987. Note that each of these plots is necessarily additive so that the actual temporal trend of a single taxon can be derived as the difference of the curves represented.

While blueback herring eggs and larvae attained high densities in the lower channel (Stations 360 and 370), they were present for relatively brief periods: March and early April 1986 and March, April, and early May 1987 (Figure 3-14). American shad eggs and larvae occurred in lower densities but over a longer period: mid-February through early June 1986 and mid-March through early June 1987. Apart from the abundance of blueback herring larvae, taxonomic composition and temporal patterns of occurrence in the channel (Figure 3-13) were fairly similar to those at the deeper sample stations in the Steel Creek swamp, probably reflecting the drift of larvae out of the swamp into the lowermost reaches of Steel Creek.

To evaluate impacts on fish spawning in Steel Creek, comparisons were made between ichthyoplankton densities preceding (1984 and 1985) and following (1986 and 1987) the impoundment of L-Lake and re-start of L-Reactor. Ichthyoplankton data from 1984 and 1985 were collected by Paller (1985) and Paller et al. (1986a), respectively, using methods similar to those employed during 1986 and 1987. Steel Creek was divided into four habitats for this comparison: corridor (Stations 280 and 290), Meyer's Branch (Station 400), delta/swamp (Stations 310, 320, 330, 340, 350, and 640) and channel (Stations 360 and 370). Stations 275, 285, and 300 were not included in the comparisons since

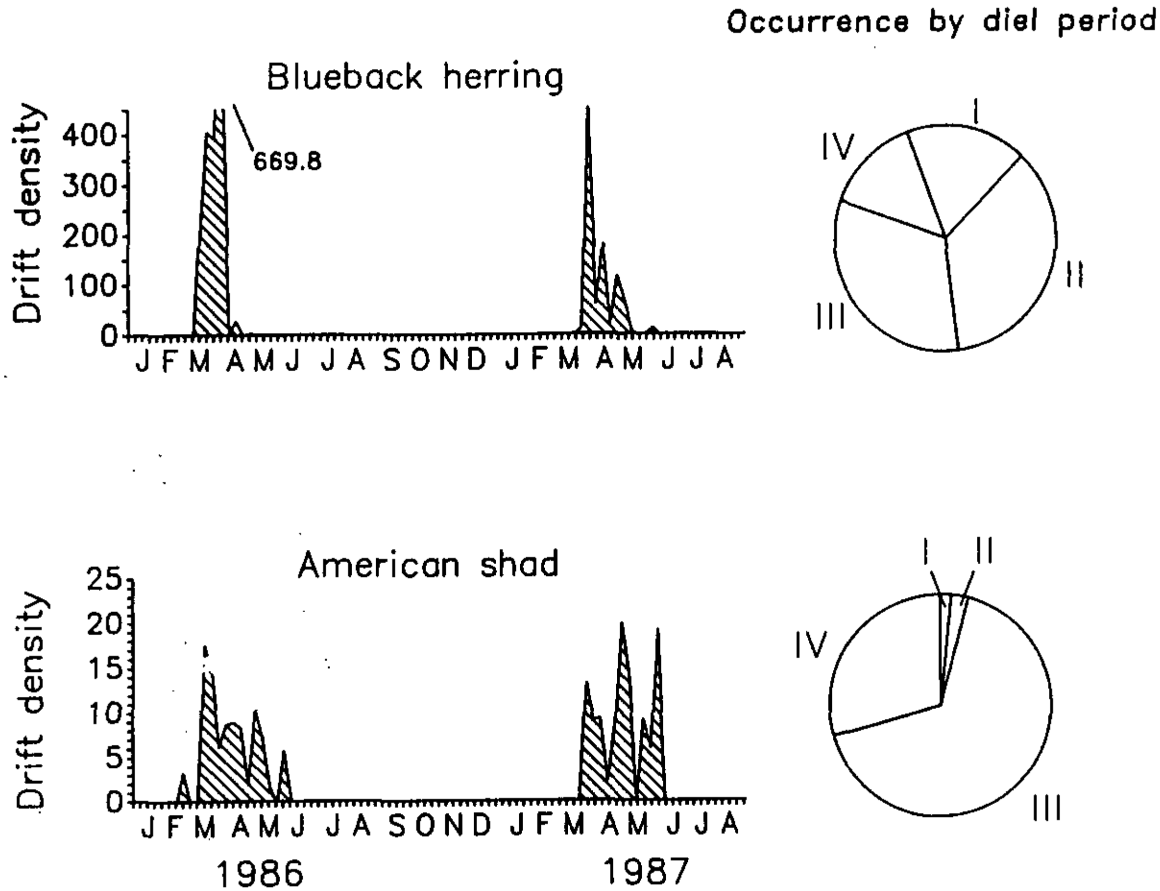


Figure 3-14. Weekly drift density (no. of eggs and larvae/1000 m^3) and diel periodicity of eggs and larvae of blueback herring and American shad in the lower channel of Steel Creek. Note the difference in scale between the ordinates of the two plots. Diel density data were collected monthly during February through July of each year. Data from 1986 and 1987 were combined to form a composite diel periodicity chart for each species. Diel periods corresponded to the following times: I = 0800 - 1359 h; II = 1400 - 1959 h; III = 2000 - 0159 h; IV = 0200 - 0759 h. January 1986 - August 1987.

they were not sampled prior to reactor re-start. Only data from the February - July spawning period is included in these analyses.

Mean icthyoplankton density in the corridor was somewhat higher (approximately 27 larvae/1000 m^3) after the re-start of L-Reactor (1986) than before (approximately 11 larvae/1000 m^3 in 1984 and 14 larvae/1000 m^3 in 1985), primarily because of a large increase in sunfish larvae (Figure 3-15). Sunfish larvae were the dominant taxa in the corridor during 1986, while minnows and darters were dominant during 1984 and 1985. The increase in sunfish densities in 1986 probably resulted from the discharge of these organisms into Steel Creek from L-Lake.

Mean ichthyoplankton densities in Meyer's Branch in the years following the re-start of L-Reactor were within the range of those in the years preceding the re-start. Mean densities were approximately 13 and 14/1000 m^3 in 1986 and 1987, respectively, in contrast to approximately 22 and 13/ 1000 m^3 in 1984 and 1985, respectively (Figure 3-16). During both periods the dominant taxa were generally darters and minnows, suggesting little impact on fish spawning in this stream.

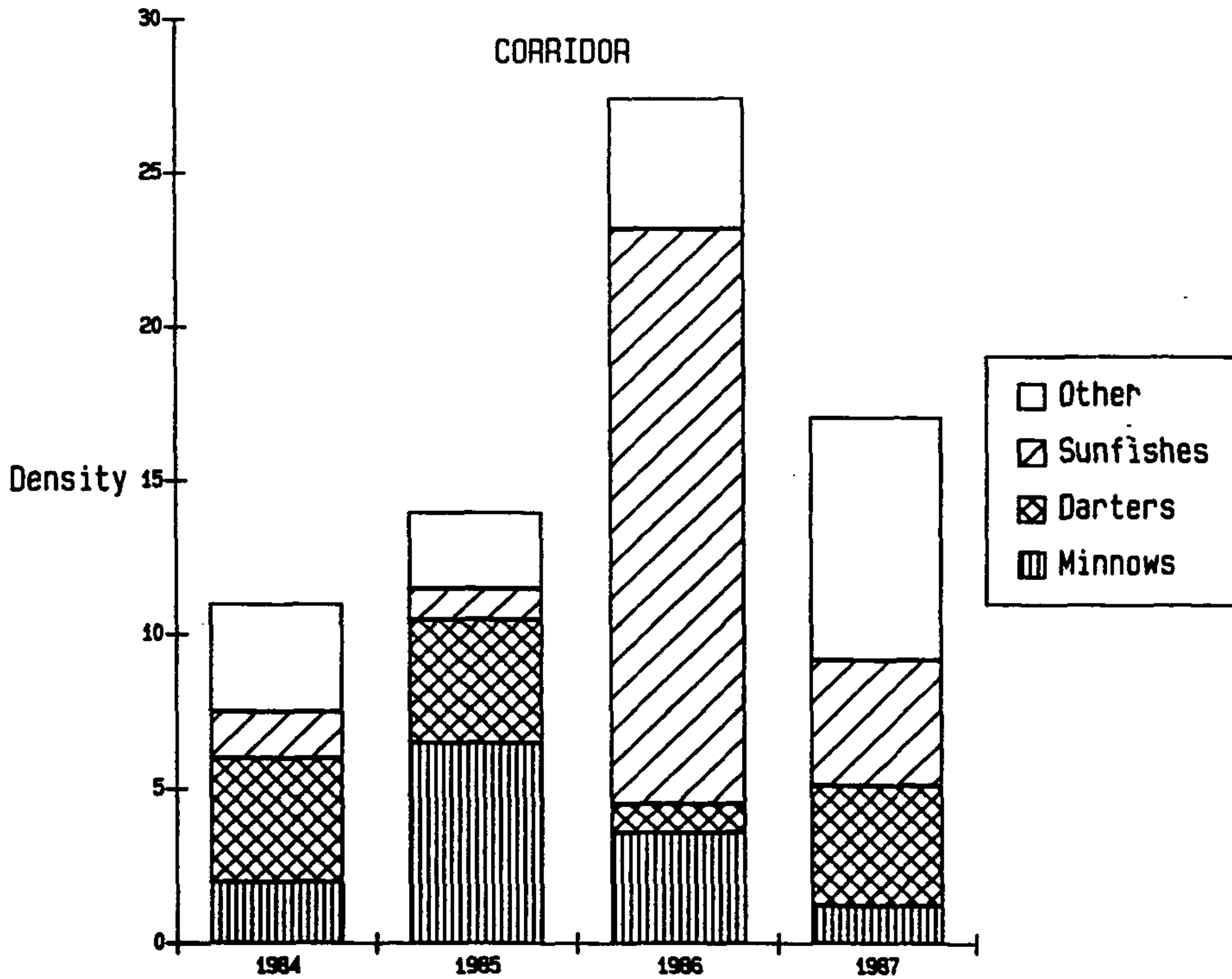


Figure 3-15. Mean ichthyoplankton densities (no./1000 m^3) in the Steel Creek corridor preceding (1984 and 1985) and following (1986 and 1987) the re-start of L-Lake. 1984 - 1987.

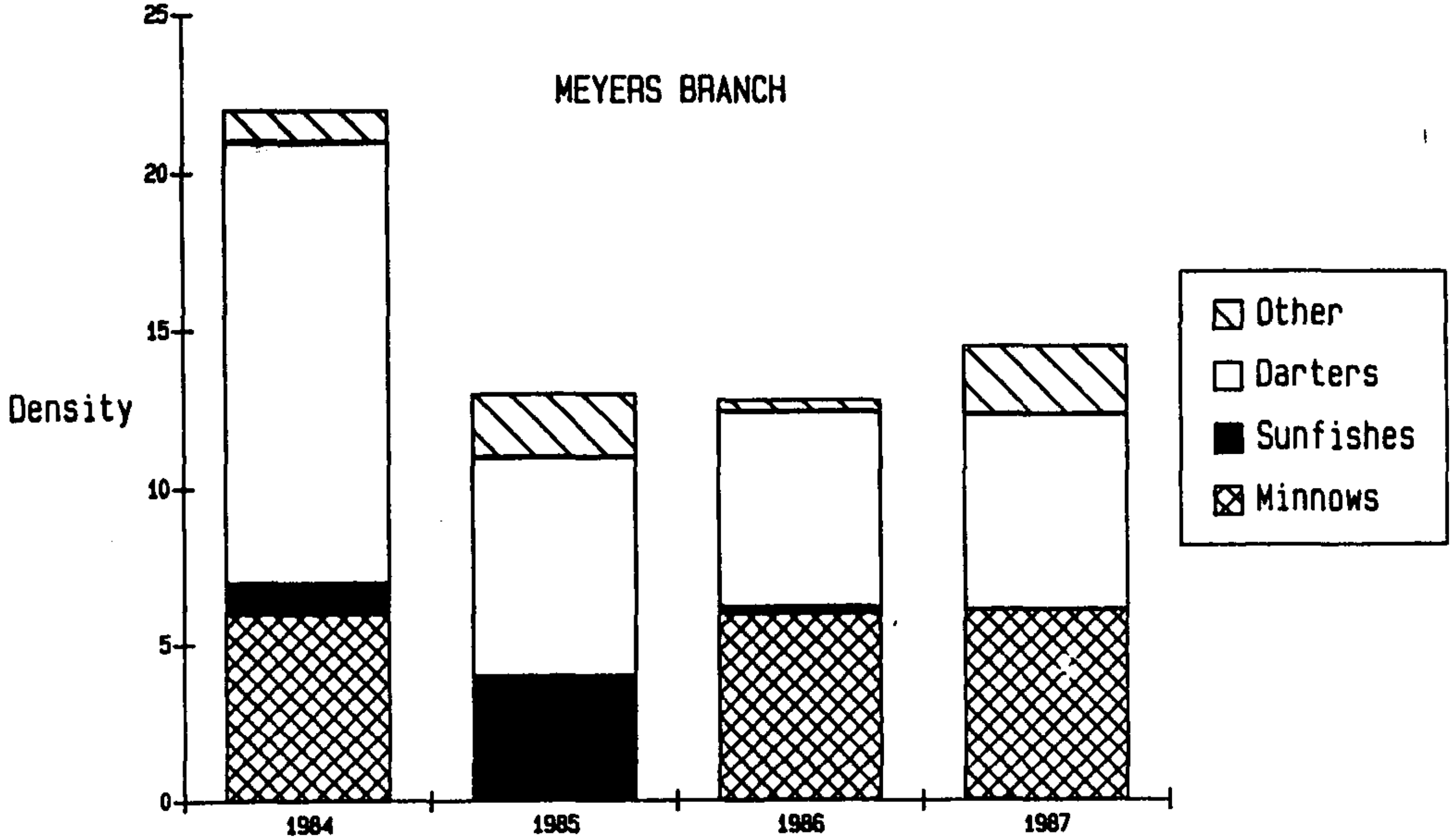


Figure 3-16. Mean ichthyoplankton densities (no./1000 m^3) in Meyer's Branch preceding (1984 and 1985) and following (1986 and 1987) the re-start of L-Reactor. 1984 - 1987.

Mean ichthyoplankton densities in the Steel Creek delta/swamp during 1986 and 1987 (approximately 28 and 23/1000 m^3) were higher than during 1985 (approximately 14/1000 m^3; Figure 3-17). However, mean densities during all three years were far lower than during 1984 (approximately 155 larvae/1000 m^3). The difference between 1986, 1985, and 1984 is largely artificial since the 1984 samples were sometimes collected in the macrophyte beds, while the 1985 and 1986 samples were collected only from the open water. Special supplemental samples taken during 1985 demonstrated that the macrophyte beds support very large numbers of fish larvae (Paller et al. 1986a). Species composition was fairly similar during all years with dominance by the sunfishes, followed by various combinations of darters, minnows, and suckers. These data indicate an absence of obvious negative effects on fish spawning in the Steel Creek delta/swamp due to the re-start of L-Reactor.

Mean yearly ichthyoplankton densities in the Steel Creek channel following the re-start of L-Reactor (approximately 89 and 55/1000 m^3) were within the range of those preceding the re-start (approximately 108 and 38/1000 m^3; Figure 3-18). The taxonomic composition of the ichthyoplankton varied during the pre-impoundment period, with sunfishes and suckers dominating during 1984 and blueback herring (the principal taxon under herring/shad in

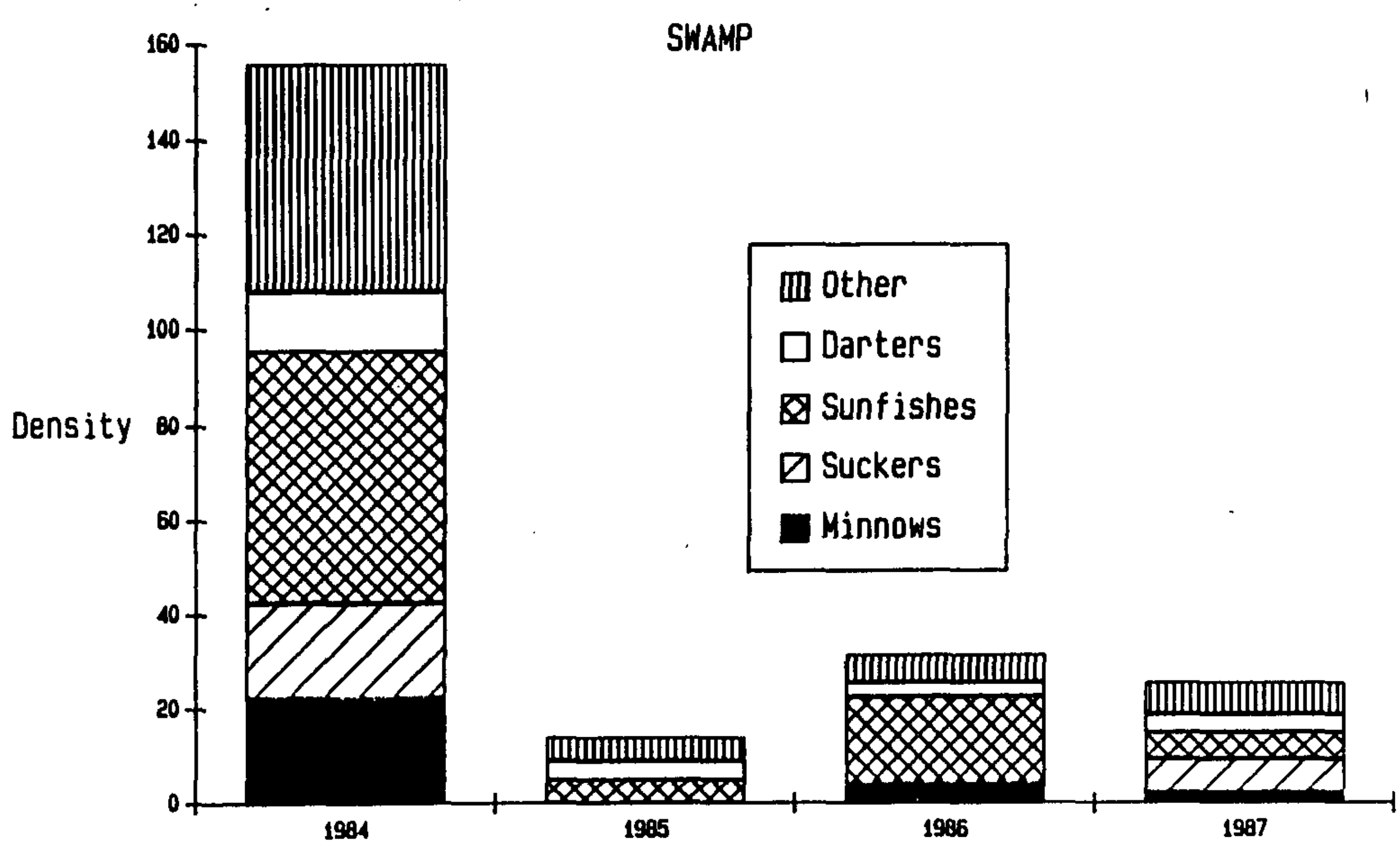


Figure 3-17. Mean ichthyoplankton densities (no./1000 m^3) in the Steel Creek delta/swamp preceding (1984 and 1985) and following (1986 and 1987) the re-start of L-Reactor. 1984 - 1987.

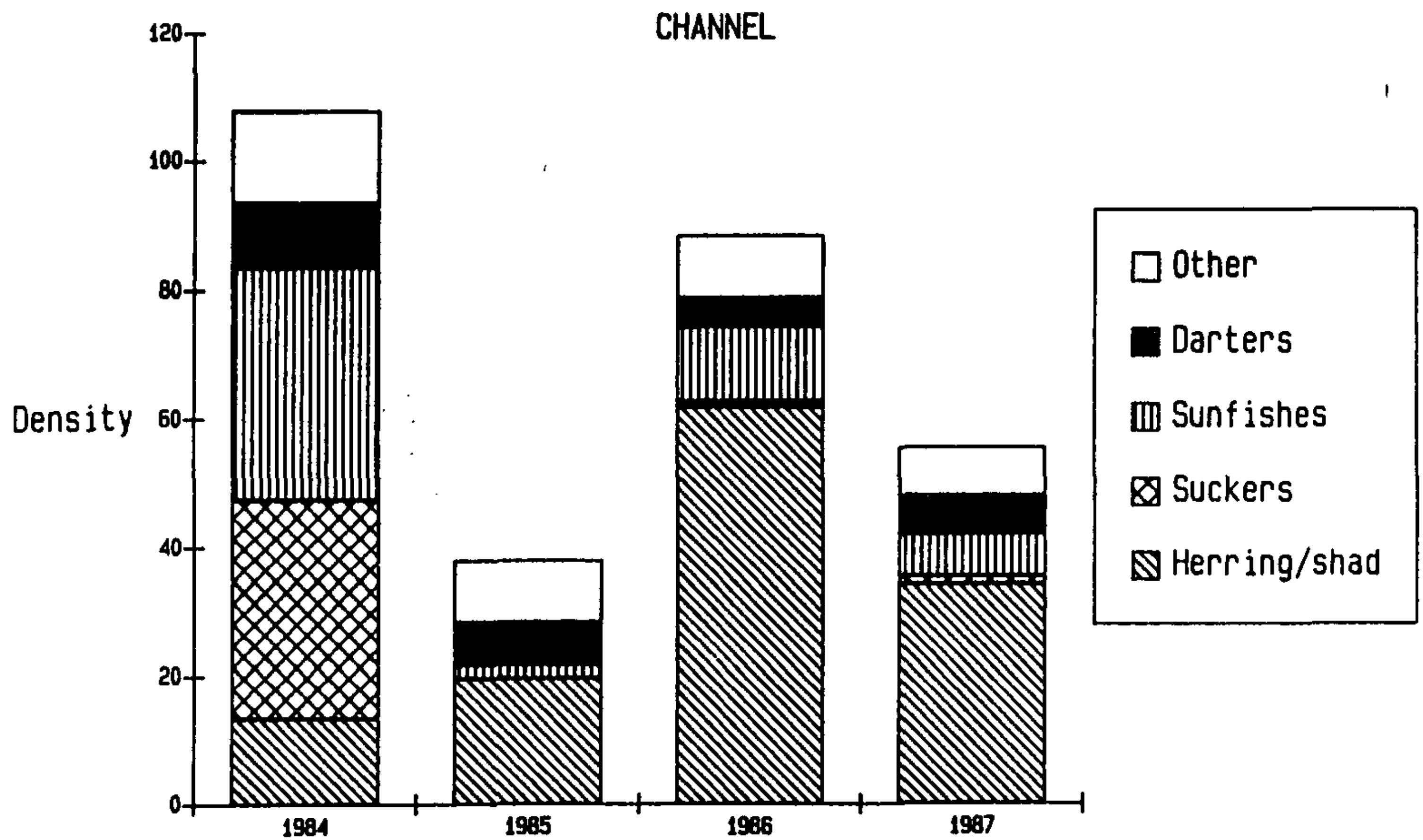


Figure 3-18. Mean ichthyoplankton densities (no./1000 m^3) in the Steel Creek channel preceding (1984 and 1985) and following (1986 and 1987) the re-start of L-Reactor. 1984 - 1987.

Figure 3-17) and darters dominating during 1985. Blueback herring dominated the collections during both years following the re-start, possibly reflecting greater attraction of spawning blueback herring because of the increased discharge of Steel Creek. The patterns of ichthyoplankton density and species composition occurring in the Steel Creek channel are not indicative of negative impacts on fish spawning due to the re-start of L-Reactor.

3.3.2 Diel Changes in Ichthyoplankton Abundance

Drift densities of fish larvae and eggs occurring in Steel Creek in 1987 were, as in 1986, greatest at night; Figures 3-19 through 3-21, Tables 3-13 through 3-15). Densities were greatest during period III (2000 - 0159 h) in the corridor and swamp (Figures 3-19 and 3-20; Tables 3-13 and 3-14), and period IV (0200 - 0759 h) in the lower channel (Figure 3-21; Table 3-15). Except for corridor densities during 1987, minimum diel densities occurred at period II (1400 - 1959 h). Nearly all taxa showed increases in drift density in all habitats after nightfall. Some species, including pirate perch and spotted sunfish, were collected only during periods III and IV.

Lepomis spp. (almost entirely bluegill) dominated the drift in the corridor during all periods in 1986 and 1987, but exhibited their highest peaks during Period III. (Figure 3-19; Table 3-13). Densities of the other sunfishes

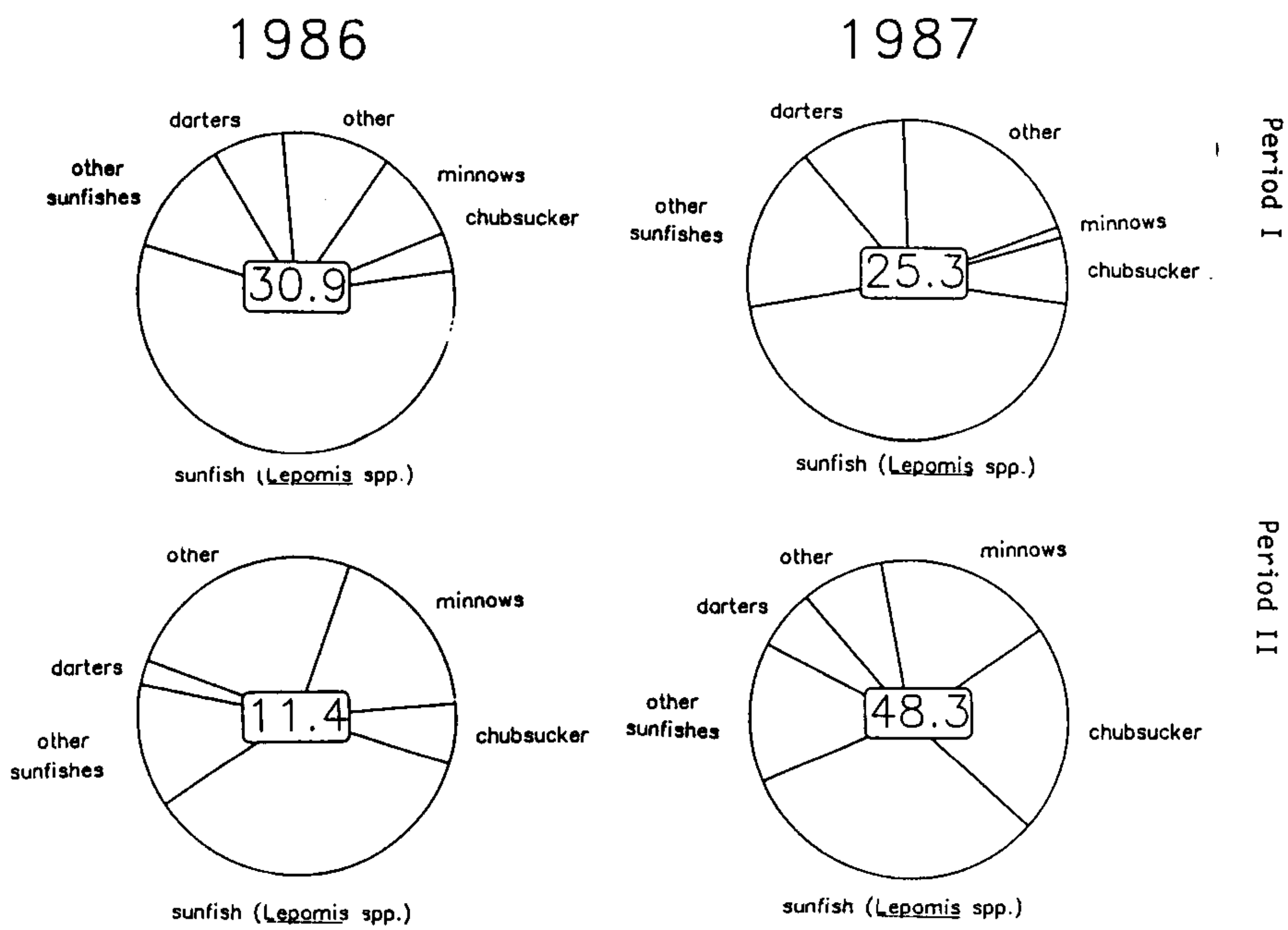


Figure 3-19. Diel periodicity of drifting fish larvae in the Steel Creek corridor (Stations 275, 280, and 290). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

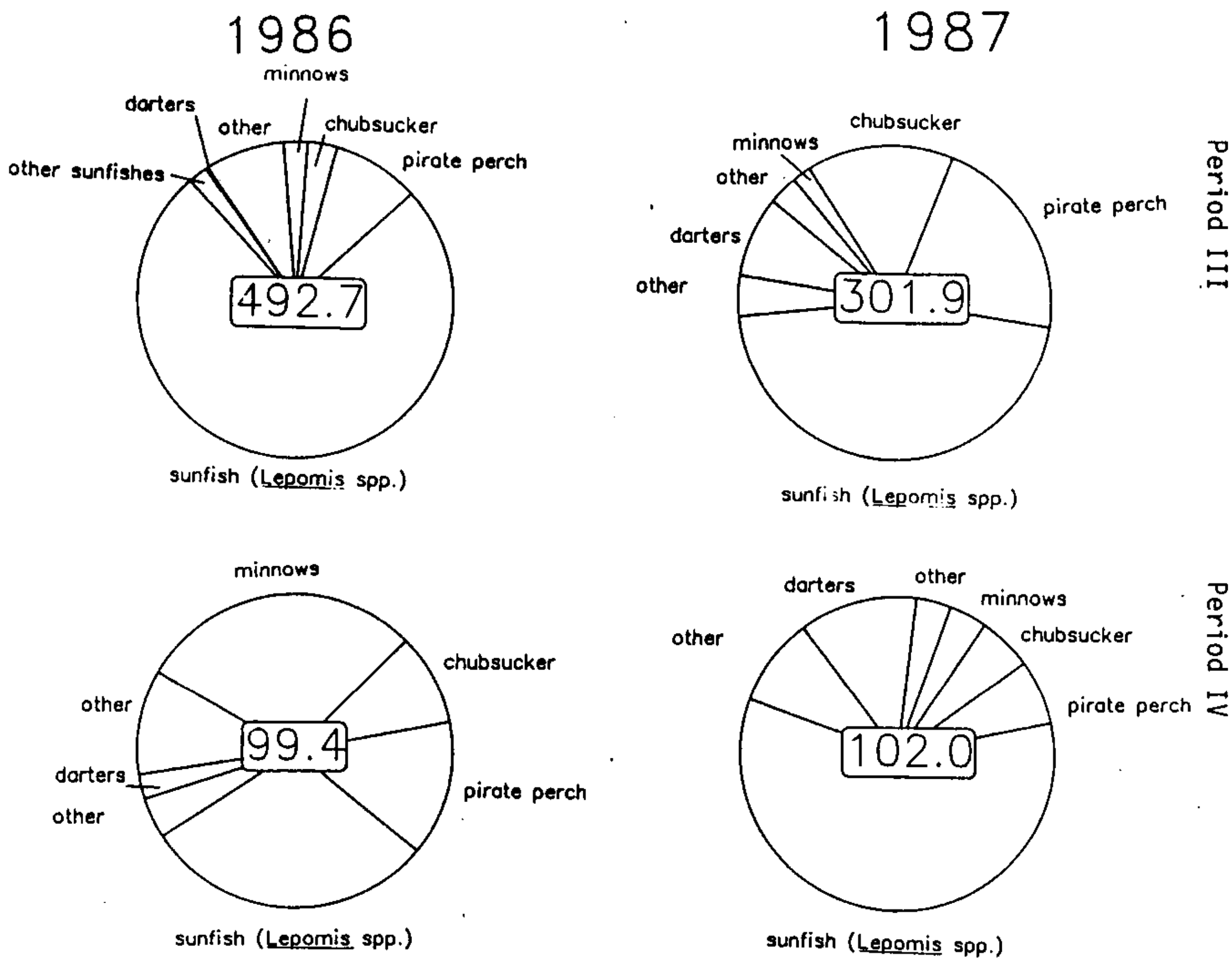


Figure 3-19 (continued). Diel periodicity of drifting fish larvae in the Steel Creek corridor (Stations 275, 280, and 290). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

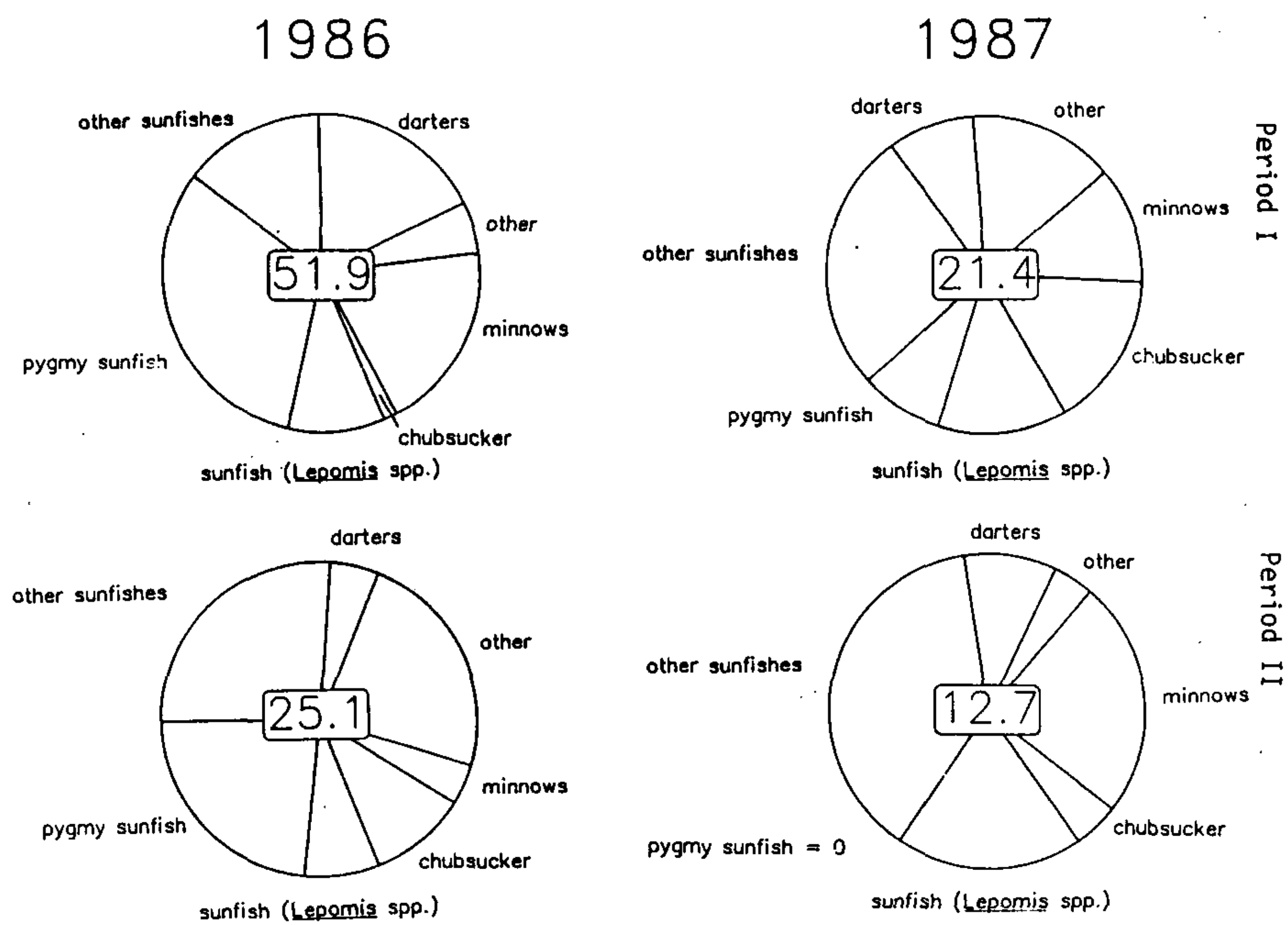


Figure 3-20. Diel periodicity of drifting fish larvae in the Steel Creek delta/swamp (Stations 310, 330, and 350). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

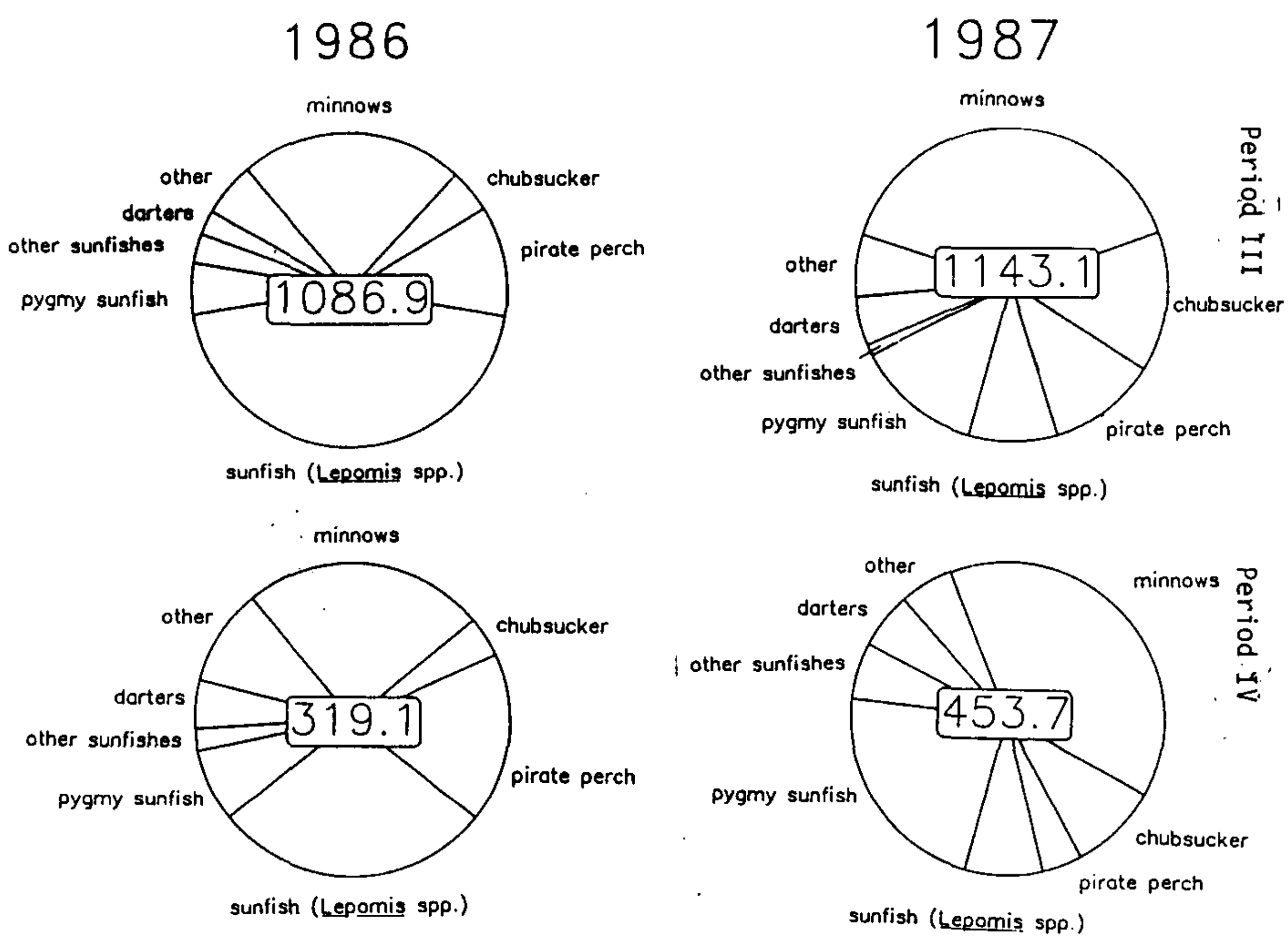


Figure 3-20 (continued). Diel periodicity of drifting fish larvae in the Steel Creek delta/swamp (Stations 310, 330, and 350). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

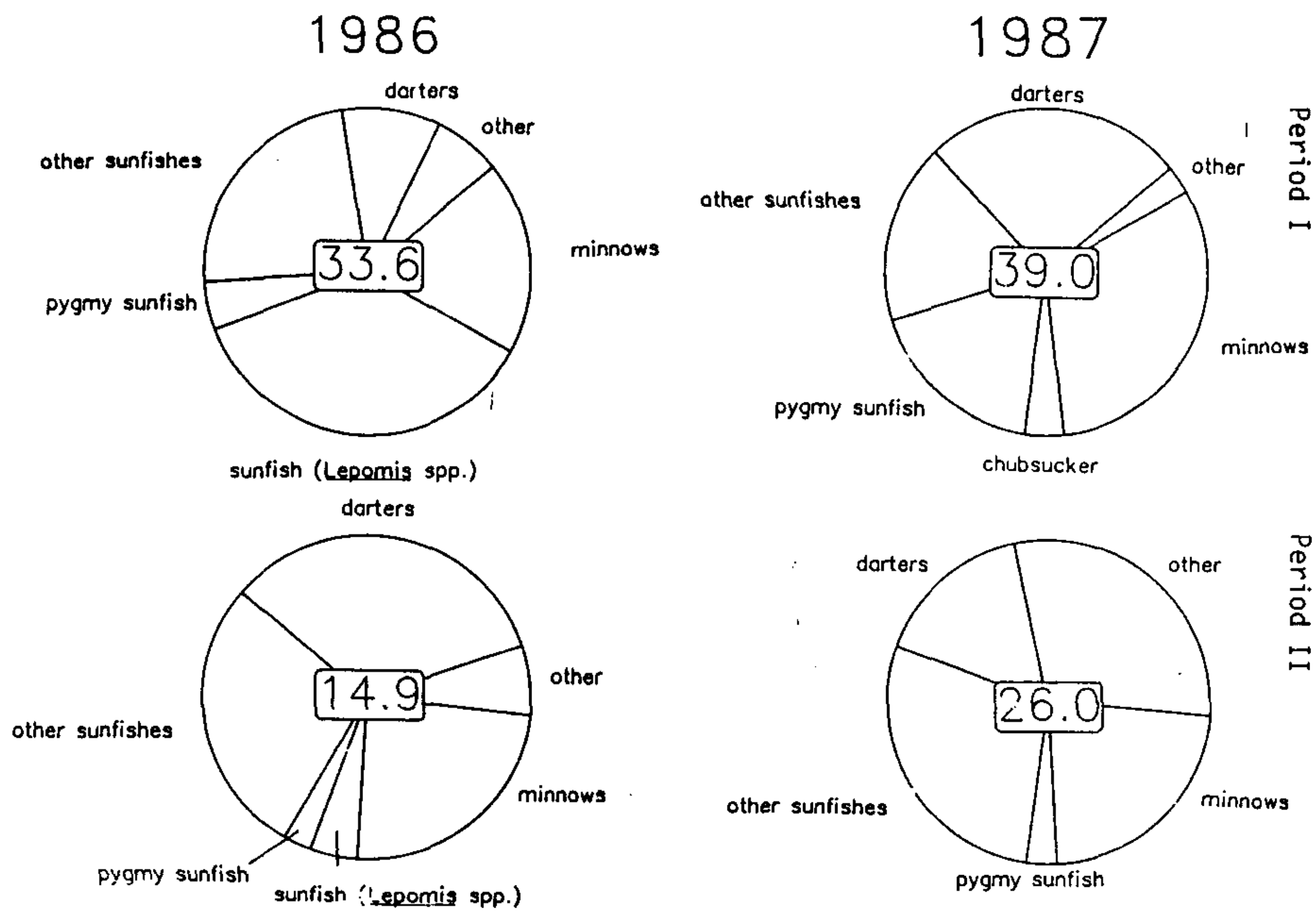


Figure 3-21. Diel periodicity of drifting fish larvae in the Steel Creek channel (Station 370). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

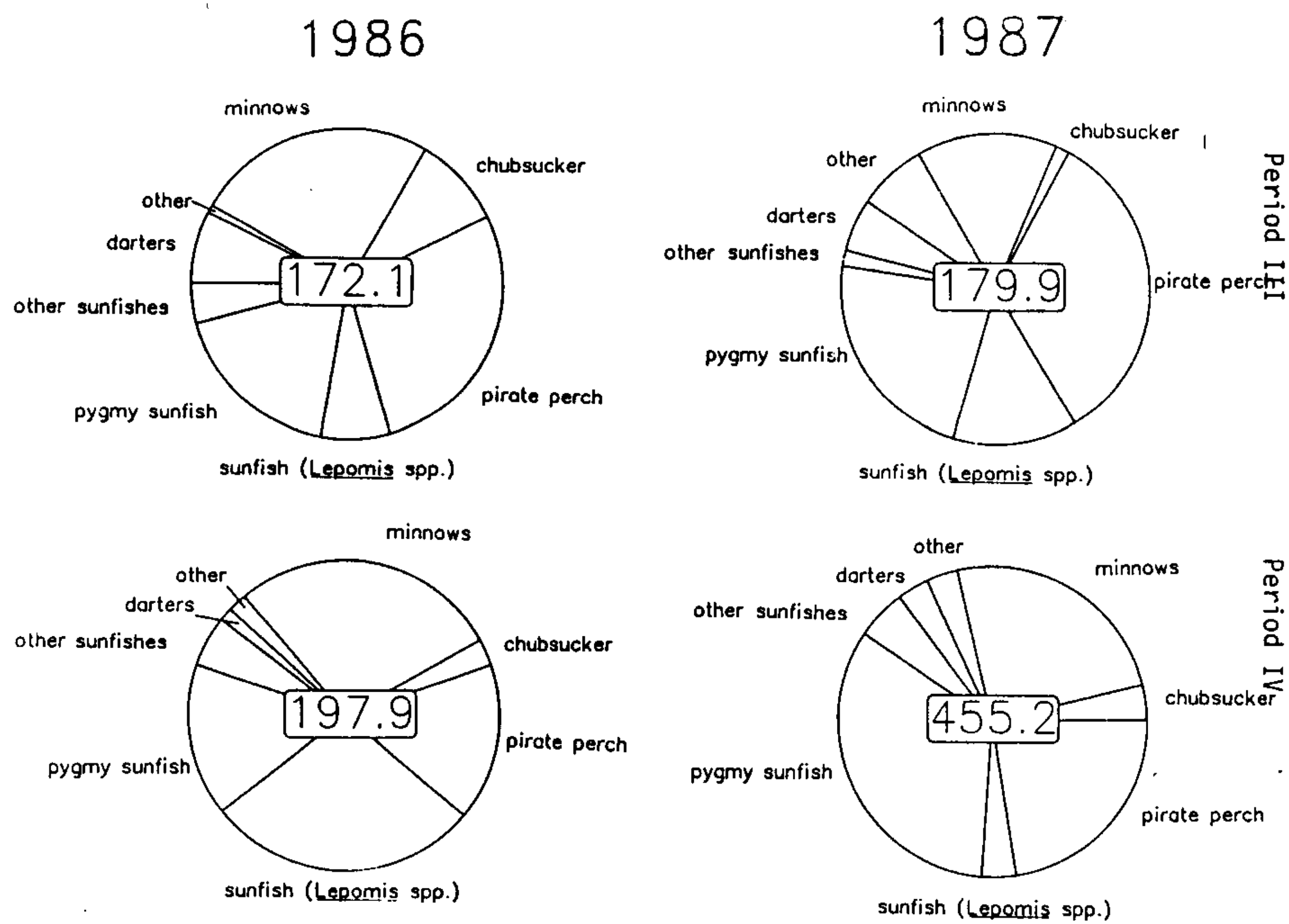


Figure 3-21 (continued). Diel periodicity of drifting fish larvae in the Steel Creek channel (Station 370). Values presented in the center of each chart represent the mean total number of fish larvae/1000 m^3 collected at that particular diel period for the year. Samples were collected monthly. February - July 1986 and 1987.

Table 3-13. Diel periodicity (sampled monthly) of selected taxa of drifting ichthyoplankton (larvae and eggs) in the Steel Creek corridor. Data were combined between years and are presented as the mean density (no./1000 m^3) collected in each diel period. Standard deviations are noted in parentheses. Diel periods corresponded to the following times: I = 0800 - 1359 h, II = 1400 - 1959 h, III = 2000 - 0158 h, IV - 0200 - 0759 h. February - July 1986 and 1987.

Taxon[a]	Diel Period I		II		III		IV	
herrings (*Alosa* spp.)								
blueback herring								
American shad								
shad (*Dorosoma* spp.)	0.2	(1.7)			0.4	(3.5)	0.6	(3.9)
ironcolor shiner					3.4	(15.8)	0.5	(3.0)
other minnows	1.6	(9.5)	5.5	(21.9)	6.3	(17.6)	16.0	(69.4)
chubsuckers	1.4	(7.8)	5.5	(30.4)	30.1	(115.7)	7.6	(20.8)
pirate perch					53.9	(207.5)	10.3	(34.0)
brook silverside	0.5	(3.1)			0.5	(2.8)		
pygmy sunfish	0.4	(2.2)			4.4	(21.9)	1.2	(6.3)
bluespotted sunfish	1.9	(8.5)	0.4	(2.6)	3.4	(25.8)	1.7	(9.1)
sunfish (*Lepomis* spp.)	14.3	(37.7)	9.8	(24.0)	253.3	(756.7)	41.9	(94.0)
redbreast sunfish[b]	0.4	(2.4)			3.5	(12.0)	1.5	(6.7)
warmouth[b]								
spotted sunfish[b]					6.0	(21.7)	4.7	(13.6)
crappie	1.4	(8.6)	3.1	(14.7)	2.6	(13.8)	2.6	(12.0)
darter (*Etheostoma* spp.)[b]	0.5	(3.2)	1.7	(6.0)	7.2	(25.0)	3.5	(11.9)
darter (*Percina* spp.)[b]	2.7	(8.1)	2.2	(7.7)	18.5	(59.9)	9.8	(21.6)
darters (unidentified)[c]	2.2	(8.6)	0.3	(1.9)	2.6	(7.0)	2.5	(9.7)

[a]Taxa collected but not reported here include bullhead catfishes, swampfish and mosquitofish.
[b]Means and standard deviations calculated for 1987 only since these taxa were not distinguished in 1986.
[c]Means and standard deviations calculated for 1986 only since this category was split into two taxa in 1987.

Table 3-14. Diel periodicity (sampled monthly) of selected taxa of drifting ichthyoplankton (larvae and eggs) in the Steel Creek swamp. Data were combined between years and are presented as the mean density (no./1000 m^3) collected in each diel period. Standard deviations are noted in parentheses. Diel periods corresponded to the following times: I = 0800 - 1359 h, II = 1400 - 1959 h, III = 2000 - 0159 h, IV - 0200 - 0759 h. February - July 1986 and 1987.

	Diel Period							
Taxon[a]	I		II		III		IV	
herrings (<u>Alosa</u> spp.)			1.2	(8.5)	6.4	(40.0)	1.7	(14.2)
blueback herring								
American shad								
shad (<u>Dorosoma</u> spp.)								
ironcolor shiner	4.9	(24.6)	1.1	(5.6)	238.4	(566.0)	81.7	(172.1)
other minnow	1.4	(6.4)	1.1	(5.3)	114.0	(228.1)	46.7	(86.6)
chubsuckers	2.0	(10.9)	1.5	(7.1)	106.8	(359.8)	27.6	(85.7)
pirate perch					126.9	(236.1)	37.3	(79.2)
brook silverside	2.8	(9.6)	2.7	(10.8)	49.0	(107.2)	19.8	(47.5)
pygmy sunfish	9.1	(47.9)	2.9	(14.6)	104.2	(250.5)	62.7	(191.2)
bluespotted sunfish	6.4	(21.5)	4.5	(15.1)	7.5	(19.5)	11.8	(29.2)
sunfish (<u>Lepomis</u> spp.)	2.6	(9.2)	1.5	(5.8)	243.1	(822.1)	47.8	(116.1)
redbreast sunfish[b]							0.6	(3.4)
warmouth[b]	2.8	(12.7)	1.3	(5.5)	8.5	(34.5)	15.1	(35.4)
spotted sunfish[b]					93.9	(279.0)	16.5	(36.8)
crappie							0.3	(2.2)
darter (<u>Etheostoma</u> spp.)[b]	1.9	(6.8)	1.2	(5.2)	57.6	(139.1)	25.5	(50.8)
darter (<u>Percina</u> spp.)[b]					1.0	(4.0)	0.5	(3.2)
darters (unidentified)[c]	9.3	(48.2)	1.2	(7.3)	27.7	(63.8)	15.9	(28.9)

[a]Taxa collected but not reported here include gar, pickerel, spotted sucker, bullhead catfishes, yellow bullhead, swampfish, topminnows, mosquitofish, and largemouth bass.
[b]See Figure 3-13.
[c]See Figure 3-13.

Table 3-15. Diel periodicity (sampled monthly) of selected taxa of drifting ichthyoplankton (larvae and eggs) in the Steel Creek channel. Data were combined between years and are reported as the mean density (no./1000 m^3) collected in each diel period. Standard deviations are noted in parentheses. Diel periods corresponded to the following times: I = 0800 - 1359 h, II = 1400 - 1959 h, III = 2000 - 0159 h, IV - 0200 - 0759 h. February through July 1986 and 1987.

Taxon[a]	Diel Period							
	I		II		III		IV	
herrings (<u>Alosa</u> spp.)	30.3	(96.0)	88.6	(201.3)	63.0	(172.5)	20.4	(52.0)
blueback herring	14.9	(73.6)			20.1	(92.4)	13.8	(46.6)
American shad	4.9	(10.0)	9.8	(30.4)	194.5	(817.5)	85.7	(196.5)
shad (<u>Dorosoma</u> spp.)					0.4	(2.6)	5.6	(36.2)
ironcolor shiner	6.1	(14.5)	3.1	(10.4)	10.0	(26.2)	38.0	(53.7)
other minnow	2.9	(9.0)	1.5	(5.0)	25.1	(51.0)	42.2	(95.1)
chubsuckers	0.6	(2.9)			10.1	(27.6)	10.2	(27.9)
pirate perch					52.3	(126.5)	63.3	(167.8)
brook silverside			0.7	(3.1)	2.4	(10.9)	5.5	(14.0)
pygmy sunfish	3.9	(12.9)	0.6	(2.8)	34.5	(88.7)	83.1	(170.1)
bluespotted sunfish	7.5	(14.6)	5.5	(14.3)	1.7	(5.4)	14.5	(33.7)
sunfish (<u>Lepomis</u> spp.)	7.0	(31.2)	0.4	(2.8)	8.2	(28.2)	32.9	(72.5)
redbreast sunfish[b]								
warmouth[b]					4.2	(18.0)	8.0	(17.5)
spotted sunfish[b]					16.9	(53.2)	5.9	(13.5)
crappie					0.3	(2.3)		
darter (<u>Etheostoma</u> spp.)[b]	10.2	(28.0)	2.7	(6.2)	13.0	(39.7)	11.8	(28.3)
darter (<u>Percina</u> spp.)[b]			1.5	(4.3)			2.9	(6.7)
darters (unidentified)[c]	4.6	(11.1)	5.6	(12.2)	12.3	(22.3)	3.3	(11.7)

[a]Taxa collected but not reported here include unidentified redhorse, bullhead catfishes, swampfish, and largemouth bass.
[b]See Figure 3-13.
[c]See Figure 3-13.

(i.e., pygmy, bluespotted, redbreast, and spotted) also peaked during Period III. Black crappie densities, however, were constant across periods. There were no diel patterns evident for larval shad (Dorosoma) spp., or larval brook silverside, probably because too few were collected in this habitat to detect any trends. There were few changes in the taxonomic composition of the larval drift between 1986 and 1987 except that minnows were less abundant in the nocturnal (Periods III and IV) samples in 1987 and chubsuckers and darters were somewhat more abundant (Figure 3-19).

Of the three habitats, nocturnal drift densities of all species were generally highest in the swamp (Figure 3-20; Table 3-14). No taxon dominated the daytime drift in 1987; bluespotted sunfish, minnows, and darters were prominent. Densities of ironcolor shiners and other minnows increased greatly at nightfall (Figure 3-20). Densities of most sunfishes (Lepomis spp., pygmy, spotted, and warmouth) also increased greatly after dark. Of the taxa considered, only bluespotted sunfish failed to show diel fluctuations in abundance.

There were noteworthy changes in the composition of the larval drift in the swamp between 1986 and 1987. Minnows were more abundant during Periods III and IV in 1987 (Figure 3-20). Nocturnal densities of pygmy sunfish, chubsuckers, and darters were also higher in 1987. Conversely, sunfishes (Lepomis spp.) densities at night were greatly reduced from those of 1986.

The diel pattern of larval abundance in the Steel Creek lower channel was unusual because maximum densities occurred during Period IV rather than Period III, as was the case in the upstream habitats (Figure 3-21; Table 3-15). Minnows (especially ironcolor shiners), darters, bluespotted sunfish (categorized as "other sunfishes" in Figure 3-21), dominated the diurnal drift in 1987, whereas minnows, pirate perch, and pygmy sunfish dominated the nocturnal drift. Eggs (few larvae were present) of species that spawned largely in the lower channel (e.g., American shad and blueback herring; Figure 3-14) showed peak densities at Period III.

Considerably more larvae were collected from the channel during Period IV in 1987 than in 1986 (Figure 3-21). Increased drift densities of pygmy sunfish, pirate perch, and cyprinids were primarily responsible for the 1987 increase, although densities for all major taxa (except Lepomis spp.) were greater in 1987.

Because drift activity by larvae is induced by decreasing light intensity, drift densities should be greatest within the first hours after sundown (Period III; Lindsey and Northcote 1963; Gale and Mohr 1978; Gerlach and Kahnle 1981; Muth and Schmulbach 1984). This pattern was evident at the corridor and swamp sites where drift densities peaked in Period III. However, Period IV densities in the lower channel were over twice as high as Period III densities. This discrepancy and the predominance of swamp species in lower channel drift (e.g., pygmy sunfish, warmouth, bluespotted sunfish, ironcolor shiner, and pirate perch) probably indicates that larvae occurring in the channel during Period IV had entered the drift in the swamp during Period III. Given a lag period of a few hours for transport, it is reasonable to assume these fish were responsible for inflating the channel drift densities at Period IV.

4.0 DISCUSSION

4.1 CHARACTERIZATION OF FISH ASSEMBLAGES IN STEEL CREEK

The fish assemblages along the length of Steel Creek exhibit changes in composition associated with variations in habitat. Some of the most important determinants of habitat in Steel Creek are current velocity, water depth, canopy cover, and proximity to the Savannah River. The creation of L-Lake and re-start of L-Reactor has caused major changes in at least two of these factors, current velocity and discharge (Hooker and Stiner 1988), and has contributed an additional factor (export of material from L-Lake).

Current velocity is one cause of the differences in fish assemblage structure between the Steel Creek corridor and the Steel Creek delta/swamp. Since the corridor is a lotic environment, characterized by relatively high current velocities and a relatively well-defined channel (or channels in some areas), species preferring standing or slow-flowing waters are absent from or comparatively scarce in this habitat. The other major influence on the structure of the fish assemblage in the corridor is L-Lake, which now effectively constitutes the headwaters of Steel Creek. The fish assemblages inhabiting the corridor during 1986 and 1987 reflected the juxtaposition of newly arrived lentic fishes (primarily bluegill larvae and juveniles) that actively or passively emigrated from L-Lake, upon a lotic fauna, with the influence of the invading fishes generally being greater with proximity to L-Lake.

The passage of Steel Creek from the corridor into the relatively broad, flat, Savannah River floodplain results in a diminution of current velocity and depth, and a broadening and division of the creek channel to form the Steel Creek delta/swamp. Another major habitat difference between the Steel Creek corridor and Steel Creek delta/swamp is the abundance of submerged and emergent macrophytes, which are prevalent throughout much of the delta/swamp but relatively scarce in the corridor. The Steel Creek delta/swamp supports a more diverse (52 species; Table 4-1) and somewhat different fish assemblage than the corridor (35 species), with greater representation by species such as the bluespotted sunfish, spotted sunfish, and banded pygmy sunfish, that are more characteristic of swamps and slow flowing waters.

The fish assemblage in the Steel Creek delta/swamp exhibited structural changes along several environmental gradients including depth and canopy (i.e., cypress - tupelo overstory) cover. These two factors influence the type and extent of submerged and emergent macrophyte growth, an important determinant of fish community structure (Shireman

Table 4-1. Occurrence of fishes in three habitats within Steel Creek (corridor, delta/swamp, and channel) and Meyer's Branch during 1986 and 1987.

	Steel Creek			
	Corridor	Swamp	Channel	Meyer's Branch
bowfin	x	x	x	x
longnose gar	x	x	x	
Florida gar	x	x	x	
American eel	x	x	x	x
blueback herring			x	
American shad		x	x	
gizzard shad	x	x	x	
eastern mudminnow	x	x		
redfin pickerel	x	x	x	x
chain pickerel	x	x	x	
bluehead chub	x			x
golden shiner	x	x	x	
ironcolor shiner		x	x	
dusky shiner	x	x	x	x
pugnose shiner		x	x	
spottail shiner	x		x	
yellowfin shiner	x	x	x	x
taillight shiner		x		
whitefin shiner			x	
coastal shiner	x	x	x	x
creek chubsucker	x	x	x	x
lake chubsucker	x	x		
northern hog sucker	x	x	x	x
spotted sucker	x	x	x	
snail bullhead		x	x	
white catfish		x	x	
yellow bullhead	x	x	x	x
brown bullhead	x	x	x	
flat bullhead	x	x	x	x
channel catfish		x	x	

Table 4-1. (continued). Occurrence of fishes in three habitats within Steel Creek (corridor, delta/swamp, and channel) and Meyer's Branch during 1986 and 1987.

	Steel Creek			
	Corridor	Swamp	Channel	Meyer's Branch
tadpole madtom		x		x
margined madtom		x		
speckled madtom	x		x	x
swampfish		x		
pirate perch	x	x	x	x
Atlantic needlefish			x	
golden topminnow		x		
lined topminnow		x	x	
mosquitofish		x	x	
brook silverside		x	x	
striped bass			x	
mud sunfish			x	
flier	x			
Everglades pygmy sunfish		x		
banded pygmy sunfish		x		x
bluespotted sunfish		x	x	x
redbreast sunfish	x	x	x	x
green sunfish			x	
warmouth	x	x	x	x
bluegill	x	x	x	x
dollar sunfish	x	x	x	x
redear sunfish		x	x	
spotted sunfish	x	x	x	x
largemouth bass	x	x	x	x
black crappie	x	x	x	
Savannah darter				x
swamp darter		x		
Christmas darter				x
tessellated darter	x	x	x	x
sawcheek darter		x		
yellow perch	x	x	x	x
blackbanded darter	x	x	x	x
striped mullet		x	x	
Total	35	52	47	27

et al. 1983). Shallow, heavily vegetated areas in the open-canopy delta (exemplified by Station 300) were dominated by small fish as indicated by a preponderance of shiners in the electrofishing collections and pygmy sunfish in the ichthyoplankton collections from this habitat. Dense macrophyte growth typically supports large numbers of small fishes, probably because predators find it difficult to forage in such areas (Shireman et al. 1983). While also supporting shiners, the deeper channels within the open-canopy delta supported more larger fish such as spotted sunfish, largemouth bass, and chubsuckers. All are sometimes associated with heavy macrophyte growth (Trautman 1981; Hardy 1978; Pfleiger 1975), but may require somewhat deeper and more open water than found in shallow, heavily overgrown areas in the Steel Creek delta/swamp. Differences between the fish assemblages from the open-canopy delta and the less heavily vegetated closed-canopy swamp consisted primarily of greater abundances of shiners and spotted sunfish in the former habitat.

The braided channels that drain the open- and closed-canopy delta/swamp coalesce to form a single large, well-defined channel that continues to the Savannah River. The channel is a lotic environment characterized by moderate current velocities, a scoured bottom lacking macrophyte growth, and occassional log and brush snags (Firth 1987;

Firth et al. 1988). The channel is unique among the habitats in Steel Creek in the extent of its usage as a spawning area by anadromous fishes, as indicated by the collection of adult and larval American shad and blueback herring near the creek mouth during 1986 and/or 1987. Relatively large numbers of adult channel catfish and, to a lesser extent, white catfish (both prominent Savannah River species; Paller and Saul 1986) have also been collected in this area, indicating that the channel is heavily used by riverine species. The proximity of the channel to the Savannah River, with its diverse fish community, has influenced the fish assemblage in this habitat and contributed to its high species richness (47; Table 4-1).

In summary, Steel Creek can be divided into three basic habitats based on fish distribution: corridor, delta/swamp, and channel. While these habitats are continuous and, in themselves, heterogeneous, they differ along basic environmental gradients of current velocity, depth, macrophyte development, and proximity to major sources of colonizing species, with resulting influences on fish assemblage structure. The habitats also differ in their importance to the maintenance of off-site fisheries resources, and in the extent to which they have been impacted by the re-start of L-Reactor.

4.2 EFFECTS OF L-REACTOR RE-START AND L-LAKE IMPOUNDMENT ON STEEL CREEK FISH ASSEMBLAGES

Impoundments influence the biota of downstream waters in a variety of ways, ranging from alterations of discharge, water temperature, and water quality to releasing lentic fauna into tailwater areas (Ward and Stanford 1979; Walburg et al. 1971). Such effects occurred in the Steel Creek corridor following the re-start of L-Reactor and impoundment of L-Lake, causing comprehensive changes in the fish assemblage occupying this habitat.

L-Lake discharge now constitutes most of the flow through the Steel Creek corridor and largely determines water quality, flow regime, and, to a lesser extent, water temperature. The large increases in flow (due to the added discharge of L-Reactor cooling water) have caused erosion within the creek bed and adjoining floodplain (Firth 1987; Firth et al. 1988). Besides altering substrate composition and channel morphometry, increased discharge has changed the reach of Steel Creek running through the corridor from a small, meandering stream to a rapidly flowing mid-sized watercourse. Comparisons between the species present just after these changes began and those present at the end of 1987 suggest the loss of several taxa characteristic of small streams and more slowly flowing waters (Section 3.2.1).

Superimposed on fish assemblage changes resulting from habitat alterations in the corridor, are those resulting from the release of L-Lake biota into Steel Creek. Most important has been the release of young-of-the-year bluegill, which was the dominant species in the corridor by the end of 1986. The escapement of fishes (often young-of-the-year) from reservoirs, possibly resulting from passive entrainment in discharge currents (Walburg 1971), is a well documented phenomenon. Young-of-the-year bluegill were extremely abundant in L-Lake during the latter half of 1986 and were sometimes observed congregating around the discharge structure where the likelihood of entrainment in water releases was high (Paller et al. 1987).

The impacts of fish escapement from L-Lake were directly correlated with proximity to the reservoir, being greatest just below the dam (Station 275) where the composition of both the adult fish and ichthyoplankton assemblages were very similar to those in L-Lake, and relatively minor near the head of the swamp (Station 290) where bluegill constituted a small proportion of the total catch. Bluegill were comparatively scarce within the delta/swamp and channel, although their numbers increased during 1987, reflecting downstream dispersal from areas in the corridor where they were present in relatively high densities.

This dispersal was associated with a steady reduction in the catch of bluegill in the corridor during 1987, suggesting that the influx of bluegill into Steel Creek during 1986 may have been a temporary phenomenon associated with the development of an unusually strong year class of this species in L-Lake during 1986 (Paller et al. 1987). Less emigration of juvenile bluegill in 1987 could also be a result of the withdrawal of water from the hypolimnion of L-Lake (Starkel et al. 1988) where fish were scarce or absent (Paller et al. 1988). This was probably responsible for the reduction in number of Lepomis larvae discharged from L-Lake during 1987 (Section 3.2.1). Bluegill may continue to decline in the corridor since they were not abundant in the corridor prior to the creation of L-Lake (although they had access to this habitat from the river where they were relatively abundant in some areas; Paller and Saul 1986, Paller and Osteen 1985) and since they are not characteristic of rapidly flowing waters (Pfleiger 1975; Hardy 1978).

The reduction in bluegill abundance in the corridor during 1987 was associated with an increase in the absolute and relative abundances of other taxa, particularly minnows

(Section 3.2.1). As a result of these changes, fish assemblage structure in the Steel Creek corridor during 1987 was much_ more similar to the pre-re-start fish assemblage than it was during 1986. However, as previously mentioned, habitat changes have resulted in the loss of several taxa and probably altered the abundance of others, although the latter is difficult to assess because of differences in sampling methodology.

Other factors that may have more subtly influenced fish assemblage structure in the corridor were changes in the macroinvertebrate forage base mediated by seston releases from L-Lake (especially important at Station 275; O'Hop et al. 1987) and changes in temperature regime. The Steel Creek corridor is still in a state of physical and biological flux, and further changes in fish assemblage structure can be anticipated in the future.

The habitat changes that occurred in the Steel Creek delta/swamp as a result of the re-start of L-Reactor and impoundment of L-Lake were more subtle than those that occurred in the corridor. Discharge through the delta/swamp presumably increased because of the large flow from L-Lake, although this increase was not as great proportionally as in the corridor where L-Lake discharge constitutes nearly all of the flow. Increased water volume (and possibly nutrient concentrations in water released from L-Lake) may, in turn, have contributed to the proliferation of some types of aquatic vegetation (Firth 1987; Firth et al. 1988). Conspicuous erosional changes, such as those that occurred in the corridor, were largely absent from most of the swamp (Firth 1987; Firth et al. 1988) as were conspicuous elevations in temperature (Chimney and Nagle 1988).

Like the habitat changes, the changes in fish assemblage structure in the delta/swamp were not particularly obvious given the level of resolution inherent in the electrofishing and ichthyoplankton sampling data. The adult fish assemblages exhibited an absence of substantive changes in abundance, species richness, and species composition during 1986 and 1987; in contrast to the obvious changes in the corridor fish assemblage. Comparisons between pre- and post-impoundment years indicated slight changes in assemblage structure following impoundment, consisting primarily of a decrease in the relative abundance of brook silverside and the appearance of several new species, most notably the bluegill. Of the preceding changes, only the increase in bluegill abundance can be strongly implicated as a likely impact of the L-Reactor re-start. The other changes, while possibly resulting from subtle habitat alterations associated with the reactor re-start and impoundment of L-Lake, may reflect stochastic annual variations or ecological processes independent of the L-Reactor re-start.

Habitat changes in the main creek channel leaving the delta/swamp included an increase in discharge and subsequent erosional changes in the stream bed. These changes, however, did not appear to be as drastic as in the corridor. Adult fish assemblage structure in the mouth of Steel Creek (the only portion of the channel consistently sampled over several years) did not change detectably following the re-start of L-Reactor and impoundment of L-Lake. However, ichthyoplankton assemblage structure changed due to an increase in the density of blueback herring larvae and eggs after the re-start. This change may be a result of increased discharge which makes Steel Creek more attractive to spawning blueback herring. In their literature survey, Jones et al. (1978) indicate that blueback herring spawn in relatively deep areas with swift flow.

In summary, the impacts of the L-Reactor re-start on the Steel Creek fish assemblages were directly related to the proximity of the assemblages to L-Lake. Fish assemblages in the corridor were impacted heavily, those in the delta/swamp and channel, slightly. The only assemblages that underwent drastic and seemingly negative changes (in terms of species losses and replacements) were those in the corridor, although some recovery was observed in 1987 as L-Lake emigrants declined in number. Much of Steel Creek is still physically and biologically unstable, and further changes in fish assemblage structure may occur in the future.

4.3 COMPARISONS BETWEEN STEEL CREEK AND OTHER STREAMS

Pre- and post- comparisons suggest that impacts caused by the re-start of L-Reactor and impoundment of L-Lake are largely limited to the Steel Creek corridor, and that the fish community in Steel Creek as a whole remains diverse and well-balanced. An additional way to assess the status of the Steel Creek fish community is to compare it to fish communities in other southeastern streams. Such comparisons are restricted by differences in sampling methods, sampling effort, and data reporting which limit the number of comparable parameters. For the purposes of this study, comparisons between fish communities in different streams have been based on only two parameters: species number and relative abundance. While these parameters can be influenced by sampling effort and methodology, they provide at least general indications of the status of the fish communities in each stream.

Streams selected for comparison with Steel Creek include Shoal Creek (AL), Barbaree Creek (AL), the Tennessee-

Tombigbee Waterway (TN), Duke Swamp (NC), Haggard Mill Creek (NC), Otter Creek (IN), Lower Three Runs Creek (SC), and Upper Three Runs Creek (SC). Of the preceding streams, seven are in the Southeast and one is in the central states. Two of the streams, Lower Three Runs Creek and Upper Three Runs Creek, are on the Savannah River Plant. While most of the creeks selected for comparison have been influenced by anthropogenic factors, none were considered severely impacted or degraded by the researchers studying them. A variety of sampling methods and intensities were used on the streams.

Total species number ranged from 24 in Duke Swamp to 60 in Steel Creek during 1986 (Table 4-2). The only stream approaching Steel Creek in species richness was the Tennessee-Tombigbee Waterway, a fairly large watercourse, with 49 species. While apparent species richness is partly a function of sampling effort (Odum 1971), the differences between Steel Creek and the other streams may be at least partially real, due to the unusual habitat diversity in Steel Creek. Because of Steel Creek's unique history and the physiography of its watershed, it contains a variety of habitats (corridor, open-canopy delta, closed-canopy swamp, and channel) that provide niches for a relatively large number of species. Species number in Steel Creek is also enhanced by Steel Creek's connection with the Savannah

Table 4-2. Species number and relative abundance (% composition) of fishes in nine southeastern streams. Relative abundances are based on the number of individual fish in each family.

Family	Otter Creek, IN[a] No.	Otter Creek, IN[a] %	Shoal Creek, AL[b] No.	Shoal Creek, AL[b] %	Barbaree Creek, AL[c] No.	Barbaree Creek, AL[c] %	Tombigbee Waterway, TN[d] No.	Tombigbee Waterway, TN[d] %	Duke Swamp NC[e] No.	Duke Swamp NC[e] %
bowfin									1	1
gars							1	<1	1	<1
freshwater eels									1	2
herrings	1	1[f]	1	<1			1	<1		
mudminnow									1	4
pikes	1	<1	1	<1					2	28
suckers	4	3	3	7	2	3	4	2	1	10
minnows	16	86	14	55	10	81	18	72	1	3
catfishes	2	2	2	1	1	<1	4	4	3	10
needlefishes										
killifishes	1	1	1	<1			2	2		
livebearers							1	5	1	<1
pirate perch									1	21
cavefishes									1	2
silversides	1	<1								
sunfishes & black basses	7	2	11	22	6	2	6	7	9	18
perches	6	8	7	9	5	11	11	6	1	<1
drums							1	2		
mullets										
sculpins			1	5	1	3				
TOTAL	39		41		25		49		24	

[a] Grossman et al. 1982.
[b] Kelly et al. 1981.
[c] Boschung and O'Neil 1981.
[d] Mundy and Boschung 1981.
[e] Pardue and Huish 1981.
[f] Value quoted directly from original paper.

Table 4-2 (continued). Species number and relative abundance (% composition) of fishes in nine southeastern streams. Relative abundances are based on the number of individual fish in each family.

Family	Haggard Mill Creek, NC[e]		Steel Creek[g] - 1986		Steel Creek - 1987[g]		Lower Three Runs[h]		Upper Three Runs[h]	
	No.	%	No.	%	No.	%	No.	%	No.	%
bowfin	1	< 1	1	2	1	1	1	1	1	3
gars			2	3	2	1	1	< 1		
freshwater eels	1	6	1	1	1	1	1	6	1	10
herrings	1	1	3	1	2	< 1			1	2
mudminnow	1	10	1	< 1	1	< 1	1	< 1		
pikes	2	11	2	2	1	1	1	1	1	2
suckers	1	3	4	9	4	6	3	8	3	13
minnows	2	1	10	26	10	40	5	1	2	16
catfishes	3	4	9	2	9	2	5	2	2	2
needlefishes			1	< 1	1	< 1	1	< 1		
killifishes			2	< 1	2	< 1			1	2
livebearers	1	8	1	1	1	2	1	1		
pirate perch	1	24	1	1	1	2	1	4	1	4
cavefishes	1	8	1	< 1	1	< 1				
silversides			1	2	1	1	1	< 1	1	1
temperate basses					1	< 1				
sunfishes & black basses	11	22	12	47	13	39	9	69	7	46
perches	2	4	6	3	6	3	4	6		
drums										
mullets			1	< 1	1	< 1				
sculpins										
TOTAL	28		60		60		35		21	

[e] Pardue and Huish 1981.
[g] present study.
[h] Paller and Saul 1986.

River, which results in occasional incursions by riverine species such as the larger catfishes, by anadromous species such as the American shad and blueback herring, and by euryhaline marine species such as the Atlantic needlefish and striped mullet. Examination of the number of species in each family indicates that Steel Creek supports a particularly rich ictalurid (catfish) fauna, consisting of a variety of bullheads and madtoms, plus several species of catfish; a rich centrarchid (sunfish and black bass) fauna; and a rich cyprinid (minnow) fauna.

Calculations of relative abundance in Steel Creek indicated that dominance was concentrated in the sunfish family (47% during 1986 and 39% during 1987), followed by the minnow family (26% during 1986 and 40% during 1987) and sucker family (9% during 1986 and 6% during 1987; Table 4-2). All of these values are within the ranges exhibited by the other streams.

In general, the fish community supported by Steel Creek following the re-start of L-Reactor compares favorably with fish communities in other southeastern streams in terms of species richness and composition. Steel Creek supports a wide variety of fishes representing numerous taxonomic groups and a variety of trophic levels. These data, in conjunction with the pre- and post- reactor re-start data, suggest that while localized assemblages within the Steel Creek fish community have been impacted by the re-start of L-Reactor, the community as a whole has not suffered serious degradation.

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APPENDICES

Appendix Table 1.

Results of Taylor's Power Law calculations for two representative gear types for fish sampling in Steel Creek 1986 - 1987. Monthly habitat means were used in the calculations for electrofishing. Means by spawning period and year for each station were used for the calculations for net tows. A slope of 1.0 indicates a square root transformation, and a slope of 2.0 indicates a logarithmic transformation (Green 1979).

Gear	constant	r^2	N	Slope
electrofishing	-0.461	0.889	59	2.17
net tows	2.341	0.892	37	1.64

Appendix Table 2.

Scientific and common names of fishes collected from Steel Creek and Meyer's Branch. January 1986 - December 1987.

Lepisosteus osseus	longnose gar
L. pletyrhincus	Florida gar
Amia calva	bowfin
Anguilla rostrata	American eel
Alosa aestivalis	blueback herring
A. sapidissima	American shad
Dorosoma cepedianum	gizzard shad
Umbra pygmaea	eastern mudminnow
Esox americanus	redfin pickerel
E. niger	chain pickerel
Nocomis leptocephalus	bluehead chub
Notemigonus crysoleucas	golden shiner
Notropis chalybaeus	ironcolor shiner
N. cummingsae	dusky shiner
N. emilaiae	pugnose shiner
N. hudsonius	spottail shiner
N. lutipinnis	yellowfin shiner
N. maculatus	taillight shiner
N. niveus	whitefin shiner
N. petersoni	coastal shiner
Erimyzon oblongus	creek chubsucker
E. sucetta	lake chubsucker
Hypentelium nigricans	northern hog sucker
Minytrema melanops	spotted sucker
Ictalurus brunneus	snail bullhead
I. catus	white catfish
Ictalurus natalis	yellow bullhead
I. nebulosus	brown bullhead
I. platycephalus	flat bullhead
I. punctatus	channel catfish
Noturus gyrinus	tadpole madtom
N. insignis	margined madtom
N. leptacanthus	speckled madtom
Chologaster cornuta	swampfish
Aphredoderus sayanus	pirate perch
Strongylura marina	Atlantic needlefish
Fundulus chrysotus	golden topminnow
F. lineolatus	lined topminnow
Gambusia affinis	mosquitofish
Labidesthes sicculus	brook silverside
Morone saxatilus	striped bass
Acantharchus pomotis	mud sunfish
Centrarchus macropterus	flier

Robins et al. 1980

Appendix Table 2 (continued).

Scientific and common names of fishes collected from Steel Creek and Meyer's Branch. January 1986 - December 1987.

Elassoma evergladei	Everglades pygmy sunfish
E. zonatum	banded pygmy sunfish
Enneacanthus gloriosus	bluespotted sunfish
Lepomis auritus	redbreast sunfish
L. cyanellus	green sunfish
L. gulosus	warmouth
L. macrochirus	bluegill
L. marginatus	dollar sunfish
L. microlophus	redear sunfish
L. punctatus	spotted sunfish
Micropterus salmoides	largemouth bass
Pomoxis nigromaculatus	black crappie
Etheostoma fricksium	Savannah darter
E. fusiforme	swamp darter
E. hopkinsi	Christmas darter
E. olmstedi	tessellated darter
E. serriferum	sawcheek darter
Perca flavescens	yellow perch
Percina nigrofasciata	blackbanded darter
Mugil cephalus	striped mullet

Appendix Table 3.

Results of principle component analysis for 1986 Steel Creek electrofishing CPUE. Data analyzed were annual means for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

Principle Component	Eigenvalue	Percent of Total Variance
1	2.263	46.63
2	1.470	30.29
3	0.461	9.50

	EIGENVECTORS		
	PC 1	PC 2	PC 3
bowfin	-0.06	0.00	0.00
American eel	0.14	0.16	-0.31
chain pickerel	-0.05	0.03	0.05
shiner(*Notropis* spp.)	-0.36	0.74	-0.26
golden shiner	-0.08	0.14	0.09
creek chubsucker	0.09	0.08	-0.09
lake chubsucker	-0.04	0.01	0.11
pirate perch	0.05	0.13	-0.28
mosquitofish	-0.05	0.06	0.11
brook silverside	-0.11	0.14	0.10
redbreast sunfish	0.27	0.16	-0.03
bluegill	0.85	0.21	-0.06
spotted sunfish	-0.02	0.13	-0.48
largemouth bass	0.09	0.53	0.65
yellow perch	-0.06	0.00	-0.02
blackbanded darter	0.01	0.04	-0.22

Appendix Table 3 (continued).

Results of principle component analysis for 1986 Steel Creek electrofishing CPUE. Data analyzed were annual means for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

Station	COMPONENT SCORES PC 1	PC 2	PC 3
275	1.21	0.29	0.19
280	0.31	-0.38	0.09
285	0.25	-0.45	0.05
290	-0.19	-0.17	-0.06
300	-0.41	0.08	0.25
310	-0.18	0.33	-0.15
320	-0.15	-0.04	0.07
330	-0.26	0.15	0.03
340	-0.22	-0.16	0.17
350	-0.28	-0.18	0.01
360	-0.19	-0.27	-0.02
370	-0.22	-0.20	-0.09
400	0.32	0.28	-0.53

Appendix Table 4.

Results of principle component analysis for 1987 Steel Creek electrofishing CPUE. Data analyzed were annual means for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

Principle Component	Eigenvalue	Percent of Total Variance
1	1.787	43.31
2	1.397	33.86
3	0.363	8.80

	EIGENVECTORS		
	PC 1	PC 2	PC 3
bowfin	-0.04	0.07	0.09
American eel	0.15	-0.17	0.28
chain pickerel	-0.02	0.10	0.15
shiner(*Notropis* spp.)	0.19	0.72	-0.53
golden shiner	0.07	0.43	0.26
creek chubsucker	0.12	0.09	0.07
lake chubsucker	-0.02	0.16	0.13
pirate perch	0.01	0.19	0.33
mosquitofish	0.00	0.26	0.33
brook silverside	-0.03	0.08	0.03
redbreast sunfish	0.32	-0.11	-0.21
bluegill	0.90	-0.11	0.14
spotted sunfish	-0.05	0.24	0.31
largemouth bass	0.02	0.16	0.23
yellow perch	-0.03	0.00	0.05
blackbanded darter	0.04	0.00	-0.30

Appendix Table 4 (continued).

Results of principle component analysis for 1987 Steel Creek electrofishing CPUE. Data analyzed were annual means for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

	COMPONENT SCORES		
Station	PC 1	PC 2	PC 3
275	0.94	-0.41	0.16
280	0.56	0.28	-0.44
285	-0.17	-0.37	-0.01
290	-0.16	-0.30	-0.04
300	0.14	0.41	0.16
310	0.10	0.60	0.26
320	-0.12	0.39	-0.07
330	-0.24	0.24	0.02
340	-0.40	-0.19	0.03
350	-0.38	-0.05	0.02
360	-0.23	-0.20	-0.06
370	-0.21	-0.08	-0.15
400	0.17	-0.31	0.13

Appendix Table 5.

Results of principle component analysis for 1986 Steel Creek ichthyoplankton densities. Data analyzed were mean spawning season (February - July 1986) densities for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

Principle Component	Eigenvalue	Percent of Total Variance
1	4.135	46.58
2	2.048	23.06
3	1.053	11.86
4	0.638	7.18

	EIGENVECTORS			
	PC 1	PC 2	PC 3	PC 4
shad (*Alosa* spp.)	0.54	-0.62	0.25	0.22
American shad	0.12	-0.28	0.11	0.17
pickerel (*Esox* spp.)	0.11	0.17	0.03	-0.07
minnows	-0.02	0.28	-0.15	0.61
ironcolor shiner	0.35	0.08	0.04	-0.32
chubsucker	0.19	0.14	0.08	-0.02
spotted sucker	-0.01	0.00	-0.04	-0.10
pirate perch	0.01	-0.02	0.00	0.02
mosquitofish	0.02	0.20	0.22	0.05
brook silverside	0.08	-0.16	0.12	-0.28
pygmy sunfish	0.40	0.38	0.00	0.30
bluespotted sunfish	0.52	0.40	0.09	-0.23
sunfish (*Lempomis* spp.)	-0.21	0.11	0.80	0.28
darter (*Etheostoma* spp.)	0.20	-0.15	-0.43	0.36

Appendix Table 5 (continued).

Results of principle component analysis for 1986 Steel Creek ichthyoplankton densities. Data analyzed were mean spawning season (February - July 1986) densities for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

	COMPONENT SCORES			
Station	PC 1	PC 2	PC 3	PC 4
275	-0.78	0.07	0.51	0.20
280	-0.63	0.07	0.30	0.06
285	-0.55	0.02	-0.07	0.10
290	-0.08	0.10	-0.18	-0.37
300	0.94	0.88	0.15	-0.03
310	0.83	0.10	-0.18	0.21
320	0.03	0.49	-0.09	0.22
330	0.07	-0.07	0.03	-0.35
340	-0.31	0.02	0.04	0.08
350	-0.16	0.04	0.00	-0.25
360	0.78	-0.73	0.20	-0.01
370	0.51	-0.64	0.10	0.22
400	-0.44	-0.12	-0.74	0.20
640	-0.22	-0.20	-0.06	-0.28

Appendix Table 6.

Results of principle component analysis for 1987 Steel Creek ichthyoplankton densities. Data analyzed were mean spawning season (February - July 1987) densities for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

Principle Component	Eigenvalue	Percent of Total Variance
1	3.738	41.66
2	2.065	23.01
3	1.184	13.20
4	0.728	8.12

	EIGENVECTORS			
	PC 1	PC 2	PC 3	PC 4
shad (*Alosa* spp.)	0.25	0.74	0.13	0.30
American shad	0.07	0.30	0.06	0.17
shad (*Dorsoma* spp.)	-0.04	0.03	0.17	0.03
pickerel (*Esox* spp.)	0.02	-0.02	0.00	-0.01
minnows	0.36	-0.19	0.14	0.45
ironcolor shiner	0.17	0.24	-0.02	-0.01
chubsucker	0.52	-0.40	0.03	0.07
spotted sucker	0.00	0.01	-0.02	-0.01
pirate perch	0.08	-0.07	0.05	0.03
mosquitofish	-	-	-	-
brook silverside	0.05	0.14	-0.03	-0.14
pygmy sunfish	0.38	0.02	0.15	-0.07
bluespotted sunfish	0.48	-0.05	0.14	-0.25
sunfish (*Lepomis* spp.)	-0.28	-0.01	0.71	0.09
redbreast sunfish	-0.02	-0.01	0.02	0.02
warmouth	-0.04	0.05	-0.12	-0.15
spotted sunfish	-0.02	-0.02	-0.06	0.01
crappie (*Pomoxis* spp.)	-0.09	-0.05	0.37	0.04
darters (*Etheostoma* spp.)	0.10	0.23	-0.33	-0.19
darters (*Percina* spp.)	-0.12	-0.13	-0.34	0.71

Appendix Table 6 (continued).

Results of principle component analysis for 1987 Steel Creek ichthyoplankton densities. Data analyzed were mean spawning season (February - July 1987) densities for selected taxa. Values were $\log_e$ transformed prior to analysis. Centered covariance analysis was used.

	COMPONENT SCORES			
Station	PC 1	PC 2	PC 3	PC 4
275	-0.78	-0.10	0.82	-0.01
280	-0.64	-0.11	0.19	0.15
285	-0.41	-0.16	-0.41	0.35
290	-0.23	-0.12	-0.16	0.07
300	1.26	-0.50	0.30	0.17
310	0.68	-0.43	0.02	-0.07
320	-0.19	-0.14	-0.18	-0.15
330	0.03	0.01	-0.04	-0.29
340	0.09	-0.13	-0.13	-0.34
350	-0.23	0.05	-0.07	-0.31
360	0.42	0.87	0.02	0.03
370	0.34	0.84	0.12	0.21
400	-0.21	-0.23	-0.24	0.38
640	-0.15	0.15	-0.24	-0.20

ADDENDUM

Table A-1. Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1986.

	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
Species	275	280	285	290	400	300	310	320
longnose gar	0.1	[a]		1.5			0.6	0.4
bowfin	0.1			1.5	0.5	0.1	0.9	3.0
American eel	1.3			4.4	8.0	0.4	1.9	1.2
blueback herring								
American shad								
herring/shad								
gizzard shad								
redfin pickerel					1.5	0.6	0.6	0.2
chain pickerel	0.1	0.9		5.8		0.4	0.9	1.6
minnow[b]	0.4		2.2	39.7	28.1	73.0	28.8	14.3
golden shiner						1.1	5.3	3.8
creek chubsucker	0.7	15.8	4.4	2.9	3.5	0.6	2.5	2.8
lake chubsucker		2.6				0.2		14.5
northern hog sucker	0.9	3.6	6.7	1.5	2.0			
spotted sucker		3.6	6.7	5.8		0.4	6.9	3.2
yellow bullhead	0.2				1.0	0.1	0.3	0.4
brown bullhead								
flat bullhead		1.7				0.1	0.9	0.2
madtom					2.5			0.6
pirate perch	0.4			1.5	4.5	0.2	4.7	3.8
mosquitofish						0.7		8.3
brook silverside						1.7	3.8	2.6
bluespotted sunfish						0.2	0.3	0.2
redbreast sunfish	5.7	15.8	6.7	17.6	4.5	1.1	5.0	3.0
warmouth					0.5		0.6	0.4
bluegill	78.5	42.1	66.7		24.6	0.4	1.9	2.6
dollar sunfish	0.1						0.3	
redear sunfish						0.2	0.6	0.2
spotted sunfish	0.6	1.7		4.4	7.5		13.8	11.7

[a] Blank indicates no fish collected.
[b] Includes various combinations of minnows and shiners (<u>Notropis</u> spp.).

Table A-1 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1986.

Species	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
	275	280	285	290	400	300	310	320
largemouth bass	10.4	11.4	6.7	8.9	1.5	17.9	14.1	18.3
black crappie	0.1						0.3	
darter	0.2			1.5	3.0			
blackbanded darter	0.2	0.9		1.5	2.5		1.6	1.0
tesselated darter	0.2				3.5	0.1		0.2
yellow perch					0.5		2.5	
other (including rare taxa)	0.1			1.5		0.2	0.6	1.2
Total	100.3	100.1	100.1	100.0	99.7	99.7	99.7	99.7

[c] Primarily juveniles.

Table A-1 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1986.

Species	Steel Creek Swamp				Steel Creek Channel	
	330	340	350	640	360	370
longnose gar	1.6	3.9	1.0	3.8	2.2	0.7
bowfin	3.8	5.0	3.7	8.2	0.6	2.8
American eel	1.0	2.1	2.1	1.1	3.3	0.4
blueback herring					0.6	0.4
American shad				0.4	0.6	0.7
herring/shad						2.1
gizzard shad		1.0		0.8		1.4
redfin pickerel					0.6	1.8
chain pickerel	3.2	3.4	1.7	1.1		3.6
minnow[b]	30.2	14.5	30.4	13.9	35.0	27.3
golden shiner	2.0	3.7	9.1			
creek chubsucker	2.4	2.6	1.3	0.8		0.7
lake chubsucker	2.0	1.8	1.0	0.8		
northern hog sucker			0.4		0.6	
spotted sucker	5.6	15.1	10.5	31.4	4.9	4.6
yellow bullhead	0.2	0.7	0.4	0.8	1.1	
brown bullhead	0.2	0.6				0.4
flat bullhead		0.3		0.8	1.1	0.7
madtom	0.2		0.7	0.4	0.6	0.4
pirate perch	0.5	2.3	0.7	0.8		2.4
mosquitofish	0.6		0.4	0.8	1.1	0.7
brook silverside	2.2	4.4	3.7	3.0	1.1	7.8
bluespotted sunfish		0.3				1.8
redbreast sunfish	1.2	0.6	0.7	1.9	13.6	7.2
warmouth	0.2					0.4
bluegill	1.0	0.3			0.6	0.7
dollar sunfish	0.2					0.4
redear sunfish	0.3	3.1		1.5	0.6	0.4
spotted sunfish	13.5	1.6	5.7	8.2	9.3	14.6
largemouth bass	24.4	21.1	12.2	10.5	14.2	8.5
black crappie	0.2	0.6				0.7
darter	0.6		0.4			0.7

[b] Includes various combinations of minnows and shiners (*Notropis* spp.).

Table A-1 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1986.

	Steel Creek Swamp				Steel Creek Channel	
Species	330	340	350	640	360	370
blackbanded darter	1.9		2.3	1.1	3.3	2.4
tesselated darter						2.4
yellow perch	1.1	9.9	10.1	6.7	1.6	0.7
other (including rare taxa)		1.3	1.7	1.5	3.7	0.4
Total	100.3	100.2	100.2	100.3	100.3	100.2

Table A-2. Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1987.

	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
Taxon	275	280	285	290	400	300	310	320
longnose gar	[a]	0.1	1.3					0.5
Florida gar							0.2	0.2
bowfin				1.2		1.9	0.6	0.5
American eel	1.4		2.7	1.2	21.3	0.2	0.2	0.3
American shad								
gizzard shad			1.3	3.6				
eastern mudminnow						0.5		
redfin pickerel						1.4	0.4	0.8
chain pickerel	0.1		2.7			2.3	1.2	0.7
minnow[b]	1.9	63.2	13.6	19.2	12.1	39.5	38.5	65.8
golden shiner	0.2	1.7		3.6		7.0	12.7	3.7
chubsucker	0.1					0.2	0.6	0.1
creek chubsucker	0.6	1.5	5.4		4.6	2.1	2.0	1.9
lake chubsucker						2.5	1.2	3.3
northern hog sucker	0.2	0.1	7.5		0.9			
spotted sucker	0.2		8.2	9.7		0.7	4.2	2.9
bullhead catfishes		0.3						
snail bullhead								0.1
yellow bullhead		0.8			6.5	1.2	1.0	0.2
brown bullhead						0.5	0.2	0.1
flat bullhead		3.0	1.3		4.6		0.2	
channel catfish								
madtom					0.9			
tadpole madtom								
speckled madtom	0.1							
swampfish						0.5		
pirate perch					4.6	6.5	2.8	1.7
mosquitofish						10.5	3.0	1.8
brook silverside		0.1				2.3	0.8	0.7
mud sunfish								
pygmy sunfish						0.5		0.2
Everglades pygmy sunfish						0.2		

[a] A blank indicates no fish collected.
[b] Includes various combinations of minnows and shiners (*Notropis* spp.).

Table A-2 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1987.

	Steel Creek Corridor				Meyer's Branch	Steel Creek Swamp		
Taxon	275	280	285	290	400	300	310	320
banded pygmy sunfish						0.2		
bluespotted sunfish						0.9	0.2	
unid. sunfish							1.2	0.2
hybrid sunfish		0.1						
redbreast sunfish	2.7	5.8	19.0	10.8	12.1	3.7	0.6	0.8
warmouth						0.7	0.4	
bluegill	90.7	19.4	16.3	19.2	21.3	10.2	7.7	3.3
dollar sunfish					0.9			
redear sunfish							0.2	0.2
spotted sunfish		0.3	2.7		7.4	0.9	9.3	3.5
largemouth bass	1.8	1.1	10.2	20.5		2.8	8.9	5.9
black crappie							0.4	0.2
tesselated darter					0.9			
yellow perch	0.1	0.1			0.9		0.8	
blackbanded darter	0.1	2.4	7.5	9.7	0.9		0.4	0.3
darter				1.2				0.4
striped mullet							0.2	
unknown								
Total	100.2	100.0	99.7	99.9	99.9	99.9	100.1	100.3

Table A-2 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek. January - December 1987.

Taxon	Steel Creek Swamp			Steel Creek Channel	
	330	340	350	360	370
longnose gar		6.4		1.1	
Florida gar					0.3
bowfin	3.1	2.6	2.6	0.4	0.8
American eel	0.3	0.5	1.3	1.1	0.6
American shad				9.7	1.1
gizzard shad		2.1			0.3
eastern mudminnow					0.3
redfin pickerel	0.3		0.7	0.4	
chain pickerel	2.0	0.9	4.3		1.1
minnow[b]	47.5	28.5	37.1	38.8	56.0
golden shiner	5.5	3.8	4.3		
chubsucker			0.4	0.4	
creek chubsucker	1.8	3.4	2.0		
lake chubsucker	2.0	1.2	2.3		
northern hog sucker					0.3
spotted sucker	5.1	13.2	5.3	5.5	4.3
bullhead catfishes	0.2	0.5	0.4	0.4	
snail bullhead					
yellow bullhead	0.8	1.7	0.4		
brown bullhead					
flat bullhead				0.8	
channel catfish				0.4	0.6
madtom					
tadpole madtom		0.5			
speckled madtom				0.4	
swampfish			1.0		
pirate perch	0.9	0.5	2.3	0.4	0.8
mosquitofish	2.3	0.9	3.7	0.8	
brook silverside	0.8	2.9	5.1		7.4
mud sunfish					0.3
pygmy sunfish				0.4	
Everglades pygmy sunfish					

[b]Includes various combinations of minnows and shiners (Notropis spp.).

Table A-2 (continued). Relative abundance of adult and juvenile fishes at sample stations in Steel Creek, January - December 1987.

	Steel Creek Swamp			Steel Creek Channel	
Taxon	330	340	350	360	370
banded pygmy sunfish					
bluespotted sunfish					0.3
unid. sunfish	0.3	0.5	0.4		
hybrid sunfish					
redbreast sunfish	0.4		0.4	7.5	3.7
warmouth	0.2				
bluegill	2.7	0.9	1.3	11.0	8.0
dollar sunfish					
redear sunfish	0.3			0.4	
spotted sunfish	8.6	2.6	6.7	4.4	4.5
largemouth bass	11.5	19.1	9.7	11.0	4.8
black crappie	0.3				
tesselated darter					0.3
yellow perch	0.9	6.7	6.4	1.6	0.6
blackbanded darter	2.1	0.9	2.0	2.4	1.7
darter					
striped mullet				0.8	1.4
unknown					0.3
Total	99.9	100.3	100.1	100.1	99.8

Table A-3. Relative abundance of ichthyoplankton at sample stations at Steel Creek. February - July 1986.

	Corridor				Swamp			
Taxa	275	280	285	290	300	310	320	330
unid. herring/shad								
blueback herring					1.3	14.0		10.5
American shad								
pickerel				1.6	2.0	0.6		1.6
other minnow	2.5	7.5	22.7	22.3	4.0	3.7	15.4	1.6
ironcolor shiner			2.2	1.6	7.8	8.3	1.0	14.2
chubsucker			2.2	6.9	3.9	1.0		1.3
spotted sucker			2.2					
redhorse					1.1			
pirate perch								
mosquitofish	2.0	2.5	1.3		2.2	0.6		
brook silverside		2.8			0.3	2.4		15.4
pygmy sunfish				2.7	13.8	28.2	11.4	5.3
bluespotted sunfish		1.9	2.2	25.0	56.6	18.9	41.5	24.8
sunfish (<u>Lepomis</u> spp.)	95.3	76.2	57.3	20.2	3.6	4.4	23.4	20.9
redbreast sunfish[a]								
warmouth[a]								
spotted sunfish[a]								
largemouth bass				2.1				
darter (<u>Etheostoma</u> spp.)			5.3	10.1	0.7	15.7	5.5	2.1
unknown	0.2	9.1	4.7	7.4	2.6	2.1	1.7	2.1
Total	100.0	100.0	100.1	99.9	99.9	99.9	99.9	99.8

[a]These taxa grouped under sunfish in 1986.

Table A-3 (continued). Relative abundance of ichthyoplankton at sample stations at Steel Creek. February - July 1986.

	Swamp (continued)			Channel		Meyer's Branch
Taxa	340	350	640	360	370	400
unid. herring/shad				0.4	1.4	
blueback herring		2.2	7.9	73.0	50.3	
American shad				2.0	8.2	
pickerel						
ironcolor shiner	1.6	12.8	4.3	2.9	5.2	
other minnow	5.2	6.7	1.4	0.1	2.2	46.9
chubsucker				0.8	0.6	
spotted sucker					0.3	
redhorse					0.5	
pirate perch					0.3	
mosquitofish		3.9				
brook silverside	18.6	14.0	19.3	2.5	1.6	
pygmy sunfish	8.5	1.7		1.2	1.3	
bluespotted sunfish	2.3	20.1	17.1	6.3	5.3	
sunfish (Lepomis spp.)	53.1	30.2	31.4	3.7	9.6	1.8
redbreast sunfish[a]						
warmouth[a]						
spotted sunfish[a]						
largemouth bass				0.4		
darter (Etheostoma spp.)	10.7	4.5	7.9	3.1	8.5	48.1
unknown		3.9	10.7	3.5	4.7	3.2
Total	100.0	100.0	100.0	99.9	100.0	100.0

[a] These taxa grouped under sunfishes in 1986.

Table A-4. Relative abundance of ichthyoplankton at sample stations at Steel Creek. February - July 1987.

	Corridor				Swamp			
Taxa	275	280	285	290	300	310	320	330
longnose gar						0.6		
unid. herring/shad								
blueback herring					0.7			
American shad								
shad (*Dorosoma* spp.)	3.6							
pickerel						0.8		
ironcolor shiner			1.8	11.2	1.0	2.1		13.9
other minnow	0.6	2.1	1.3		14.5	9.6		3.0
chubsucker			4.4	16.3	34.2	53.3	9.8	5.0
spotted sucker								
pirate perch					0.8	0.6		
brook silverside				3.6		0.6		16.9
pygmy sunfish					13.9	2.3		3.0
bluespotted sunfish				3.1	25.6	8.6	12.8	19.9
sunfish (*Lepomis* spp.)	79.7	33.3		4.6				
redbreast sunfish		3.5						
warmouth			1.8	3.6				
spotted sunfish			1.8				6.1	
other sunfishes	1.1	2.1		2.0	4.0	2.6	2.4	
crappie	12.0	4.3			0.3			
darter (*Etheostoma* spp.)		3.5	8.0	7.1	0.5	4.9	12.2	4.5
blackside darter		16.3	58.7	17.9	0.7		4.9	
unknown	3.1	34.8	22.2	30.6	3.9	13.9	51.8	33.8
Total	100.1	99.9	100.0	100.0	100.1	99.9	100.0	100.0

Table A-4 (continued). Relative abundance of ichthyoplankton at sample stations at Steel Creek. February - July 1987.

	Swamp (continued)			Lower Channel		Meyer's Branch
Taxa	340	350	640	360	370	400
longnose gar						
unid. herring/shad					1.9	
blueback herring			1.7	62.3	41.8	
American shad				1.4	13.5	
shad (<u>Dorosoma</u> spp.)					1.1	
pickerel						
ironcolor shiner		4.8	5.6	5.0	9.1	
other minnow		3.2	1.7	1.3	4.2	42.4
chubsucker	25.3		1.3	2.5	1.3	6.6
spotted sucker				0.3		3.3
redhorse						
pirate perch						
brook silverside			1.3	3.0	0.8	
pygmy sunfish	10.8	11.1	7.2	2.8	5.7	
bluespotted sunfish	18.4	11.9	2.8	6.3	5.9	
sunfish (<u>Lepomis</u> spp.)		4.0		0.3	1.1	
redbreast sunfish						
warmouth		23.8	6.5	0.3	0.4	
spotted sunfish						
other sunfishes	7.0		1.3	1.3		
crappie						
darter (<u>Etheostoma</u> spp.)	38.6	22.2	28.6	11.3	8.6	14.6
blackside darter			2.5	0.3	1.1	28.5
unknown		19.0	39.5	1.6	3.4	4.6
Total	100.1	100.0	100.0	100.0	99.9	100.0

Table A-5.- Relative abundance of fishes (collected by electrofishing) in the Steel Creek corridor, swamp, and channel, and Meyer's Branch before and after (1986 and 1987) the re-start of L-Reactor.

Taxa	Corridor			Swamp			Channel			Meyer's Branch		
	pre	1986	1987	pre	1986	1987	pre	1986	1987	pre	1986	1987
longnose gar		0.6	0.1	2.0	1.2	0.4		0.7				
Florida gar		0.6					0.6		0.3			
bowfin		0.6	0.1	3.1	2.3	1.1	8.1	2.8	0.9		0.2	
American eel	3.9	1.7	0.1	1.5	1.7	0.3		0.4	0.6	16.2	8.9	18.0
unid. herring/shad								2.1				
blueback herring								0.4				
American shad								0.7	1.1			
gizzard shad			0.4	0.4	0.1	0.1	0.8	1.4	0.3			
eastern mudminnow	0.2								0.3			
redfin pickerel	0.8			3.8	0.3	0.4	5.8	1.8		2.5	1.6	0.9
chain pickerel	0.2	2.8			1.7	1.4	1.2	3.5	1.1	0.1		
minnow[a]	43.0	14.8	58.8	39.1	25.7	44.5	3.1	26.8	55.5	47.1	25.7	16.7
golden shiner			1.9	3.2	4.7	9.1						
chubsucker	0.4	12.6	1.3	3.7	5.1	4.2		0.7		0.8	3.0	2.6
northern hog sucker	1.3	2.8	0.1						0.3	0.2	1.1	0.4
spotted sucker	0.8	4.4	1.0	4.7	7.3	4.5	7.0	4.6	4.3	0.1	0.2	
redhorse							0.8				0.2	
unid. bullhead	<0.1		0.2									
yellow bullhead	1.0		0.7		0.2	0.6				0.2	1.4	10.3
brown bullhead	0.2							0.4		1.1		
flat bullhead	0.5	1.1	2.7		0.5	0.1		0.7		0.6	0.5	3.0
snail bullhead							0.8					
channel catfish							1.7		0.6			0.4
unid. madtom											1.6	0.9
tadpole madtom	0.8									0.4		0.4
margined madtom	0.3											
speckled madtom	3.0							0.4		3.7	0.5	0.9

[a] Includes various combinations of minnows and shiners.

Table A-5 (continued). Relative abundance of fishes (collected by electrofishing) in the Steel Creek corridor, swamp, and channel, and Meyer's Branch before and after (1986 and 1987) the re-start of L-Reactor.

Taxa	Corridor			Swamp			Channel			Meyer's Branch		
	pre	1986	1987	pre	1986	1987	pre	1986	1987	pre	1986	1987
swampfish	0.3											
pirate perch	7.1	0.6		3.4	3.3	2.2	1.7	2.5	0.9	8.8	3.9	2.6
Atlantic needlefish								0.4				
lined topminnow					<0.1							
mosquitofish	3.7			1.1	1.2	2.6		0.7		0.1		
brook silverside	0.1		0.1	10.7	3.4	1.1	3.1	7.8	7.4			
unid. sunfish			0.1									
mud sunfish						0.7			0.3	0.1	0.2	
flier										0.1		
banded pygmy sunfish											0.2	
bluespotted *sunfish*	<0.1						0.8	1.8	0.3			
redbreast sunfish	4.3	16.5	6.3	0.2	3.3	0.6	13.0	7.1	3.7	1.9	5.2	12.8
warmouth							0.8	0.4			0.5	
bluegill		26.4	19.4		1.5	5.5	1.7	0.7	8.0		28.0	18.0
dollar sunfish	0.5							0.4				0.4
redear sunfish				0.3	0.6	0.1	0.8	0.4				
spotted sunfish	11.4	2.8	0.2	10.5	11.6	7.6	26.0	14.5	4.6	3.6	8.0	5.6
largemouth bass	3.0	10.4	3.0	9.5	17.0	9.2	13.8	8.5	4.9	0.7	0.9	
black crappie								0.7				
unid. darter		0.6						0.7			2.7	
Savannah darter	0.3		0.1							1.4		
swamp darter	<0.1											
Christmas darter											0.2	
tesselated darter	9.7							2.5	0.3	7.9	3.2	1.7
sawcheek darter	0.1											
yellow perch	<0.1		0.1	1.4	3.1	1.1	4.8	0.7	0.6		0.2	0.4
blackbanded darter	3.2	1.1	3.1	1.0	1.4	0.7	0.8	2.5	1.7	2.2	1.8	4.3
striped mullet					<0.1	0.1			1.4			
other				0.6	2.4	1.8	2.9		0.3			
Total	100.1	100.4		100.2	99.6	100.0	100.1	99.7	99.7	99.8	99.9	100.3

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