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SHEARON HARRIS NUCLEAR POWER PLANT
1989 ANNUAL ENVIRONMENTAL MONITORING REPORT

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CAROLINA POWER & LIGHT COMPANY

NEW HILL, NORTH CAROLINA

September 1990

Reviewed and Approved by:

Manager
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Environmental Assessment Unit

This report was prepared under my supervision and direction, and I accept full responsibility for its content.

Manager
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This copy of the report is not a controlled document as detailed in the *Biological Monitoring Unit, Biological Assessment Unit, and Environmental Assessment Unit Procedures Manual and Quality Assurance Manual.* Any changes made to the original of this report subsequent to the date of issuance can be obtained from:

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Acknowledgments

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Table of Contents

List of Appendices

List of Appendices (continued)

Metric-English Conversion and Units of Measure

Length

1 micron (μm) = 4.0×10^{-5} inch
1 millimeter (mm) = 1000 μm = 0.04 inch
1 centimeter (cm) = 10 mm = 0.4 inch
1 meter (m) = 100 cm = 3.28 feet
1 kilometer (km) = 1000 m = 0.62 mile

Area

1 square meter (m^2) = 10.76 square feet
1 hectare = 10,000 m^2 = 2.47 acres

Weight

1 microgram (μg) = 10^{-3} mg or 10^{-6} g = 3.5×10^{-8} ounce
1 milligram (mg) = 3.5×10^{-5} ounce
1 gram (g) = 1000 mg = 0.035 ounce
1 kilogram (kg) = 1000 g = 2.2 pounds
1 metric ton = 1000 kg = 1.1 tons
1 kg/hectare = 0.89 pound/acre

Volume

1 milliliter (ml) = 0.034 fluid ounce
1 liter (l) = 1000 ml = 0.26 gallon
1 cubic meter (m^3) = 35.3 cubic feet

Temperature

Degrees Celsius (°C) = 5/9 (°F - 32)

Conductivity

Microsiemens/centimeters = μS/cm = μmhos/cm

Turbidity

NTU = Nephelometric Turbidity Unit

INTRODUCTION

The Shearon Harris Nuclear Power Plant (SHNPP) circulating and cooling tower makeup water systems began testing operations in January 1987, and the plant began commercial operation in May 1987. The nonradiological environmental monitoring program continued during 1989 to support the Environmental Protection Plan for SHNPP. The program included investigations of the water quality, water chemistry, phytoplankton, benthic macroinvertebrates, fish, and vegetation of the 1660-hectare Harris Lake (Appendices 1-4). Wildlife management activities were conducted on the surrounding lands.

"Key indicators" of the environmental quality of Harris Lake were evaluated during 1989, and appropriate supporting data summaries and statistical results are attached (Appendices 5-26).

SUMMARY OF KEY ENVIRONMENTAL INDICATORS

Water Quality

(Appendices 6-8)

- The thermal characteristics of Harris Lake included one period of complete water column mixing (monomictic) during the winter and a period of thermal stratification producing distinct temperature strata in the main reaches of the lake during the summer. Stratification was observed during May, July, and September 1989, with a well-defined thermocline ranging between 2 and 9 m depending on station and month.

- Harris Lake surface waters were well oxygenated throughout the year with oxygen saturation exceeding 100 percent at all stations (E2--105%; H2--112%; P2--116%; and S2--115%) during September. Portions of the deeper water strata (metalimnion and hypolimnion) exhibited near anoxic conditions

(dissolved oxygen concentration < 1.0 mg/liter) during May, July, and September. Reservoirwide annual mean surface dissolved oxygen concentrations increased during 1989 over those of 1987, probably as a result of oxygen additions from photosynthesis by increased phytoplankton populations.

- The 1989 specific conductance values were significantly higher than values observed prior to plant operation (1985 and 1986). An increase in precipitation, which contributed to lake water ion concentration dilution and ion flushing from the lake, was reflected in slightly lower specific conductance values during 1989 than in 1988.

- The pH of the lake surface water ranged from 5.9 to 7.9 and remained relatively constant with depth. Surface pH values exhibited no statistically significant spatial or temporal trends.

- Secchi disk transparencies were similar in the main reaches of the lake (Stations E2, H2, and P2). Transparencies were generally less in the headwaters (Station S2) due to the greater quantities of dissolved and suspended matter introduced with stream inflows.

Water Chemistry

(Appendices 7 and 9-14)

- Mean annual anion and cation (except magnesium) concentrations in surface waters exhibited no statistically significant reservoirwide spatial differences. Mean annual magnesium concentrations were significantly higher at Stations E2 and P2 than at Stations H2 and S2. The mean annual magnesium concentration in bottom waters at Station E2 was significantly higher than the concentration in surface waters at Station E2. This greater concentration of magnesium reflected resuspension of magnesium from the sediments during

anoxic conditions. All other mean anion and cation concentrations did not vary significantly between surface and bottom waters at Station E2.

- Temporal trends indicated anion and cation (except calcium) concentrations were generally higher during 1988 and 1989 than those concentrations during 1985 through 1987. All 1989 anion and cation (except magnesium) concentrations were slightly lower than 1988 levels reflecting increased precipitation resulting in dilution of ion concentrations in the lake water.

- Calculated hardness, a function of calcium and magnesium concentrations, exhibited no statistically significant spatial trends. Reservoirwide calculated hardness was lower during 1989 than in 1988 and similar to 1987 values. These temporal changes may be related to variations in precipitation and the inverse relationship which may exist between precipitation and ion concentrations.

- Reservoirwide total alkalinity declined from 1988 to 1989, while the 1989 annual mean concentration was similar to the 1987 mean. Variations in total annual precipitation may partially explain these temporal differences since during the relatively wet years of 1987 and 1989, alkalinity declined, and during a somewhat drier year (1988), alkalinity increased.

- With the exception of total solids which were significantly higher at the bottom of Station E2 compared to the surface at Station E2, no significant spatial trends were apparent for total solids, total suspended solids, or total organic carbon concentrations. Likewise, there were no significant spatial trends for turbidity. Reservoirwide total organic carbon annual mean concentrations were higher during 1989 than during 1986 through 1988, possibly due to increased phytoplankton abundance. Turbidity in 1989 was higher than during 1988 but was similar to 1986 and 1987 values.

- Surface water annual mean total nitrogen concentrations were similar at all stations during 1989. The decomposition of biogenic materials below the thermocline and nitrogen resuspension from the sediments during anoxic conditions was reflected in significantly higher total nitrogen concentrations in the bottom waters than in surface waters at Station E2. The 1989 reservoirwide annual mean total nitrogen concentration was similar to that of 1988 but was significantly higher than either the 1985 or 1986 annual mean concentrations.

- Total phosphorus concentrations were significantly higher in the surface waters at Station E2 than at any other station. Although resuspension of phosphorus from the sediments during anoxic conditions increased the phosphorus concentrations of bottom waters at Station E2, there was no significant difference between concentrations in bottom and surface waters. Reservoirwide total phosphorus concentrations were significantly higher during 1989 than during previous years. This increase was related to the zinc phosphate contained in the cooling tower blowdown which was discharged near Station E2. The amount of phosphorus discharged peaked during June and July then declined to lower levels for the remainder of the year.

- With a few exceptions, annual mean surface water trace element concentrations were below or near laboratory reporting limits. One exception was surface water aluminum concentrations which were significantly higher in the headwaters (Station S2) as compared to Station E2. Concentrations at Stations H2 and P2 were intermediate. Annual mean aluminum concentrations increased during 1989 at Stations H2 and P2 compared to 1988. The higher concentrations at Stations H2 and P2 influenced the 1989 reservoirwide annual mean aluminum concentration which was significantly higher than concentrations during 1987 or 1988. The annual mean aluminum concentration in the bottom waters during 1989 was higher (but not significantly different) compared to the surface waters at Station E2. This

difference in aluminum concentrations reflected resuspension of aluminum into bottom waters during anoxic conditions.

- Station E2 bottom water concentrations of mercury were significantly higher than surface water concentrations. These higher concentrations in the bottom waters appeared to be related to resuspension of mercury during anoxic conditions. Surface water copper and zinc concentrations were above laboratory reporting limits, but in both cases, concentrations in 1989 were similar to those values observed in 1988.

- All surface water trace element concentrations, with the possible exception of mercury, were below the specified North Carolina Water Quality Standards and Action Levels (CP&L laboratory reporting limit for mercury was 0.05 μg/liter and the N.C. Water Quality Standard was 0.012 μg/liter).

Phytoplankton (Algae)

(Appendix 15)

- Seasonal changes of total biomass (estimated by chlorophyll *a* concentrations) were evident at all stations (E2, H2, P2, and S2). At each station, chlorophyll *a* concentrations peaked during May and then declined. Peak chlorophyll *a* concentrations occurred when the water temperature, day length, and biologically available macronutrients (particularly phosphorus) were most favorable for algal growth.

- During 1989, the magnitude of the peak chlorophyll *a* concentration for each station increased relative to previous years. The increased peak concentrations of chlorophyll *a* probably indicated increased biologically available phosphorus. These peaks contributed to increased annual mean chlorophyll *a* concentrations. The 1989 means were 5%, 75%, and 134% higher than 1988 values at Stations E2, H2, and P2, respectively. Differences

among annual mean concentrations could not be tested because of significant year/transect interactions.

- The maximum chlorophyll *a* concentrations in Harris Lake during 1989 were high compared to maximum concentrations in other Carolina Power & Light Company piedmont impoundments (e.g., Hyco Reservoir and Mayo Reservoir) but similar to concentrations reported for the nearby highly productive Jordan Lake (Weiss and Francisco 1984).

- Spatial variation in annual mean chlorophyll *a* concentrations included lower values upstream of the State Road 1127 bridge (Station S2--22.9 μg/liter) and near the main dam (Station E2--23.1 μg/liter) and relatively higher values in the two main arms of the lake (Station H2--37.8 μg/liter and Station P2--39.8 μg/liter)(Appendix 3). During 1987 and 1988, the annual mean chlorophyll *a* concentrations at Station H2 were higher than the concentrations at Station P2. Due to an increase in chlorophyll *a* concentrations at Station P2, the 1987 and 1988 spatial pattern did not recur, rather the 1989 mean chlorophyll *a* concentrations were similar at Stations P2 and H2.

- Although an explanation for the 1989 spatial variation in chlorophyll *a* concentrations was not apparent, possible contributory factors included (1) wind-induced phytoplankton clumping; (2) spatial variability in biologically available macronutrients; or (3) spatial differences in phytoplankton abundance due to variability in the rate phytoplankton settled from the optimal light zone or the rate at which they were consumed by predators.

Benthic Macroinvertebrates

- Monitoring for Asiatic clams *Corbicula fluminea* was conducted in Harris Lake, the intake canals, the intake structure, and the auxiliary reservoir during April and October 1989.

- Asiatic clams were found during the October sampling at Harris Lake at Station P2 (Holleman's boat ramp) and Station E2 (NC 42 boat ramp). Organism densities were $57/m^2$ at Station P2 and $14/m^2$ at Station E2.

- No Asiatic clams were found in the intake structures, the intake canals, or the auxiliary reservoir.

- The 1989 Asiatic clam distribution and density did not pose a threat to Shearon Harris Nuclear Power Plant operations.

Fisheries

(Appendices 16-25)

- Species composition during 1989 (19 species representing 6 families) was similar to the composition observed during previous years (1985 and 1987) when boat electrofisher was the only sampling gear used. No previously uncollected species were found.

- Gizzard shad, bluegill, and largemouth bass continued to dominate the fish community. Threadfin shad, which were introduced during 1988, overwintered successfully and were collected in moderate numbers.

- Catch rates increased during 1989 for gizzard shad, bluegill, pumpkinseed, redear sunfish, largemouth bass, and black crappie. Higher catch rates were attributed primarily to increased boat electrofisher catch success around newly

constructed beaver lodges in Areas S and V. Fish typically seek refuge and concentrate around beaver lodges making them more susceptible to collection by the boat electrofisher. Brown bullhead catch rates decreased in 1989. However, this species has shown wide variations in catch rates from year to year in Harris Lake.

- Length-frequency distributions indicated good recruitment for most species. The number of intermediate and large fish increased for bluegill, redear sunfish, largemouth bass, and black crappie providing better fishing opportunities for anglers. There was a slight increase in the number of brown bullhead larger than 275 mm. Similar to 1988, the number of pumpkinseed greater than 150 mm decreased. Gizzard shad length-frequency distribution was similar to previous years except the number of young-of-year fish increased during 1989. Only three channel catfish (which were stocked during 1985) were collected during 1989. These channel catfish ranged from 461 mm to 558 mm indicating good growth since their introduction.

- The Harris Plant has had no detectable impact on the fish community in Harris Lake.

Wildlife Management

- Wildlife management activities were conducted to monitor the Greentree Reservoir and the wood duck and bluebird nest boxes. No systematic terrestrial vertebrate sampling was conducted during 1989.

- Beavers constructed a large dam in the spillway of the Greentree Reservoir in the summer of 1988. The pond remained flooded during the winter and provided the intended waterfowl habitat. The dam was destroyed as a result of the flow from heavy rains during the spring of 1989 and beavers did not recolonize the area during the remainder of 1989. Due to the poor condition

of the access road, it was not possible to haul in stoplogs and the greentree basin was not impounded during the fall of 1989.

- The wood duck nest boxes were checked once during the spring of 1989 for nesting activity. At least 25 (61% occupancy) wood duck nests had been initiated with evidence that young hatched successfully in 17 (68%) nests. For the first time since 1984 when the boxes were first placed in Harris Lake, evidence of nest predation was noted when a black rat snake was found in one box. Due to the high water level, the predator shield was only an inch or two above water which allowed the snake to access the box.

- During October 1989, 30 of the original 45 wood duck nest boxes (15 wooden and 15 light plastic bucket boxes) were removed from Harris Lake and replaced with 45 new wooden boxes. The 15 "Tom Tubbs" plastic boxes obtained from the Minnesota Waterfowl Association were left in place since they were still in good condition. However, the exteriors of these boxes were painted with a gray primer since there was some concern that their dark color made the interior temperature too high for the ducks nesting later in the spring. A total of 60 boxes was then present in three arms of Harris Lake (Little White Oak, Cary, and White Oak creek arms).

- Bluebird nest boxes were checked periodically to clean and remove old nests during the spring and summer of 1989. Boxes continued to be used regularly by bluebirds.

- The red-cockaded woodpecker colony site was checked during July 1989. No signs of activity were noted on the cavity trees or cavity starts associated with this colony site and no woodpeckers were observed.

Aquatic Vegetation

(Appendix 26)

- Harris Lake continued to support moderate to large quantities of submersed vegetation during 1989. Dominant species were pondweed *Potamogeton berchtoldii*, spike-rush *Eleocharis baldwinii*, and naiad *Najas minor*. These grew in almost all areas of the lake where water depth was approximately 3 m deep or less.

- Hydrilla *Hydrilla verticillata*, a potentially problematic submersed species, also occurred in the lake. Hydrilla grew in an area covering approximately 30 ha upstream and downstream from the SR 1127 causeway and bridge over the White Oak Creek arm of the lake. The application of a registered aquatic herbicide during the spring did not arrest the growth and spread of this species. Although impacts to power plant operations are not expected to result from the presence of hydrilla, it has the potential to spread to all areas of the lake less than 3-4 m deep and impact recreational activities and alter other biological components.

- Floating-leaf vegetation in the lake consisted of water shield *Brasenia schreberi*, lotus *Nelumbo lutea*, and water-lily *Nymphaea odorata*. These species grew in shallow (up to 2 m deep) water around the perimeter, primarily in the White Oak Creek arm.

- Emergent vegetation grew in a band approximately 2 m wide around most of Harris Lake. Dominant species were cat-tail *Typha latifolia*, rush *Juncus effusus*, bulrushes *Scirpus atrovirens* and *S. cyperinus*, and creeping water primrose *Ludwigia uruguayensis*.

- The auxiliary reservoir supported small quantities of submersed vegetation dominated by naiad, pondweed *Potamogeton diversifolius*, and musk grass

Chara sp. Floating-leaf vegetation was absent and emergent vegetation consisted of the same species that grew around the main lake.

CONCLUSIONS

- Harris Lake continued to be warm and well oxygenated with a relatively low degree of mineralization and low concentrations of dissolved ions as is typical for most southeastern United States piedmont reservoirs. Statistically significant spatial or temporal trends in most water quality and chemistry variables were not apparent. Temporal changes in specific conductance, alkalinity, and anion/cation concentrations in surface waters appeared to be related to dilution from increased precipitation during 1989. Higher bottom versus surface concentrations of various ions and trace elements at Station E2 reflected the resuspension of these constituents during anoxic conditions. Macronutrient concentrations, particularly total phosphorus, increased in 1989 due to phosphorus additions from power plant blowdown effluents. This increase was sufficient to increase lake chlorophyll *a* concentrations.

- Chlorophyll *a* concentrations peaked during May 1989. These peak concentrations were greater than peak concentrations observed during previous years. The 1989 peak chlorophyll *a* concentrations were higher than concentrations observed in other Carolina Power & Light Company piedmont impoundments which have been categorized as low to moderately productive. Spatial differences in annual mean chlorophyll *a* concentrations included relatively low concentrations at Stations E2 and S2 and high concentrations at Stations H2 and P2.

- Although Asiatic clams were found in Harris Lake during 1989, none were found in the auxiliary reservoir, intake structures, or intake canals. Harris Plant operations were not threatened by Asiatic clams at this time.

- An abundant fishery existed at Harris Lake with gizzard shad, bluegill, and largemouth bass dominating the fish community. Increases in larger sport fish (i.e., largemouth bass and bluegill) provided anglers with excellent fishing opportunities. The Harris Plant had little or no measurable impact on the fish population in the lake.

- Harris Lake continued to support moderate to large amounts of submersed aquatic vegetation in almost all areas less than 3 m deep. The dominant species were pondweed and naiad. The auxiliary reservoir supported small quantities of submersed and no floating-leaf vegetation. Hydrilla, first observed in the lake in 1988, has spread to cover about 30 ha in the White Oak Creek arm. This species was expected to expand in coverage to dominate the existing submersed species and might cover as much as 45% of the lake surface area. Hydrilla was not observed in the auxiliary reservoir. Although no impacts to power plant operations were expected because of the low water intake velocities and quantities, impacts to recreation and other biological components may occur in the future.

- Harris Lake appeared typical of many impoundments in the southeastern United States--shallow, warm, and well oxygenated with moderately high productivity. It is common for such waters to contain an excellent sport fishery and for the littoral zone to support large amounts of aquatic vegetation. Also, the presence of Asiatic clams in lakes and reservoirs is becoming increasingly common throughout the southeast.

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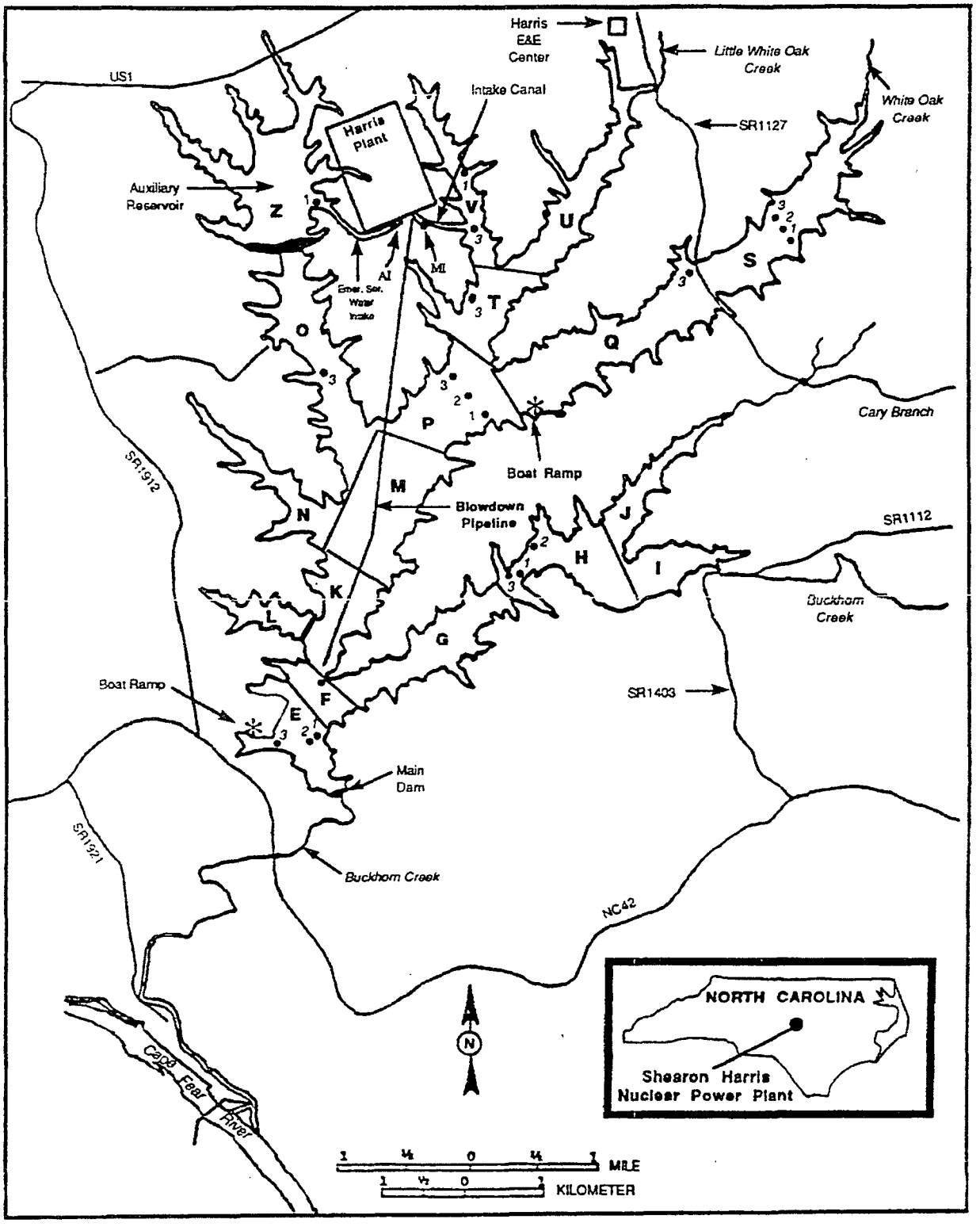
Appendix 1. Harris Lake environmental monitoring program for 1989.

Program	Frequency	Location
Water quality (temperature, DO, pH, specific conductance, Secchi disk transparency)	Alternate months (Jan, Mar, May, Jul, Sep, Nov)	E2, H2, P2, S2 (surface to bottom at 1-m intervals)
Water chemistry	Alternate months (Jan, Mar, May, Jul, Sep, Nov)	E2 (surface and bottom); H2, P2, S2 (surface)
Plankton (phytoplankton and chlorophyll)	Alternate months (Jan, Mar, May, Jul, Sep, Nov)	E2, H2, P2, S2
Benthic invertebrates		
Shoreline *Corbicula* survey	Once per year (Oct)	E3, H1, O3, P1, Q3, T3
Emergency service water and cooling tower makeup systems *Corbicula* survey	Twice per year (Apr, Oct)	Emergency service water and cooling tower makeup system intake structures
Intake canal *Corbicula* survey	Twice per year (Apr, Oct)	V3, Z1, MI, AI (3 samples per station)
Fisheries		
Electrofisher	Once every three months (Feb, May, Aug, Nov)	E1, E3, H1, H3, P1, P3, S1, S3, V1, V3
Troublesome aquatic vegetation survey	Spring, summer, fall	I, E, P, Q, S, V, Z
Wildlife program maintenance	As needed	Wildlife Management Areas

Appendix 2. Harris Lake environmental monitoring program changes from the 1988 study plan to the 1989 study plan.

Program	Change(s)
Water quality and chemistry	Station S2 added
Chlorophyll	Station S2 added
Plankton	Phytoplankton to be collected but not identified unless needed to assess bloom conditions
	Zooplankton sampling discontinued
Benthic macroinvertebrates	Ponar sampling at E1, H1, and P1 discontinued
Shoreline *Corbicula* survey	Stations MI and AI discontinued
Intake canal *Corbicula* survey	Frequency reduced from alternate months to twice per year
	Stations MI and AI added
Fisheries	Larval fish sampling discontinued
	Rotenone sampling discontinued



Appendix 3. Harris Lake sampling areas and stations for 1989.

Appendix 4. References for field sampling and laboratory methods followed in the 1989 Harris Lake environmental monitoring program.

Program	References
Water Quality	CP&L (1987), CP&L (1990)
Water Chemistry	USEPA (1979), APHA (1986), CP&L (1990)
Phytoplankton	CP&L (1984a), CP&L (1984b)
Benthic Macroinvertebrates	CP&L (1986), CP&L (1990)
Fisheries	CP&L (1987)
Aquatic Vegetation	CP&L (1985)
Wildlife Management	CP&L (1985)

Appendix 5. Statistical analyses performed on data collected in the 1989 Harris Lake environmental monitoring program.

Program	Variable	Statistical test/model‡	Main effect(s)	Interaction term
Water quality	Specific conductance, Secchi disk transparency	Two-way, block on month	Station, year	Station-by-year
Water chemistry	Chemical variables	Paired t-test	Station: surface vs bottom	
		Two-way, block on month	Station, year	Station-by-year
Phytoplankton	Chlorophyll *a*	Two-way, block on month	Station, year	Station-by-year

‡Statistical tests used were analysis of variance (ANOVA) one-way and two-way models and paired t-tests (water chemistry program only). A Type I error rate of 0.5% ($\alpha = 0.05$) was used to judge the significance of all tests. For the ANOVA models, Fisher's protected least significant difference (LSD) test was applied to determine where differences in means occurred.

Appendix 6. Water quality data collected from Harris Lake during 1989.

January 10, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	8.3	8.2	8.0	8.0	10.4	9.9	10.5	10.3	7.1	7.1	7.3	7.2	83	76	79	74	1.7	1.5	1.7	1.3
1.0	8.3	8.2	8.0	8.0	10.5	9.9	10.7	10.2	7.1	7.1	7.3	7.2	83	74	78	74	.	.	.	.
2.0	8.3	8.2	8.0	8.0	10.5	10.0	10.8	10.2	7.1	7.0	7.3	7.2	84	73	78	74	.	.	.	.
3.0	8.3	8.2	8.0	8.0	10.5	10.0	10.7	10.2	7.1	7.0	7.3	7.2	83	74	78	74	.	.	.	.
4.0	8.3	8.2	8.1	.	10.6	10.0	10.5	.	7.1	7.0	7.3	.	83	73	77	.	.	.	.	.
5.0	8.4	8.2	8.1	.	10.7	10.1	10.5	.	7.1	7.0	7.3	.	83	74	77	.	.	.	.	.
6.0	8.4	7.8	8.1	.	11.0	8.5	10.5	.	7.1	7.0	7.3	.	84	73	77	.	.	.	.	.
7.0	8.4	7.8	8.1	.	11.1	8.3	10.8	.	7.1	7.0	7.3	.	83	73	77	.	.	.	.	.
8.0	8.4	7.7	8.1	.	11.2	7.7	10.9	.	7.1	7.0	7.3	.	83	73	76	.	.	.	.	.
9.0	8.4	.	.	.	11.3	.	.	.	7.1	.	.	.	83	.	.	.	.	.	.	.
10.0	8.4	.	.	.	11.5	.	.	.	7.1	.	.	.	84	.	.	.	.	.	.	.
11.0	8.4	.	.	.	11.5	.	.	.	7.1	.	.	.	83	.	.	.	.	.	.	.
12.0	8.4	.	.	.	11.6	.	.	.	7.1	.	.	.	83	.	.	.	.	.	.	.
13.0	8.0	.	.	.	10.6	.	.	.	7.1	.	.	.	84	.	.	.	.	.	.	.

March 7, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	8.1	8.3	7.9	8.6	9.4	9.6	9.3	8.7	7.0	7.1	7.9	6.7	81	63	74	43	1.1	0.9	1.1	0.5
1.0	8.1	8.3	7.9	8.6	9.4	9.6	9.4	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
2.0	8.1	8.3	8.0	8.7	9.4	9.6	9.4	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
3.0	8.1	8.3	8.0	8.7	9.4	9.6	9.5	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
4.0	8.1	8.3	8.0	8.7	9.4	9.6	9.5	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
5.0	8.1	8.3	8.0	8.7	9.4	9.6	9.5	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
6.0	8.1	8.3	8.0	8.7	9.4	9.6	9.5	8.7	7.0	7.1	7.9	6.7	81	63	74	43	.	.	.	.
7.0	8.1	8.3	8.0	.	9.4	9.6	9.5	.	7.0	7.1	7.9	.	81	63	74	.	.	.	.	.
8.0	8.1	8.3	8.0	.	9.4	9.6	9.5	.	7.0	7.1	7.9	.	81	63	74	.	.	.	.	.
9.0	8.1	8.1	8.0	.	9.4	8.8	9.5	.	7.0	7.1	7.9	.	81	67	74	.	.	.	.	.
10.0	8.2	.	.	.	9.5	.	.	.	7.0	.	.	.	81	.	.	.	.	.	.	.
11.0	8.2	.	.	.	9.5	.	.	.	7.1	.	.	.	81	.	.	.	.	.	.	.
12.0	8.2	.	.	.	9.5	.	.	.	7.0	.	.	.	81	.	.	.	.	.	.	.
13.0	8.2	.	.	.	9.5	.	.	.	7.0	.	.	.	81	.	.	.	.	.	.	.
14.0	8.2	.	.	.	9.3	.	.	.	7.0	.	.	.	81	.	.	.	.	.	.	.

Appendix 6. (continued)

May 10, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	18.0	19.0	19.0	18.2	7.6	8.8	8.1	8.0	6.4	6.5	6.2	5.9	69	58	64	50	1.7	1.1	1.2	0.6
1.0	18.0	18.9	19.0	18.2	7.6	8.7	8.1	8.0	6.4	6.5	6.2	6.0	69	58	64	50	.	.	.	.
2.0	18.0	18.9	19.0	17.9	7.6	8.6	8.1	7.5	6.3	6.5	6.2	6.0	69	59	65	49	.	.	.	.
3.0	17.9	18.8	18.9	17.2	7.3	7.9	7.8	6.3	6.3	6.5	6.2	6.0	69	59	65	47	.	.	.	.
4.0	17.8	18.4	18.7	16.7	7.3	7.4	7.6	5.8	6.4	6.5	6.2	5.9	69	58	66	45	.	.	.	.
5.0	17.8	17.3	18.6	.	7.2	3.8	7.6	.	6.4	6.4	6.2	.	70	65	66	.	.	.	.	.
6.0	17.5	15.3	18.2	.	6.4	1.3	7.5	.	6.4	6.3	6.2	.	69	71	67	.	.	.	.	.
7.0	17.0	14.0	16.2	.	4.6	0.4	2.3	.	6.3	6.3	6.2	.	72	71	68	.	.	.	.	.
8.0	14.6	13.6	13.9	.	2.8	0.2	0.3	.	6.3	6.3	6.2	.	73	74	80	.	.	.	.	.
9.0	13.5	13.3	13.6	.	2.8	0.0	0.0	.	6.3	6.2	6.2	.	74	82	86	.	.	.	.	.
10.0	13.0	13.2	.	.	2.8	0.0	.	.	6.3	6.2	.	.	74	87	.	.	.	.	.	.
11.0	12.6	.	.	.	2.7	.	.	.	6.3	.	.	.	75	.	.	.	.	.	.	.
12.0	12.1	.	.	.	2.1	.	.	.	6.3	.	.	.	75	.	.	.	.	.	.	.
13.0	10.9	.	.	.	0.2	.	.	.	6.3	.	.	.	82	.	.	.	.	.	.	.

July 17, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	28.0	27.9	28.0	27.9	6.0	5.2	6.5	6.4	6.7	6.6	6.9	7.0	71	67	71	72	1.4	1.3	1.3	0.9
1.0	28.0	27.9	28.0	27.9	5.9	5.1	6.5	6.4	6.7	6.6	6.9	7.0	70	67	71	72	.	.	.	.
2.0	28.0	27.9	28.0	27.9	5.9	5.1	6.5	6.3	6.7	6.5	6.9	7.0	70	67	72	72	.	.	.	.
3.0	28.0	27.8	28.0	26.7	5.1	5.0	6.5	3.1	6.7	6.6	6.9	6.6	70	67	72	67	.	.	.	.
4.0	28.0	25.8	28.0	.	4.9	0.6	6.5	.	6.7	6.3	6.7	.	71	75	73	.	.	.	.	.
5.0	26.9	24.6	26.8	.	1.8	0.0	1.8	.	6.3	6.3	6.5	.	73	76	77	.	.	.	.	.
6.0	23.8	23.0	22.7	.	0.0	0.0	0.1	.	6.4	6.4	6.4	.	91	91	89	.	.	.	.	.
7.0	22.0	21.2	20.9	.	0.0	0.0	0.0	.	6.5	6.5	6.4	.	103	99	96	.	.	.	.	.
8.0	20.6	19.8	19.4	.	0.0	0.0	0.0	.	6.6	6.5	6.5	.	105	114	100	.	.	.	.	.
9.0	17.4	.	.	.	0.0	.	.	.	6.7	.	.	.	107	.	.	.	.	.	.	.
10.0	16.0	.	.	.	0.0	.	.	.	6.7	.	.	.	105	.	.	.	.	.	.	.
11.0	14.8	.	.	.	0.0	.	.	.	6.8	.	.	.	106	.	.	.	.	.	.	.
12.0	12.9	.	.	.	0.0	.	.	.	7.0	.	.	.	123	.	.	.	.	.	.	.
13.0	12.1	.	.	.	0.0	.	.	.	7.0	.	.	.	129	.	.	.	.	.	.	.

Appendix 6. (continued)

September 11, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	27.0	27.4	27.5	27.3	8.2	8.9	9.2	9.1	6.7	7.2	7.6	7.4	77	78	84	76	1.3	1.9	1.5	1.2
1.0	26.3	27.4	27.4	27.3	8.1	8.9	9.2	9.1	6.6	7.3	7.7	7.0	88	85	89	82	.	.	.	.
2.0	25.6	26.7	26.9	25.8	6.1	7.7	8.9	3.4	6.4	6.6	7.5	6.2	89	87	90	85	.	.	.	.
3.0	25.2	25.1	25.6	24.6	2.5	2.5	6.9	0.0	6.0	6.0	6.6	5.9	94	90	93	91	.	.	.	.
4.0	24.9	24.7	24.8	24.0	2.4	0.1	3.5	0.0	5.9	5.8	6.3	5.9	93	93	96	92	.	.	.	.
5.0	24.7	24.4	24.3	23.9	2.5	0.0	1.7	0.0	5.9	5.8	6.0	5.9	92	103	99	97	.	.	.	.
6.0	24.5	24.0	24.0	.	1.7	0.0	0.4	.	5.9	5.9	5.9	.	94	109	102	.	.	.	.	.
7.0	23.7	23.3	23.8	.	0.0	0.0	0.0	.	6.1	6.2	5.9	.	121	125	104	.	.	.	.	.
8.0	22.4	22.1	20.9	.	0.0	0.0	0.0	.	6.2	6.2	6.4	.	135	139	176	.	.	.	.	.
9.0	19.4	.	.	.	0.0	.	.	.	6.4	.	.	.	139	.	.	.	.	.	.	.
10.0	17.6	.	.	.	0.0	.	.	.	6.5	.	.	.	139	.	.	.	.	.	.	.
11.0	15.6	.	.	.	0.0	.	.	.	6.6	.	.	.	143	.	.	.	.	.	.	.
12.0	14.3	.	.	.	0.0	.	.	.	6.8	.	.	.	155	.	.	.	.	.	.	.
13.0	13.0	.	.	.	0.0	.	.	.	6.9	.	.	.	174	.	.	.	.	.	.	.

November 7, 1989

Depth (m)	Temperature (°C)				Dissolved Oxygen (mg/L)				pH				Conductivity (µS/cm)				Secchi (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	17.5	17.8	17.3	15.6	6.9	8.4	7.4	8.6	6.8	7.0	6.9	7.1	74	72	73	71	1.5	1.7	1.3	1.6
1.0	16.8	16.7	16.7	15.4	6.4	8.2	7.3	8.5	6.8	7.1	7.0	7.2	76	73	74	71	.	.	.	.
2.0	16.6	16.3	16.5	15.1	6.1	8.0	7.1	8.3	6.8	7.0	7.0	7.2	76	73	74	71	.	.	.	.
3.0	16.6	16.1	16.4	14.8	6.0	7.7	7.1	7.3	6.8	7.0	7.0	7.1	76	73	74	71	.	.	.	.
4.0	16.6	16.0	16.4	.	5.7	7.7	7.1	.	6.8	7.0	7.0	.	76	72	74	.	.	.	.	.
5.0	16.5	16.0	16.3	.	5.4	7.4	7.2	.	6.8	7.0	7.0	.	76	73	74	.	.	.	.	.
6.0	16.5	15.8	16.1	.	5.5	7.4	7.1	.	6.8	6.9	7.0	.	76	73	74	.	.	.	.	.
7.0	16.4	15.8	15.8	.	5.5	7.2	6.0	.	6.7	6.9	7.0	.	76	72	74	.	.	.	.	.
8.0	16.4	15.6	15.8	.	5.4	6.5	5.9	.	6.7	6.9	6.8	.	76	72	74	.	.	.	.	.
9.0	16.3	.	.	.	5.4	.	.	.	6.7	.	.	.	76	.	.	.	.	.	.	.
10.0	16.3	.	.	.	5.4	.	.	.	6.7	.	.	.	76	.	.	.	.	.	.	.
11.0	16.3	.	.	.	5.4	.	.	.	6.7	.	.	.	76	.	.	.	.	.	.	.
12.0	16.2	.	.	.	1.8	.	.	.	6.7	.	.	.	87	.	.	.	.	.	.	.
13.0	14.3	.	.	.	0.0	.	.	.	7.0	.	.	.	197	.	.	.	.	.	.	.

Appendix 7. Temporal trends of selected limnological variables from the surface waters at Stations E2, H2, and P2 of Harris Lake, 1985-1989.‡ All variables are in mg/liter except for Secchi disk transparency in meters, specific conductance in μS/cm, and turbidity in NTU.

Variable	1985	1986	1987	1988	1989
Secchi disk transparency	1.7^{a}	1.6^{ab}	1.4^{bc}	1.3^{c}	1.4^{bc}
Specific conductance	56^{d}	64^{c}	68^{bc}	83^{a}	73^{b}
Chloride	4.1^{c}	4.6^{b}	4.3^{bc}	5.7^{a}	5.5^{a}
Sulfate	5.0^{c}	5.7^{c}	6.8^{b}	8.7^{a}	7.8^{a}
Calcium	4.0^{a}	3.8^{a}	3.5^{b}	3.8^{a}	3.3^{b}
Magnesium	1.6^{a}	1.5^{b}	1.5^{b}	1.7^{a}	1.7^{a}
Sodium	4.5^{b}	4.9^{b}	5.1^{b}	7.8^{a}	7.3^{a}
Total phosphorus	0.013^{c}	0.013^{c}	0.024^{b}	0.029^{b}	0.045^{a}
Total nitrogen	0.39^{b}	0.35^{b}	0.44^{ba}	0.47^{a}	0.49^{a}
Total organic carbon	NS¶	6.6^{b}	6.1^{b}	6.7^{b}	8.4^{a}
Total solids	NS	NS	NS	NS	67
Total suspended solids	NS	NS	NS	NS	3.0
Turbidity	NS	3.6^{a}	3.7^{a}	2.8^{b}	4.0^{a}
Total alkalinity	15^{a}	16^{a}	13^{b}	15^{a}	12^{b}
Calculated hardness	17^{a}	16^{ba}	15^{b}	17^{a}	15^{b}
Dissolved oxygen	8.2^{ab}	8.0^{bc}	7.5^{c}	9.0^{a}	8.4^{ab}

‡Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Means followed by the same superscript were not significantly different ($P > 0.05$).

¶NS = Not sampled.

Appendix 8. Mean, maximum, and minimum values calculated from surface water quality samples collected from Harris Lake during 1989.

Station	Temperature (°C)			Dissolved oxygen (mg/liter)			Conductivity (μS/cm)			pH			Secchi disk transparency (m)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
E2	17.8	28.0	8.1	8.1	10.4	6.0	76	83	69	6.7	7.1	6.4	1.5	1.7	1.1
H2	18.1	27.9	8.2	8.5	9.9	5.2	69	78	58	6.8	7.1	6.4	1.4	1.9	0.9
P2	18.0	28.0	7.9	8.5	10.5	6.5	74	84	64	6.8	7.9	6.2	1.4	1.7	1.1
S2	17.6	27.9	8.0	8.5	10.3	6.4	64	76	43	6.9	7.4	5.9	1.0	1.6	0.5

Appendix 9. Means and ranges (in parentheses) of water chemistry monitoring variables from the surface and bottom waters of Harris Lake during 1989‡. All units are mg/liter except for turbidity which is in NTU.

Variable	Station				
	E2-Surface	E2-Bottom	H2-Surface	P2-Surface	S2-Surface
Chloride	(5.2-7.1)5.9	(4.8-7.0)5.8	(4.5-6.6)5.2	(3.6-6.7)5.4	(3.5-7.1)5.1
Sulfate	(5.0-11)8.2	(2.9-13)8.2	(4.7-10)7.3	(5.2-11)8.1	(5.1-9.8)7.5
Calcium	(2.9-4.0)3.5	(3.2-5.6)4.2	(2.6-3.7)3.2	(3.0-3.7)3.4	(2.7-3.8)3.3
Magnesium	(1.6-1.8)1.8[a]	(1.8-2.1)1.9¶	(1.5-1.8)1.6[b]	(1.6-1.8)1.7[a]	(1.3-1.8)1.6[b]
Sodium	(6.5-9.5)7.8	(7.2-9.6)8.2	(5.4-8.6)7.0	(4.4-8.8)7.1	(3.6-8.3)6.5
Total phosphorus	(0.023-0.14)0.070[a]	(0.024-0.63)0.22	(0.013-0.052)0.035[b]	(0.018-0.051)0.031[b]	(0.018-0.058)0.032[b]
Total nitrogen	(0.34-0.67)0.46	(0.49-2.20)1.02	(0.32-0.69)0.50	(0.43-0.70)0.50	(0.43-0.72)0.50
Total organic carbon	(6.6-8.9)7.5	(6.6-9.9)7.9	(6.3-9.3)7.3	(6.2-9.0)7.4	(6.4-9.6)8.0
Total solids	(40-120)67	(40-110)77¶	(50-100)68	(30-100)67	(40-100)70
Total suspended solids	(1-3)2	(2-6)4	(1-6)4	(<1-9)4	(2-17)6
Turbidity	(1.5-4.8)2.8	(2.3-9.9)5.2	(1.6-8.8)4.1	(1.7-10)5.1	(2.0-29.0)7.9
Total alkalinity	(11-16)13	(14-42)22	(10-14)12	(8-14)12	(11-14)13
Calculated hardness	(14-17)16	(15-23)18	(13-16)15	(14-16)16	(12-17)15
Total nitrogen/ Total phosphorus§	(4.8-16.7)9.8	(3.5-22.1)8.7	(9.1-24.6)15.5	(9.6-26.1)19.2	(9.8-24.4)18.2

‡Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Means followed by the same superscript were not significantly different ($P > 0.05$).

¶Mean concentrations in the surface and bottom waters were significantly different at Station E2 as determined by paired t tests ($P \leq 0.05$).

§Total nitrogen/total phosphorus is a weight ratio.

Appendix 10. Means and ranges (in parentheses) of trace element monitoring variables from the surface and bottom waters of Harris Lake during 1989‡. Statistical analyses are given when concentrations were at or above the analytical reporting limits. All units are μg/liter and sample size equaled 6.

Variable	Station					N.C. Water Quality Standard¶
	E2-Surface	E2-Bottom	H2-Surface	P2-Surface	S2-Surface	
Arsenic	(<1-1)<1	(<1-1)<1	<1	<1	<1	50
Aluminum	(<20-100)52[b]	(<20-230)113	(<20-220)124[ab]	(20-150)78[ab]	(<20-420)134[a]	None
Cadmium	<0.1	(<0.1-0.2)<0.1	<0.1	<0.1	<0.1	2
Chromium	<2	<2	<2	<2	<2	50
Copper	(2.2-4.9)3.5	(2.8-8.6)4.5	(1.9-3.8)2.8	(2.2-5.0)3.2	(1.3-5.3)3.0	7§
Lead	<1.0	<1.0-3.8)1.1	<1.0	<1.0	(<1.0-1.3)<1.0	25
Mercury	<0.05	(0.06-0.18)0.11†	<0.05	<0.05	<0.05	0.012§£
Nickel	<5.0	<5.0	<5.0	<5.0	<5.0	88§
Selenium	<1	<1	<1	<1	<1	5
Zinc	(<20-40)22	(<20-30)23	<20	(<20-20)<20	<20	50

‡Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Means followed by the same superscript were not significantly different ($P > 0.05$).

¶Copper and zinc are Action Levels (NCDEM 1989).

§Effective October 1, 1989, the N.C. Water Quality Standards or Action Level changed from 15 μg/liter to 7 μg/liter for copper, from 0.2 μg/liter to 0.012 μg/liter for mercury, and from 50 μg/liter to 88 μg/liter for nickel (NCDEM 1989).

£Laboratory detection level was 0.05 μg/liter.

†Mean concentrations in the surface and bottom waters were significantly different at Station E2 as determined by paired t tests ($P \leq 0.05$).

Appendix 11. Key to water chemistry abbreviations used in Appendix 12.

Ions and Nutrients	Variable
Cl^-	Chloride
SO_4^{2-}	Sulfate
Ca^{2+}	Total calcium
Mg^{2+}	Total magnesium
Na^+	Total sodium
Total N	Total nitrogen
Total P	Total phosphorus
TOC	Total organic carbon
TS	Total solids
TSS	Total suspended solids

Trace Elements	Variable
Al	Total aluminum
As	Total arsenic
Cd	Total cadmium
Cr	Total chromium
Cu	Total copper
Hg	Total mercury
Ni	Total nickel
Pb	Total lead
Se	Total selenium
Zn	Total zinc

Appendix 12. Concentrations of water chemistry variables in Harris Lake during 1989. Units are mg/liter except trace elements which are in μg/liter and turbidity which is in NTU.

Station E2, surface

Month	Total alkalinity ($CaCO_3$)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	Total N	Total P	TOC	Turbidity
January	16	7.1	11	3.9	1.8	9.5	0.67	0.14	6.6	1.6
March	15	6.6	13	4.0	1.8	9.0	0.53	0.11	8.9	4.8
May	11	5.2	9.8	3.7	1.8	6.9	0.45	0.073	8.0	2.9
July	11	5.5	5.1	2.9	1.6	6.5	0.34	0.023	7.0	3.1
September	12	5.2	5.0	3.0	1.8	6.9	0.40	0.024	7.4	1.5
November	13	5.5	5.0	3.3	1.8	7.9	0.60	0.052	7.3	3.1

Month	TS	TSS	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
January	120	1	30	<1	<0.1	<2	3.7	<0.05	<5.0	<1.0	<1	30
March	70	3	100	<1	<0.1	<2	3.8	<0.05	<5.0	<1.0	<1	40
May	40	2	69	<1	<0.1	<2	4.9	<0.05	<5.0	<1.0	<1	30
July	50	3	76	<1	<0.1	<2	3.8	<0.05	<5.0	<1.0	<1	<20
September	50	2	26	1	<0.1	<2	2.5	<0.05	<5.0	<1.0	<1	<20
November	70	1	<20	<1	<0.1	<2	2.2	<0.05	<5.0	<1.0	<1	<20

Appendix 12. (continued)

Station E2, bottom

Month	Total alkalinity ($CaCO_3$)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	Total N	Total P	TOC	Turbidity
January	16	7.0	11	4.2	2.0	9.6	0.78	0.14	6.6	2.3
March	15	6.6	13	4.0	1.8	9.0	0.49	0.13	7.0	5.2
May	14	5.6	9.8	4.1	1.9	7.2	0.59	0.047	7.7	3.7
July	32	4.8	7.2	4.3	1.9	7.7	1.5	0.32	9.1	6.5
September	42	5.5	2.9	5.6	2.1	7.6	2.2	0.63	9.9	9.9
November	14	5.5	5.1	3.2	1.8	7.8	0.53	0.024	7.2	3.8

Month	TS	TSS	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
January	110	3	30	<1	<0.1	<2	3.9	0.09	<5.0	<1.0	<1	30
March	70	4	100	<1	<0.1	<2	3.2	0.12	<5.0	<1.0	<1	30
May	40	2	180	<1	<0.1	<2	4.3	0.10	<5.0	<1.0	<1	20
July	80	6	130	1	0.2	<2	8.6	0.06	<5.0	3.8	<1	30
September	90	6	230	1	<0.1	<2	2.8	0.18	<5.0	<1.0	<1	20
November	70	2	<20	<1	<0.1	<2	3.9	0.08	<5.0	<1.0	<1	<20

Appendix 12. (continued)

Station H2, surface

Month	Total alkalinity ($CaCO_3$)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	Total N	Total P	TOC	Turbidity
January	14	6.6	10	3.7	1.7	8.6	0.69	0.052	6.3	3.0
March	11	5.3	10	3.3	1.5	6.6	0.39	0.043	6.8	8.8
May	10	4.5	7.7	3.3	1.6	5.7	0.48	0.051	9.3	6.2
July	10	4.6	6.7	2.6	1.5	6.3	0.32	0.013	7.0	3.6
September	12	5.0	4.7	3.0	1.7	6.8	0.41	0.019	7.4	1.9
November	13	5.5	4.9	3.2	1.8	7.9	0.49	0.033	6.8	1.6

Month	TS	TSS	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
January	100	3	100	<1	<0.1	<2	3.0	<0.05	<5.0	<1.0	<1	<20
March	70	6	180	<1	<0.1	<2	1.9	<0.05	<5.0	<1.0	<1	<20
May	50	5	220	<1	<0.1	<2	3.2	<0.05	<5.0	<1.0	<1	<20
July	50	4	92	<1	<0.1	<2	2.5	<0.05	<5.0	<1.0	<1	<20
September	70	2	140	<1	<0.1	<2	2.1	<0.05	<5.0	<1.0	<1	<20
November	70	1	<20	<1	<0.1	<2	3.8	<0.05	<5.0	<1.0	<1	<20

Appendix 12. (continued)

Station P2, surface

Month	Total alkalinity ($CaCO_3$)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	Total N	Total P	TOC	Turbidity
January	14	6.7	11	3.7	1.7	8.8	0.70	0.032	6.2	2.5
March	12	6.3	12	3.6	1.7	8.0	0.49	0.051	6.8	6.2
May	8	3.6	6.4	3.6	1.7	4.4	0.48	0.046	9.0	10.0
July	11	4.8	7.3	3.0	1.6	6.7	0.44	0.017	7.7	7.6
September	12	5.2	6.4	3.2	1.8	7.0	0.43	0.020	7.7	1.7
November	13	5.5	5.2	3.2	1.8	7.7	0.47	0.018	7.0	2.3

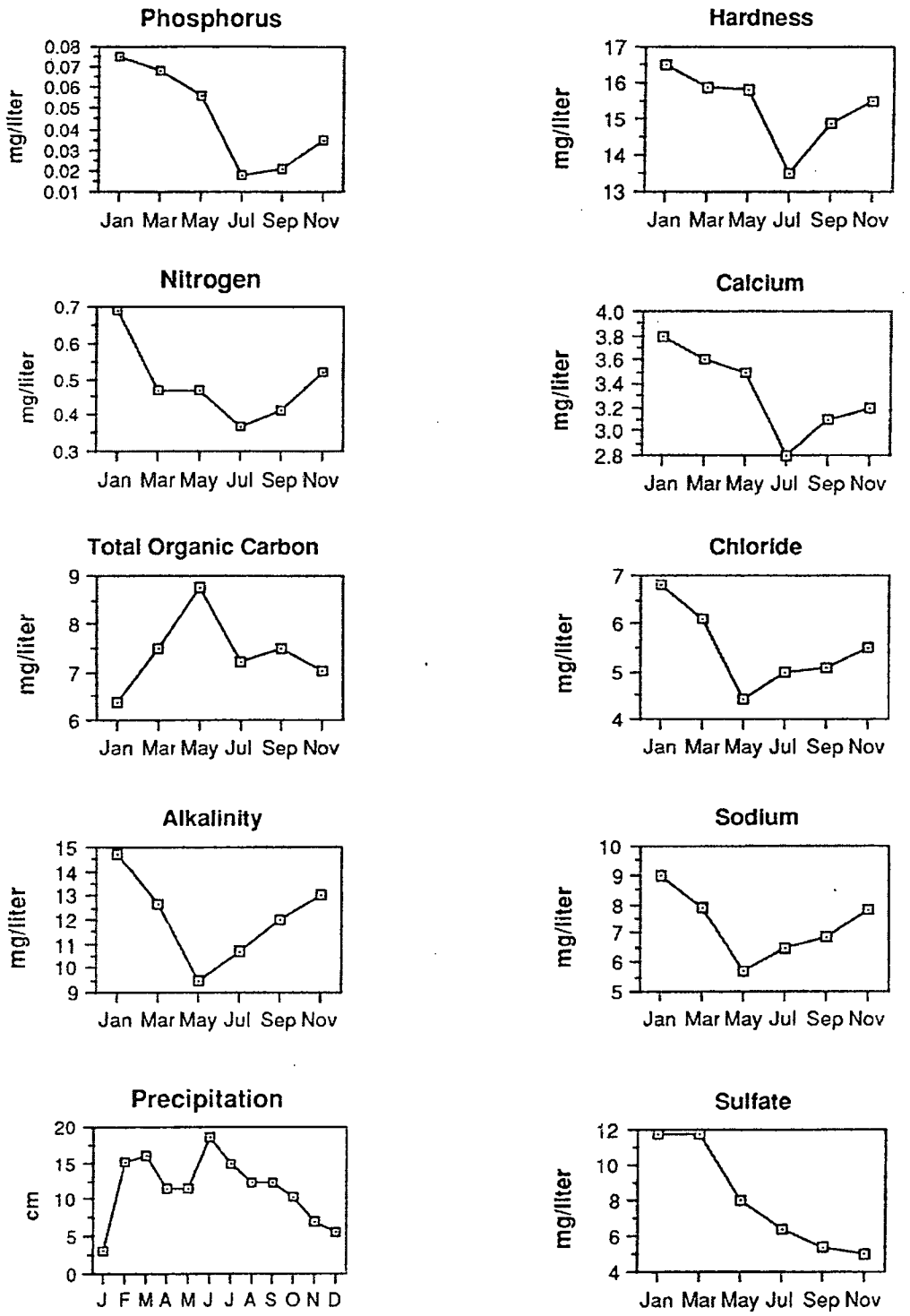
Month	TS	TSS	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
January	100	3	70	<1	<0.1	<2	3.0	<0.05	<5.0	<1.0	<1	<20
March	80	5	150	<1	<0.1	<2	2.2	<0.05	<5.0	<1.0	<1	<20
May	30	9	120	<1	<0.1	<2	5.0	<0.05	<5.0	<1.0	<1	20
July	50	2	46	<1	<0.1	<2	3.2	<0.05	<5.0	<1.0	<1	<20
September	80	2	71	<1	<0.1	<2	2.5	<0.05	<5.0	<1.0	<1	<20
November	60	<1	<20	<1	<0.1	<2	3.2	<0.05	<5.0	<1.0	<1	<20

Appendix 12. (continued)

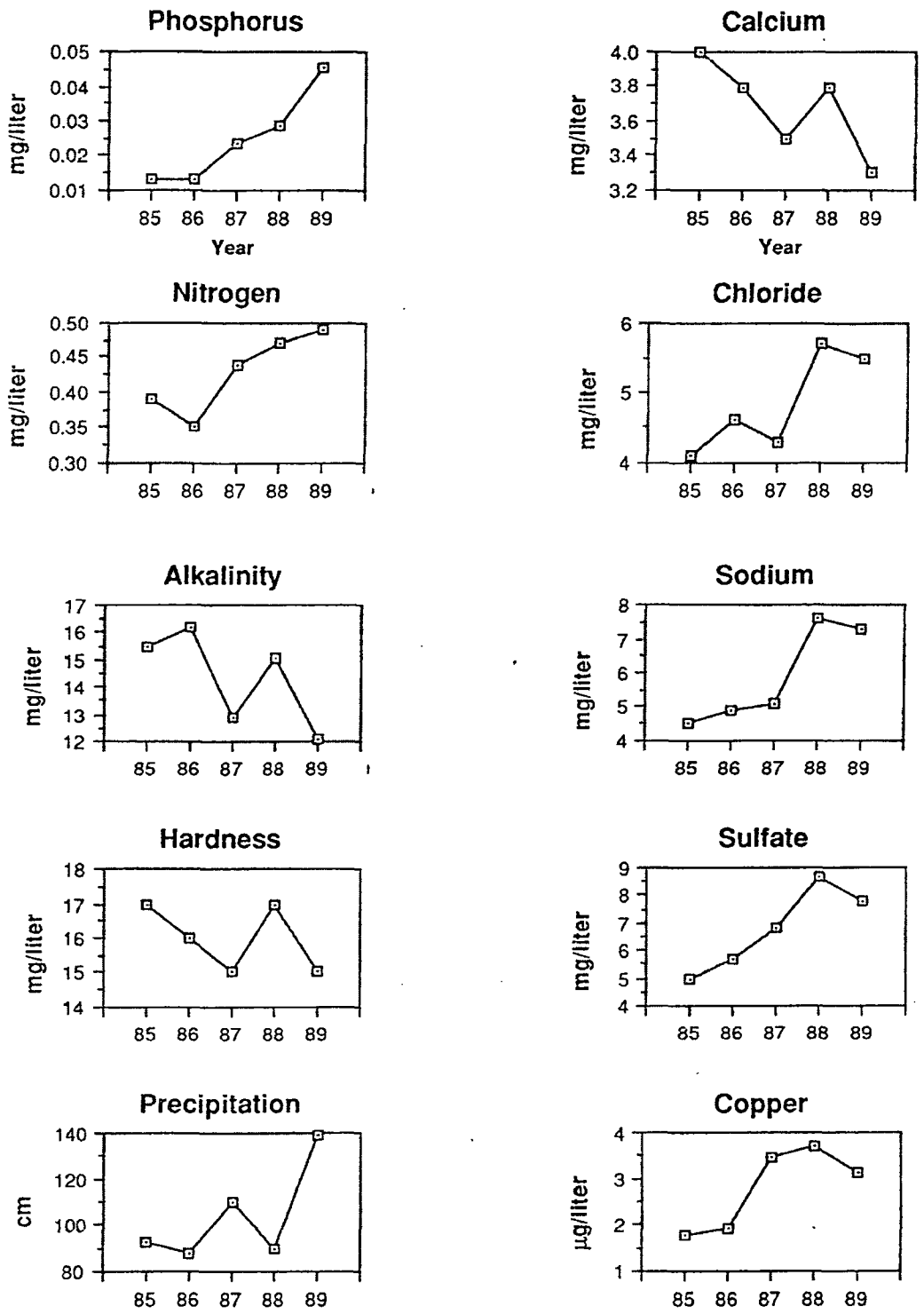
Station S2, surface

Month	Total alkalinity ($CaCO_3$)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	Total N	Total P	TOC	Turbidity
January	13	7.1*	9.8	3.8	1.7	8.3	0.51	0.026	7.1	2.8
March	14	3.5	8.7	2.7	1.3	3.6	0.43	0.044	9.4	29.0
May	11	4.8	9.0	3.2	1.4	6.3	0.72	0.058	9.6	3.0
July	12	4.7	6.1	3.2	1.6	6.4	0.44	0.018	8.0	7.0
September	13	5.3	6.4	3.6	1.8	7.0	0.47	0.023	6.4	2.0
November	12	5.4	5.1	3.2	1.8	7.5	0.45	0.020	7.6	3.4

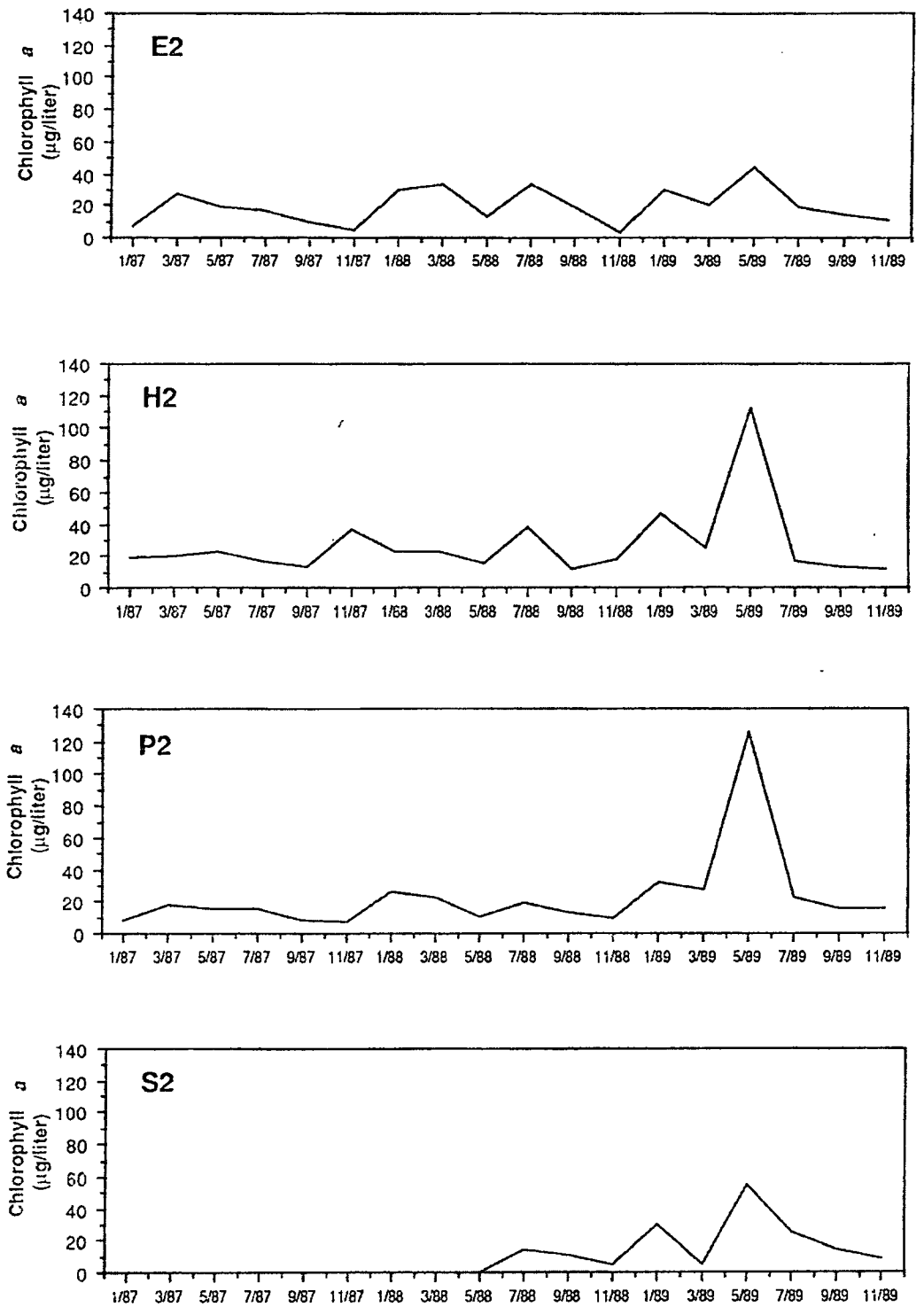
Month	TS	TSS	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
January	100	2	30	<1	<0.1	<2	2.3	<0.05	<5.0	<1.0	<1	<20
March	90	17	420	<1	<0.1	<2	1.3	<0.05	<5.0	1.3	<1	<20
May	40	3	180	<1	<0.1	<2	5.3	<0.05	<5.0	<1.0	<1	<20
July	40	6	120	<1	<0.1	<2	3.3	<0.05	<5.0	<1.0	<1	<20
September	90	3	<20	<1	<0.1	<2	3.3	<0.05	<5.0	<1.0	<1	<20
November	60	2	41	<1	<0.1	<2	2.4	<0.05	<5.0	<1.0	<1	<20



Appendix 13. Trends in selected water chemistry variables and precipitation in Harris Lake during 1989.



Appendix 14. Trends in selected water chemistry variables and precipitation in Harris Lake, 1985-1989.



Appendix 15. Chlorophyll *a* concentrations by station in Harris Lake during 1987 - 1989.

Appendix 16. Fish species collected from Harris Lake, 1986-1989.

Scientific name	Common name	1986	1987	1988	1989
Amiidae	bowfins				
Amia calva	bowfin			x	x
Anguillidae	freshwater eels				
Anguilla rostrata	American eel	x	x		
Clupeidae	herrings				
Dorsoma cepedianum	gizzard shad	x	x	x	x
D. petenense	threadfin shad			x	x
Esocidae	pikes				
Esox americanus americanus	redfin pickerel	x		x	
E. niger	chain pickerel	x	x	x	x
Cyprinidae	carps and minnows				
Clinostomus funduloides	rosyside dace			x	
Notemigonus crysoleucas	golden shiner	x	x	x	x
Notropis spp.	unidentified shiner	x	x	x	
N. petersoni	coastal shiner			x	x
Catostomidae	suckers				
Erimyzon oblongus	creek chubsucker	x		x	x
Moxostoma anisurum	silver redhorse			x	
Ictaluridae	bullhead catfishes				
Ictalurus spp.	unidentifed bullhead	x		x	
I. natalis	yellow bullhead	x	x	x	x
I. nebulosus	brown bullhead	x	x	x	x
I. platycephalus	flat bullhead	x	x	x	
I. punctatus	channel catfish	x		x	x
Noturus spp.	unidentified madtom	x			
N. gyrinus	tadpole madtom			x	
Plyodictis olivaris	flathead catfish	x		x	
Poeciliidae	livebearers				
Gambusia affinis	mosquitofish	x		x	
Centrarchidae	sunfishes				
Acantharchus pomotis	mud fish	x			
Centrarchus macropterus	flier		x	x	
Enneacanthus gloriosus	bluespotted sunfish	x	x	x	x
Lepomis sp.	unidentified sunfish	x	x	x	
Lepomis spp.	hybrid sunfish		x	x	x
L. auritus	redbreast sunfish	x	x	x	x
L. cyanellus	green sunfish	x	x	x	x
L. gibbosus	pumpkinseed	x	x	x	x
L. gulosus	warmouth	x	x	x	x
L. macrochirus	bluegill	x	x	x	x
L. microlophus	redear sunfish	x		x	x
Micropterus salmoides	largemouth bass	x	x	x	x
Pomoxis spp.	unidentified crappie	x	x	x	
P. annularis	white crappie	x			x
P. nigromaculatus	black crappie	x	x	x	x
Percidae	perches				
Etheostoma spp.	unidentified darter	x	x	x	
E. fusiforme	swamp darter	x			

Appendix 17. **Fish collected (number/hour) during boat electrofisher sampling in Harris Lake during 1989.**

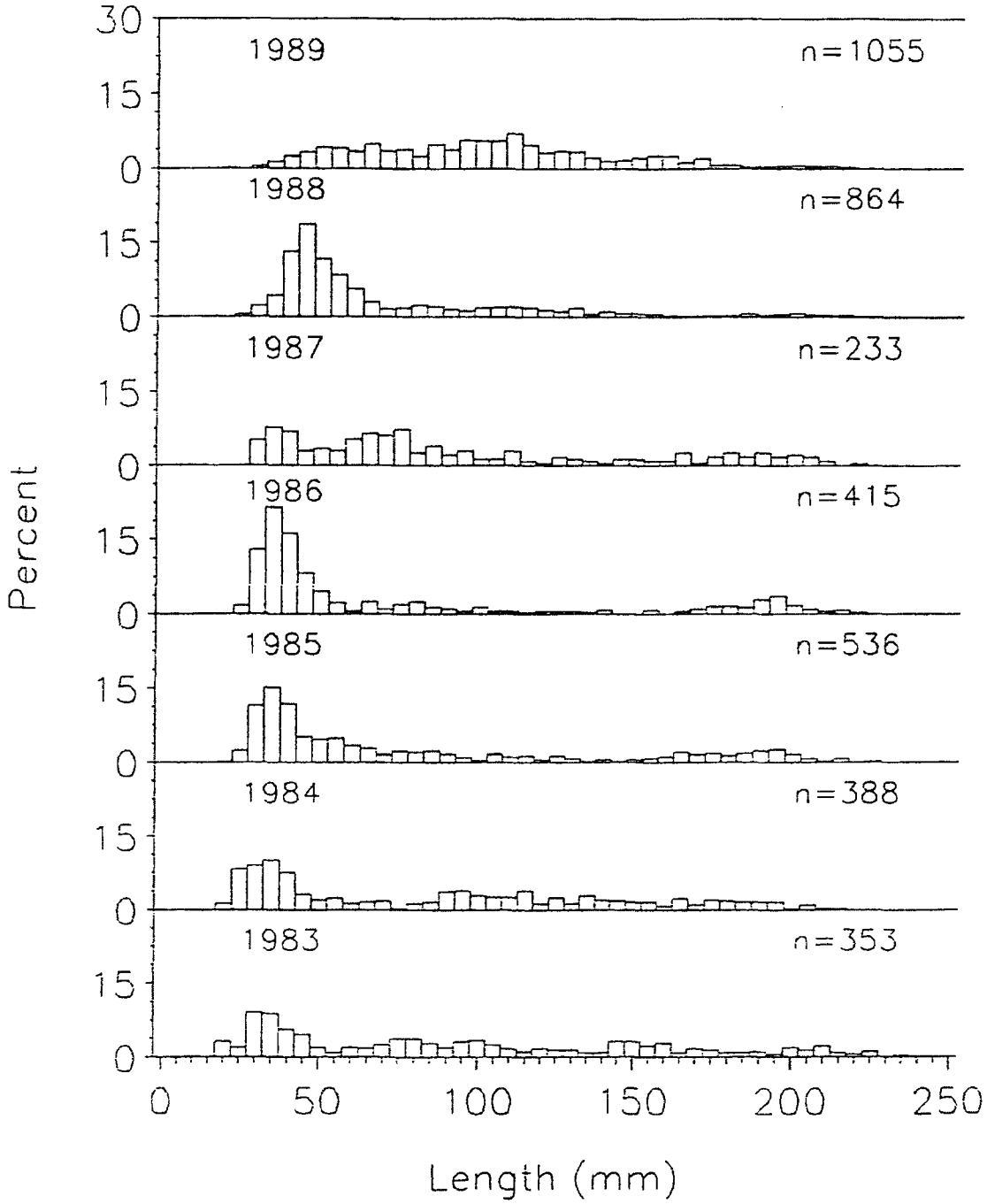
Species	Area E	Area H	Area P	Area S	Area V	Mean
Bowfin					0.5	0.1
Gizzard shad	31.0	9.0	26.0	44.0	33.0	28.6
Threadfin shad					60.0	12.0
Chain pickerel	1.0	1.5	0.5	1.5	4.5	1.8
Golden shiner	27.5	1.0	1.5	4.5	12.0	9.3
Unidentified shiner	5.0		5.5		2.0	2.5
Coastal shiner			5.0		5.5	2.1
Creek chubsucker	0.5					0.1
Yellow bullhead					0.5	0.1
Brown bullhead	7.0	8.0	8.0	8.5	11.0	8.5
Channel catfish	0.5	0.5	0.5			0.3
Hybrid sunfish			0.5	0.5	1.5	0.5
Bluespotted sunfish				2.5	0.5	0.6
Redbreast sunfish	2.5	7.5	0.5	0.5	7.0	3.6
Pumpkinseed	16.0	37.0	35.0	96.0	63.5	49.5
Warmouth	3.5	6.0	2.5	19.0	14.5	9.1
Bluegill	43.0	86.0	32.0	209.5	135.5	101.2
Redear sunfish	13.0	17.5	11.5	14.0	11.5	13.5
Largemouth bass	34.5	51.0	48.0	33.0	41.0	41.5
White crappie				0.5	0.5	0.2
Black crappie	4.0	1.0	1.5	36.0	27.5	14.0
TOTAL	**189.0**	**226.0**	**178.5**	**470.0**	**432.0**	**299.1**

Totals may differ from sums due to rounding.

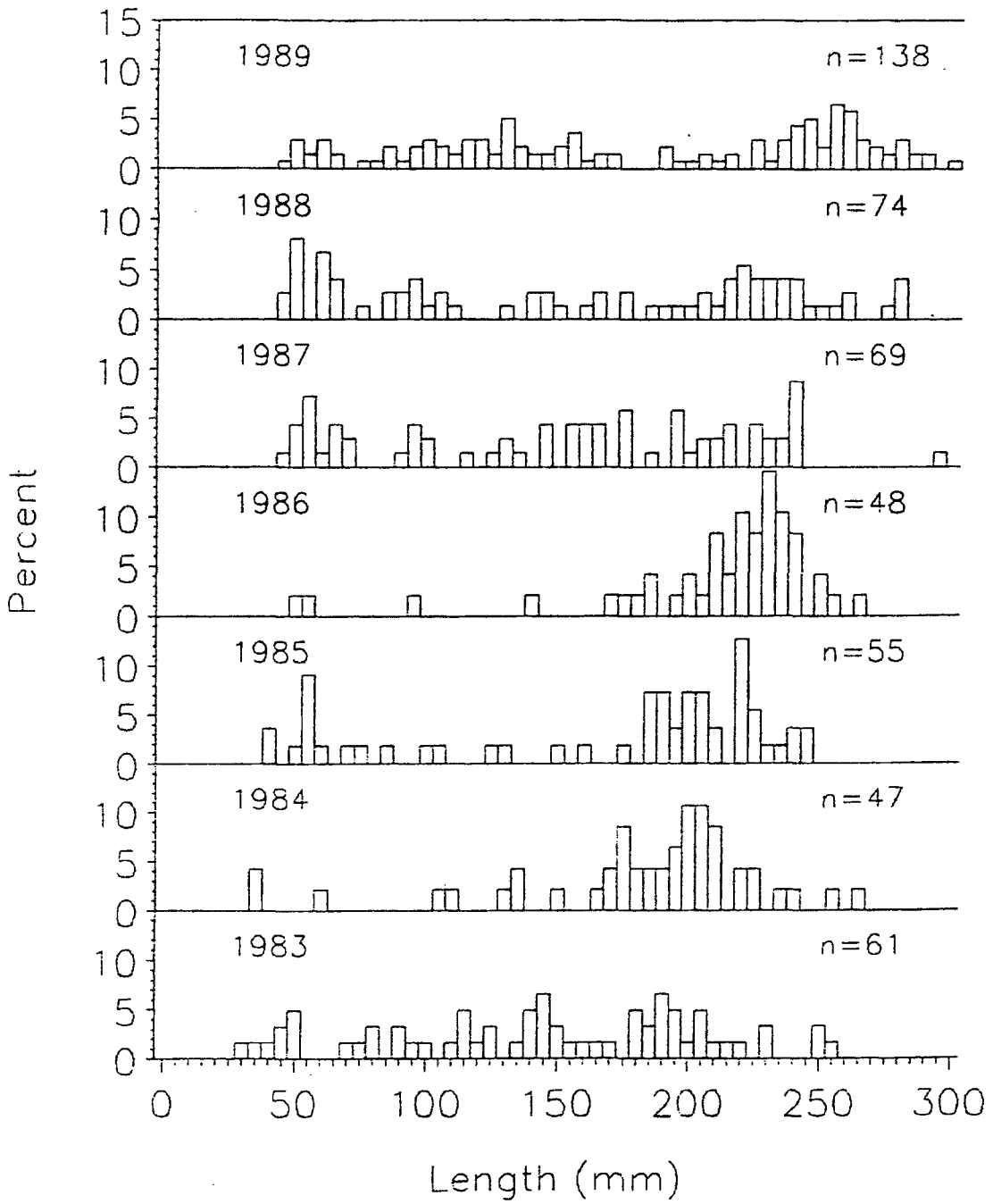
Appendix 18. Annual mean catch rate of fish collected (number/hour) during boat electrofisher sampling in Harris Lake, 1983-1989.

Species	1983	1984	1985	1986	1987	1988	1989
Bowfin						0.1	0.1
American eel	0.8	0.9	0.5	0.2	0.2		
Gizzard shad	15.6	10.4	5.5	10.8	8.7	8.4	28.6
Threadfin shad							12.0
Redfin pickerel	0.3			0.1			
Chain pickerel	1.2	2.5	0.8	0.8	1.3	2.3	1.8
Rosyside dace						0.1	
Golden shiner	2.3	3.9	1.8	1.3	2.4	5.3	9.3
Unidentified shiner	0.5	2.3	4.5	0.5	0.2	0.4	2.5
Coastal shiner						0.6	2.1
Creek chubsucker	0.1					0.1	0.1
Yellow bullhead	0.7	2.0	2.1	0.8	0.4	0.4	0.1
Brown bullhead	9.9	5.2	12.7	11.3	16.7	15.8	8.5
Flat bullhead			0.3		0.1	0.1	
Channel catfish			0.3			0.1	0.3
Mosquitofish	0.1		< 0.1				
Hybrid sunfish	1.7	0.8	1.2		0.2	0.2	0.5
Flier	1.1	0.5	< 0.1		0.3	0.1	
Bluespotted sunfish	0.2				0.1	0.1	0.6
Redbreast sunfish	3.0	1.5	0.9	1.4	0.8	0.9	3.6
Green sunfish	4.9	2.1	1.2	0.2	0.2	0.3	
Pumpkinseed	13.8	11.0	9.3	5.5	6.0	15.7	49.5
Warmouth	8.6	9.9	9.9	11.1	11.0	9.1	9.1
Bluegill	34.4	33.2	30.6	40.6	23.3	86.4	101.2
Redear sunfish	6.0	4.7	3.1	4.6	6.9	7.4	13.5
Largemouth bass	63.8	44.9	32.7	48.3	29.5	32.6	41.5
White crappie				0.1			0.2
Black crappie	2.8	2.4	2.0	1.5	2.2	7.9	14.0
Unidentified darter						0.1	
Swamp darter			0.2	0.3		0.3	
TOTAL	**171.8**	**137.3**	**119.4**	**140.8**	**110.5**	**194.8**	**299.1**

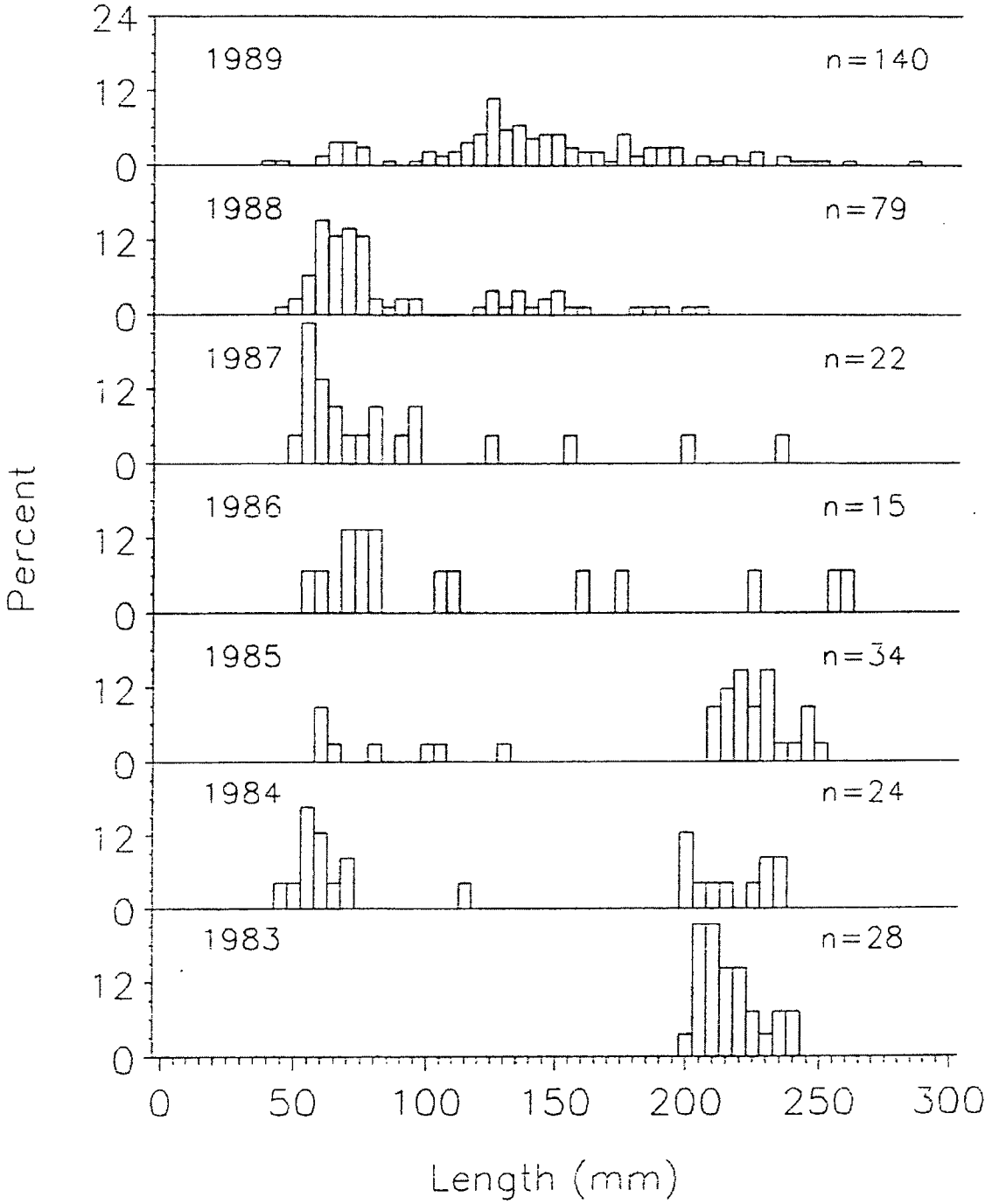
Totals may differ from sums due to rounding.



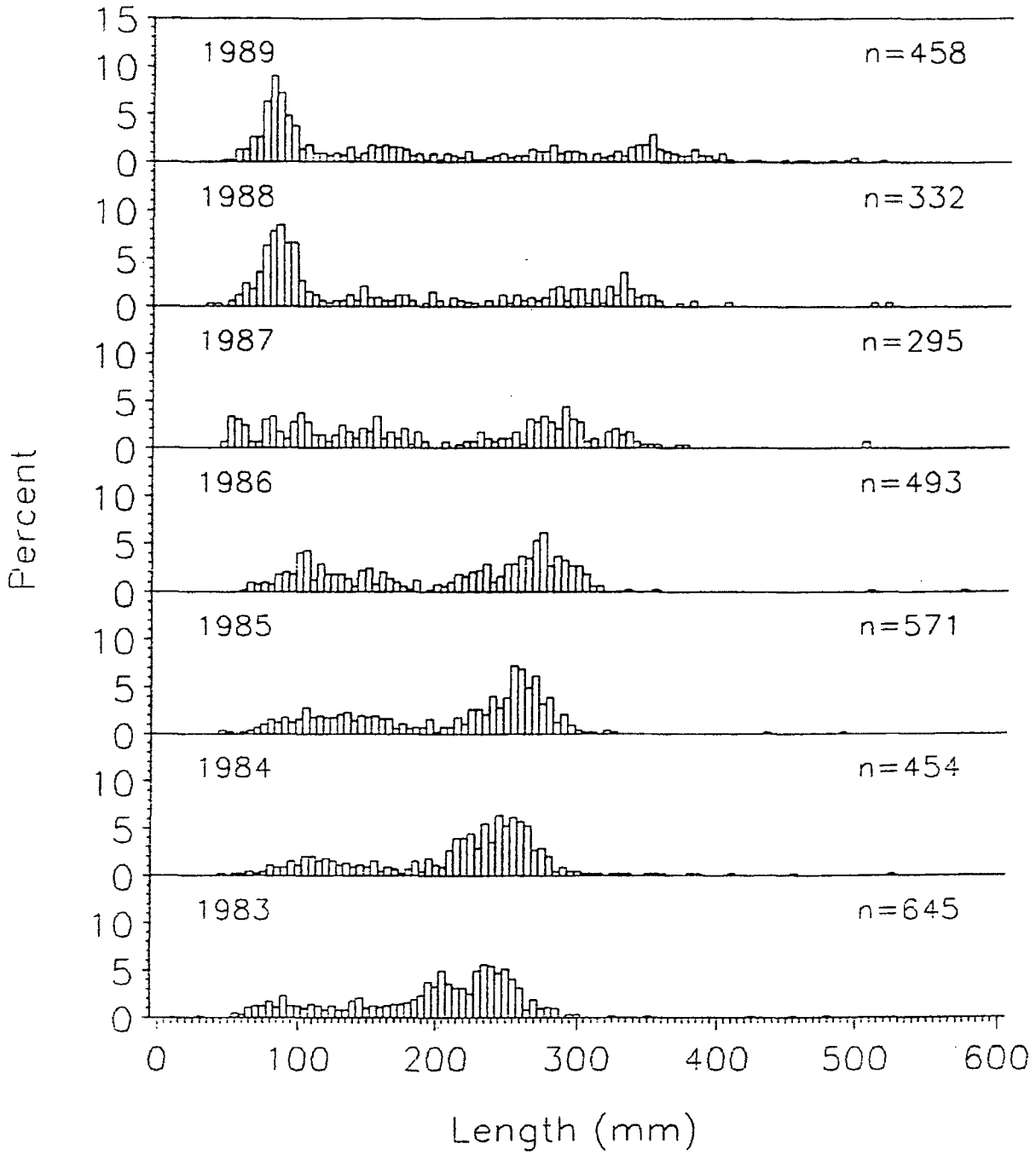
Appendix 19. Length-frequency distribution of bluegill collected during boat electrofisher sampling at Harris Lake, 1983-1989.



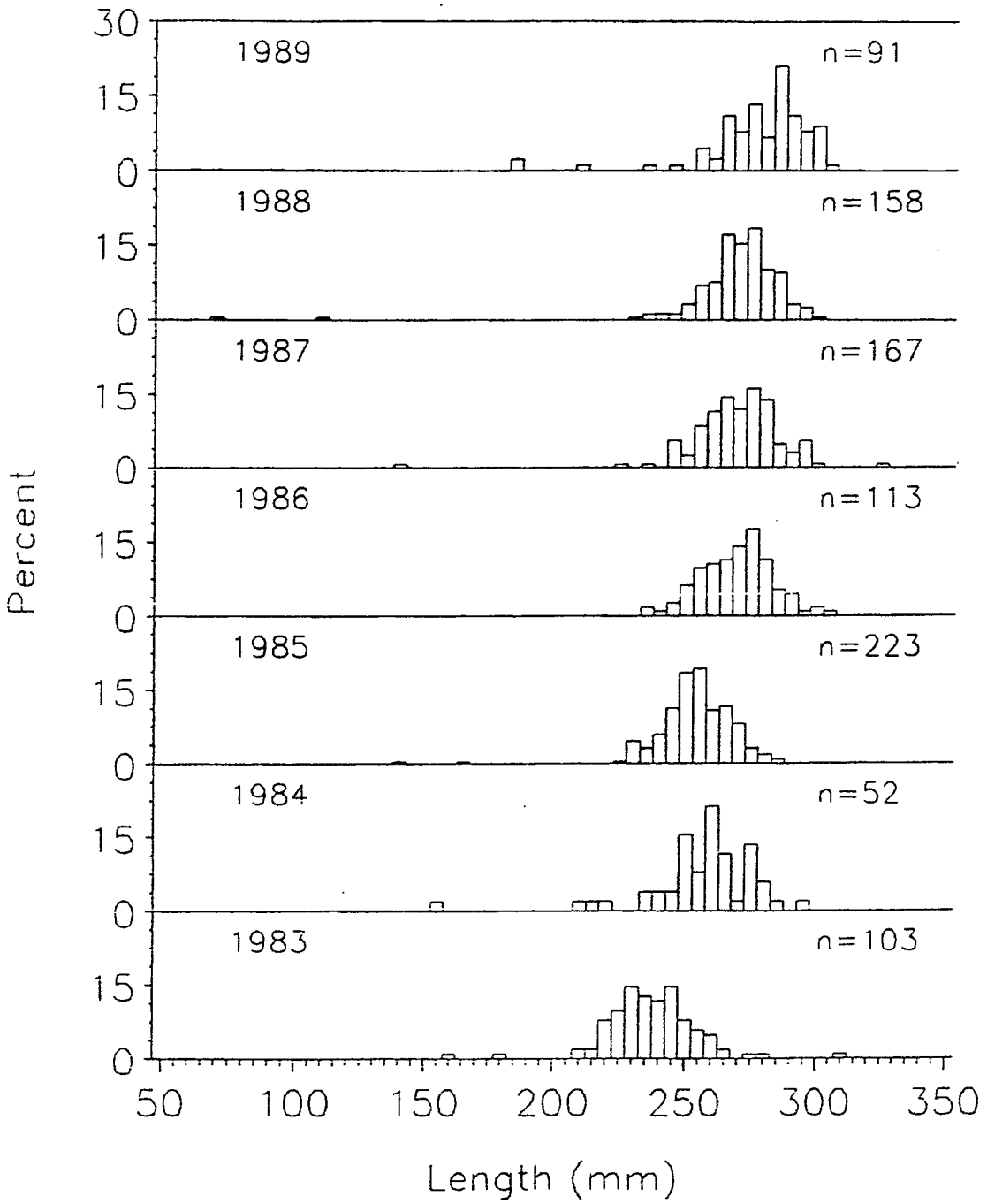
Appendix 20. Length-frequency distribution of redear sunfish collected during boat electrofisher sampling at Harris Lake, 1983-1989.



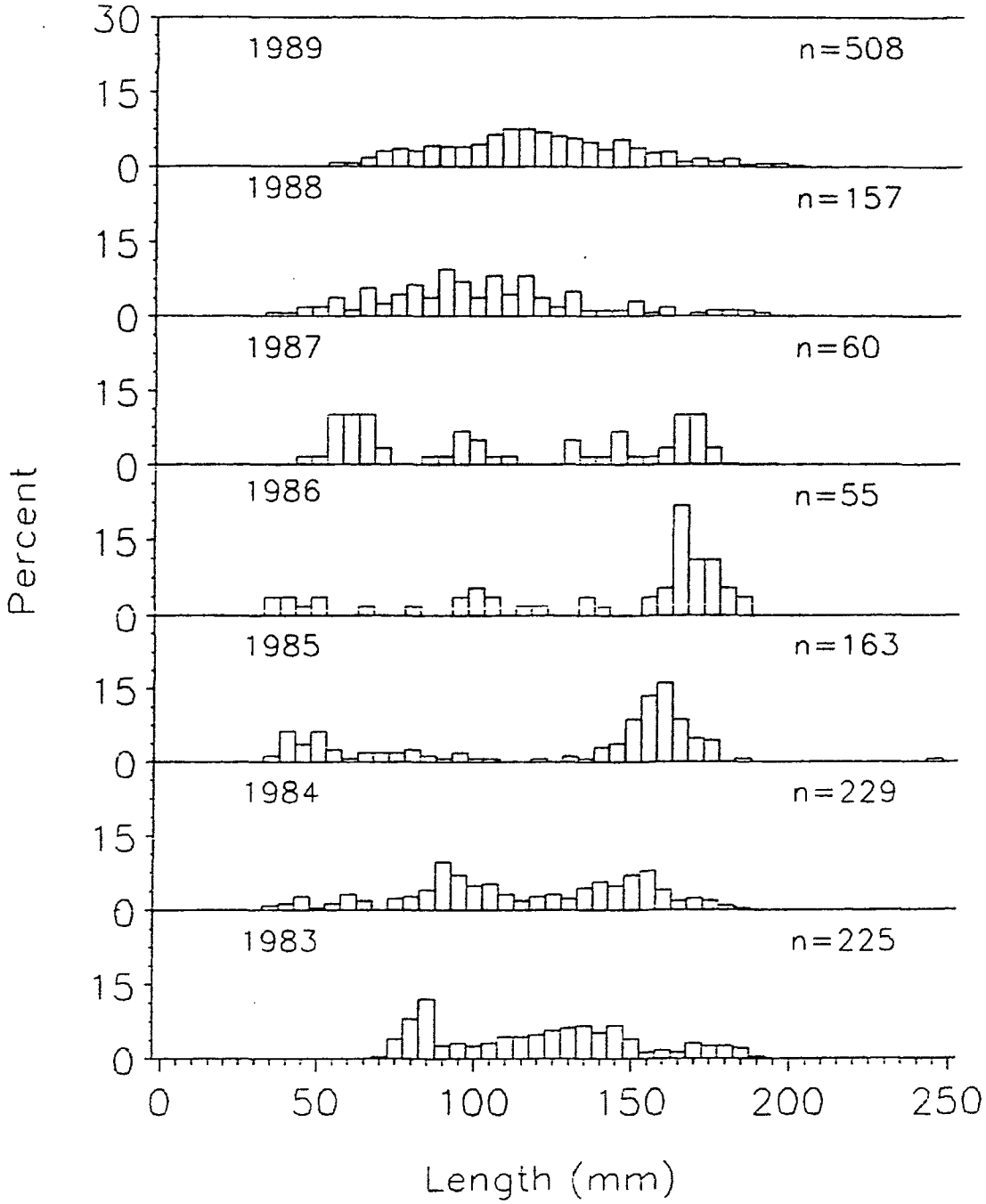
Appendix 21. Length-frequency distribution of black crappie collected during boat electrofisher sampling at Harris Lake, 1983-1989



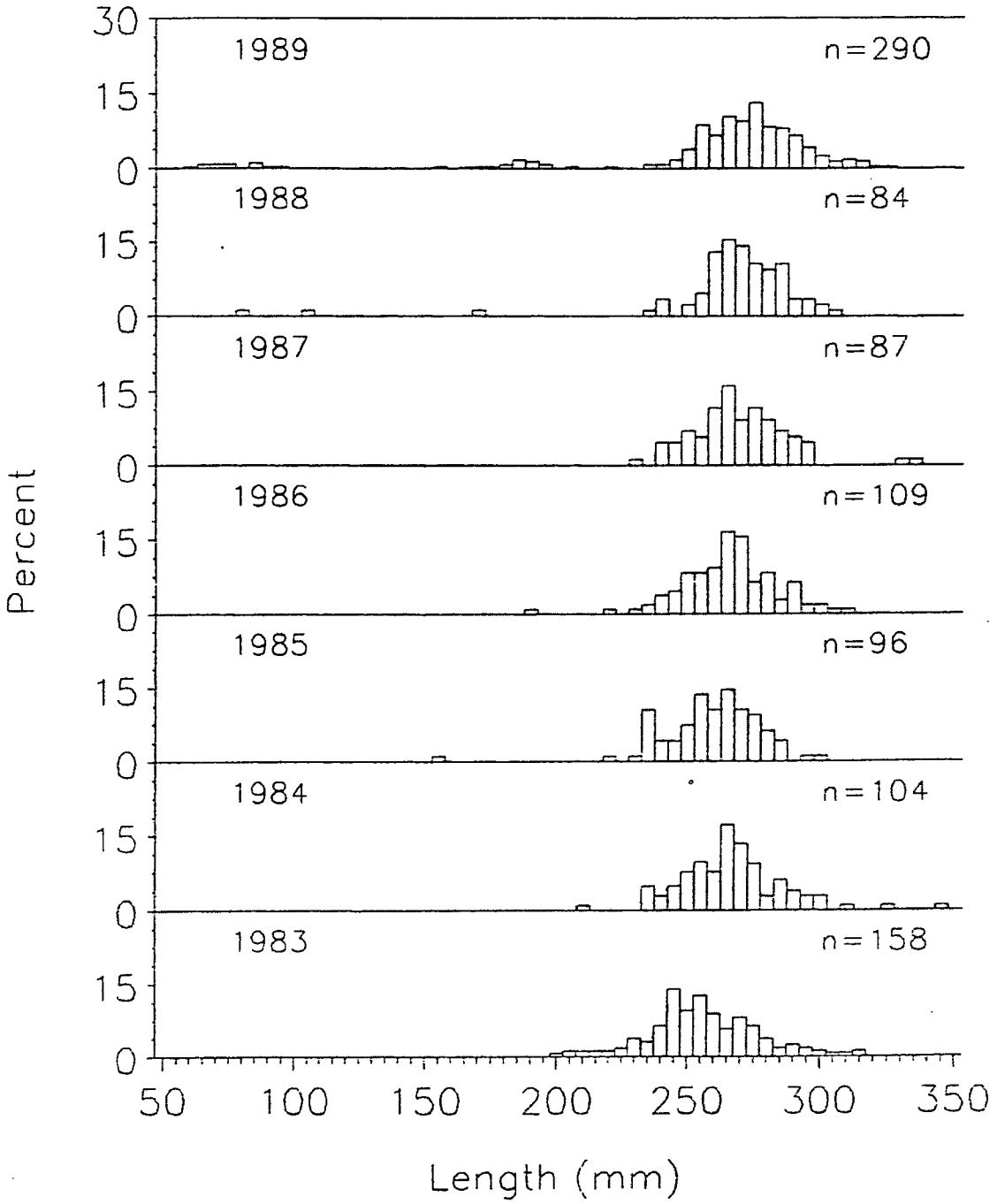
Appendix 22. Length-frequency distribution of largemouth bass collected during boat electrofisher sampling at Harris Lake, 1983-1989.



Appendix 23. Length-frequency distribution of brown bullhead collected during boat electrofisher sampling at Harris Lake, 1983-1989.



Appendix 24. Length-frequency distribution of pumpkinseed collected during boat electrofisher sampling at Harris Lake, 1983-1989.



Appendix 25. Length-frequency distribution of gizzard shad collected during boat electrofisher sampling at Harris Lake, 1983-1989.

Appendix 26. Aquatic and wetland plants observed in or adjacent to Harris Lake and the auxiliary reservoir during 1989.

Submersed Vegetation

Characeae
- *Chara* sp.
- *Nitella flexilis*

Potamogetonaceae
- *Potamogeton berchtoldii*
- *P. diversifolius*

Najadaceae
- *Najas gracillima*
- *N. guadalupensis*
- *N. minor*

Hydrocharitaceae
- *Hydrilla verticilatta*

Cyperaceae
- *Eleocharis baldwinii*

Haloragaceae
- *Myriophyllum brasiliense*

Lentibulariaceae
- *Utricularia inflata*

Floating-Leaf Vegetation

Azollaceae
- *Azolla caroliniana*

Lemnaceae
- *Spirodela polyrhiza*

Nymphaeaceae
- *Nymphaea odorata*

Nelumbonaceae
- *Nelumbo lutea*

Cabombaceae
- *Brasenia schreberi*

Onagraceae
- *Ludwigia uruguayensis*

Emergent Vegetation

Osmundaceae
- *Osmunda cinnamomea*

Typhaceae
- *Typha latifolia*

Sparganiaceae
- *Sparganium americanum*

Alismataceae
- *Alisma subcordatum*
- *Sagittaria engelmanniana*

Poaceae
- *Echinochloa crusagalli*
- *Erianthus giganteus*

Emergent Vegetation (continued)

- *Leersia oryzoides*
- *Panicum dichotomiflorum*
- *P. stipitatum*
- *Zizaniopsis aquatica*

Cyperaceae
- *Carex lurida*
- *C. odoratus*
- *C. pseudovegetus*
- *Eleocharis microcarpa*
- *E. obtusa*
- *E. quadrangulata*
- *Fimbristylis autumnalis*
- *Rhynchospora corniculata*
- *Scirpus atrovirens*
- *S. cyperinus*

Juncaceae
- *Juncus acuminatus*
- *J. coriaceus*
- *J. effusus*
- *J. marginatus*
- *J. tenuis*

Salicaceae
- *Populus deltoides*
- *Salix nigra*

Saururaceae
- *Saururus cernuus*

Betulaceae
- *Betula nigra*
- *Alnus serrulata*

Polygonaceae
- *Polygonum pensylvanicum*
- *P. hydropiperoides*

Platanaceae
- *Platanus occidentalis*

Melastomataceae
- *Rhexia mariana*

Onagraceae
- *Ludwigia leptocarpa*
- *L. palustris*

Cornaceae
- *Cornus amomum*

Rubiaceae
- *Cephalanthus occidentalis*

Campanulaceae
- *Lobelia siphilitica*

Asteraceae
- *Mikania scandens*
- *Pluchea foetida*
