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# HARRIS NUCLEAR POWER PLANT
# 1990 ANNUAL ENVIRONMENTAL MONITORING REPORT


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Environmental Services Section

CAROLINA POWER & LIGHT COMPANY

NEW HILL, NORTH CAROLINA


September 1991

Reviewed and Approved

Manager
Biological Assessment Unit

Manager
Environmental Assessment Unit

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

Manager
Environmental Services Section

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

Many members of Carolina Power & Light Company's Biological Assessment Unit and Environmental Assessment Unit assisted with the collection of field samples and contributed to the preparation of this report. Ms. Betty Carter maintained water quality and chemistry field sampling equipment, and Mr. Mack McKinnie maintained the boats used for field sampling. Ms. Ann Harris assisted with data analyses and figure preparation. Special thanks are given to Ms. Robbie Blue for assisting with the production of this report.

Thanks are given to members of Carolina Power & Light Company's Chemistry Laboratory for conducting the chemical analyses and to Ms. Mary Milligan of the Office Services Unit at the Harris Energy & Environmental Center for assistance with proofreading.

# Table of Contents

# List of Appendices

**List of Appendices continued**

## Metric-English Conversion and Units of Measure

### Length

1 micron (µm) = 4.0 x $10^{-5}$ 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 (ha) = 10,000 $m^2$ = 2.47 acres

### Weight

1 microgram (µg) = $10^{-3}$ mg or
$10^{-6}$ g = 3.5 x $10^{-8}$ ounce
1 milligram (mg) = 3.5 x $10^{-5}$ 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 = 1000 ml = 0.26 gallon
1 cubic meter = 35.3 cubic feet

### Temperature

Degrees Celsius (°C) = 5/9 (°F-32)

### Conductivity

Microsiemens/centimeter = µS/cm = µmhos/cm

### Turbidity

NTU = Nephelometric Turbidity Unit

## Water Chemistry Abbreviations

| | | | | | |
|---|---|---|---|---|---|
| $Cl^-$ | Chloride | P | Total phosphorus | Cu | Total copper |
| $SO_4^{2-}$ | Sulfate | TOC | Total organic carbon | Pb | Total lead |
| $Ca^{2+}$ | Total calcium | Al | Total aluminum | Hg | Total mercury |
| $Mg^{2+}$ | Total magnesium | As | Total arsenic | Ni | Total nickel |
| $Na^+$ | Total sodium | Cd | Total cadmium | Se | Total selenium |
| N | Total nitrogen | Cr | Total chromium | Zn | Total zinc |

# HARRIS NUCLEAR POWER PLANT 1990 ENVIRONMENTAL MONITORING REPORT

## HISTORICAL OVERVIEW

The 1660-hectare Harris Lake, which supplies cooling tower makeup and service water to the 900-MWe, single-unit Harris Nuclear Power Plant, began filling in December 1980 and reached full-pool elevation (220 ft msl) in early 1983. Testing of the Harris Nuclear Power Plant circulating and cooling tower makeup water systems was initiated in January 1987, and the plant started commercial operation in May 1987.

With the initiation of plant operations, Harris Lake began receiving cooling tower blowdown near the main dam. As a result, phosphorus and nitrogen concentrations increased in the downstream area of the lake in 1987. During 1988 and 1989, phosphorus and nitrogen concentrations increased throughout other areas of the lake as a result of mixing and diffusion. This process was accelerated by the extreme drought conditions that occurred from late 1987 through 1988.

The increases in concentrations of phosphorus and nitrogen resulted in increased algal biomass throughout much of the lake. The overall result of these changes was that Harris Lake shifted from a lake of low productivity to one of medium to high productivity within the range (for nutrient and algal concentrations) typical of many southeastern United States reservoirs.

The most significant change to the Harris Lake benthic community during 1988-1989 was the colonization by Asiatic clams *Corbicula fluminea*. The Asiatic clam is a biofouling organism with the potential to block power plant pipes and tubes in raw water systems. This nonnative species was probably introduced into the lake by boaters. Through 1989, no clams were collected from the intake canal area of the main lake and auxiliary reservoir, the plant intake structures, or the auxiliary reservoir.

Previous monitoring of fish populations and a study of fish age and growth in 1985 documented a slow growth rate for largemouth bass. However, during 1988 and 1989, the slow growth rate of largemouth bass increased, probably the result of an introduction of threadfin shad into the lake and/or the increased abundance of smaller gizzard shad, both of which provided an improved food source. No impacts from power plant operations on the fish community have been observed.

Hydrilla *Hydrilla verticillata* was found growing in Harris Lake during 1988 in the White Oak Creek arm. This introduced aquatic plant species has the ability to outcompete native species and colonize large areas of the lake.

A wildlife management plan was established for Harris Lake and surrounding lands in 1984. Various management activities were initiated to enhance wildlife habitat and game land agreements were made between Carolina Power & Light Company and the North Carolina Wildlife Resources Commission to provide public access to the management areas.

## OBJECTIVES

The primary objective of the 1990 Harris Nuclear Power Plant nonradiological environmental monitoring program was to continue to support the Environmental Protection Plan for the Harris Nuclear Power Plant and to provide an environmental assessment of the effects of power plant operations on the water and aquatic organisms in Harris Lake.

The program included monitoring of the water quality and chemistry, phytoplankton, Asiatic clams, fisheries, and aquatic vegetation of Harris Lake (Appendices 1 and 2). Various wildlife management activities were conducted on lands surrounding Harris Lake. The methods used (Appendix 3) were similar to those used in previous years. Supporting data summaries were tabulated, statistical analyses (Appendix 4) were performed, and key indicators were described to characterize the environmental quality of the lake. These key indicators were included when a significant change or abnormal event occurred, an important trend was observed, or the potential for any of these was present. Other items were included as key indicators when there was environmental, public, or regulatory interest.

## KEY INDICATORS OF HARRIS LAKE ENVIRONMENTAL QUALITY DURING 1990

### Water Quality and Chemistry
(Appendices 5-11 and 24)

1990 Conditions

- Harris Lake continued to be a warm and monomictic (one period of complete water column mixing) lake. All stations were stratified in March from about 2-4 meters (Appendix 6). The deeper stations (E2, H2, and P2) remained stratified until November.

- Portions of the deeper water strata (metalimnion and hypolimnion) exhibited near anoxic conditions (dissolved oxygen concentrations < 1.0 mg/liter) during May, July, and September 1990 (Appendix 5). At Station E2, a metalimnetic oxygen minimum (a region of low DO in the middle region of the water column) was observed in July from 4 to 6 meters.

- There were no statistical differences during 1990 between Station E2 surface and bottom waters for the variables tested except for total solids, which were more concentrated at the bottom than at the surface (Appendix 7).

- The highest turbidity measurements were recorded in March at all stations (Appendix 7). Turbidity at Station S2 was significantly higher than at the other locations with values ranging from 0.8 to 13 NTU (Appendix 8). The annual mean Secchi disk transparency values ranged from 1.1 m at Station S2 to 1.7 m at Station E2 (Appendix 8).

- Generally, nutrient concentrations (total nitrogen, total phosphorus, and total organic carbon) were greater near the dam (Station E2) and at Station H2 than towards the headwaters (Stations P2 and S2) (Appendix 8).

- The mean sodium and sulfate concentrations at Station S2 (headwaters) were significantly less than concentrations at the other stations (Appendix 8). All other annual mean ion concentrations measured (calcium, chloride, and magnesium) were similar at all stations.

- The annual mean aluminum concentration at Station S2 (120 µg/liter) was significantly greater than concentrations at the other stations (ranging from 32 µg/liter at P2 to 63 µg/liter at E2) (Appendix 9). Aluminum concentrations were greatest during January at all surface stations (Appendix 7).

- The annual mean copper concentrations remained below the North Carolina action level (7 µg/liter) during 1990 (Appendix 9). One value of 7 µg/liter was measured at Station H2 in September (Appendix 7). The mean copper concentration observed at Station E2 was significantly greater than the mean concentrations measured at Stations P2 and S2 (Appendix 9).

- The annual mean mercury concentrations were below the CP&L Chemistry Laboratory reporting limit (0.05 µg/liter) in surface water at all stations but averaged 0.08 µg/liter in the bottom water at Station E2 (Appendices 7 and 9). The North Carolina water quality standard for mercury is 0.012 µg/liter.

- Mean zinc concentrations were significantly greatest at Station E2 (22 µg/liter). These concentrations decreased along an upstream gradient to Station S2 (< 20 µg/liter) (Appendix 9). The North Carolina water quality standard for zinc is 50 µg/liter.

- All other trace elements measured (As, Cd, Cr, Pb, Ni, and Se) were below analytical reporting limits and well below North Carolina water quality standards (Appendix 9).

Year Comparisons

- The 1990 mean alkalinity and hardness concentrations were the lowest observed for the period 1986-1990 (Appendices 10 and 11).

- The annual mean total nitrogen and total phosphorus concentrations continued to increase (Appendix 11). The 1990 mean total nitrogen concentration was significantly greater than the annual means for the period 1986-1989 (Appendix 10). The 1990 mean total phosphorus concentration was not significantly different from the 1989 mean concentration but was significantly greater than the concentrations for the years 1986-1988.

- The annual mean calcium concentration exhibited a significant decrease during 1990, continuing a trend of declining values since 1988 (Appendices 10 and 11).

- The annual mean chloride concentration continued to increase over the period 1986-1990 with the 1990 annual mean concentrations significantly greater than concentrations for the years 1986-1989 (Appendices 10 and 11).

- An overall trend of increasing sulfate concentrations was observed for the period 1986-1990 (Appendices 10 and 11).

- Except for aluminum and copper, all annual mean trace element concentrations observed during 1990 were either within the ranges previously observed during the period 1986-1989, were not significantly different from values observed during the period 1986-1989, or were below laboratory reporting limits (Appendix 10).

- The 1990 mean aluminum concentration decreased from a high in 1989 (84 µg/liter) to a level within the range of values observed from 1986 to 1988 (32-56 µg/liter). The 1990 mean copper concentration (3.8 µg/liter) was significantly greater than the 1989 concentration (1.9 µg/liter).

## Phytoplankton (Algae)

(Appendix 12)

<u>1990 Conditions</u>

- Two monthly mean chlorophyll *a* concentrations (an estimate of phytoplankton biomass) in Harris Lake were above the North Carolina standard of 40 µg/liter during 1990 (72.5 µg/liter in May at E2 and 63.4 µg/liter in March at H2). The primary phytoplankton (algae) species contributing to these peaks were *Rhodomonas lacustris* and *Cryptomonas* spp. (two flagellated algae) in March and *Microcystis* sp. (a bluegreen algae) in May.

- Other criteria establishing an algal bloom condition, including units of phytoplankton per ml and approximate biovolume, were not observed.

- Monthly mean chlorophyll *a* concentrations at Stations P2 and S2 were below 40 µg/liter throughout the year.

<u>Year Comparisons</u>

- The chlorophyll *a* concentration peak at Station E2 (72.5 µg/liter) in May was the highest value reported for this station during the period 1987-1990. The peak at Station H2 (63.4 µg/liter in March) was not as high as the peak observed during 1989 (112.5 µg/liter in May) but was higher than any value observed during the 1987-1988 period.

- The annual mean chlorophyll *a* concentration at Station E2 has been increasing since 1986 (range of 9.3-27.0 µg/liter). The annual mean chlorophyll *a* concentrations at Stations H2 and P2 have increased each year since 1986 with the greatest peak in annual means occurring during 1989. However, the mean chlorophyll *a* concentration for 1990 decreased to near the 1988 mean.

- The annual mean chlorophyll *a* concentrations at Stations P2 and S2 were significantly less than concentrations measured at these stations during 1989. The annual mean chlorophyll *a* concentration at Station S2 was half the value measured in 1989. Both of these stations had higher peaks during May 1989 than for any month during 1990.

## Asiatic Clam Monitoring

- No Asiatic clams *Corbicula fluminea* were found in the intake structures or fire protection system during April or October.

- No Asiatic clams were collected in the intake canals during April. In October 1990, a single Asiatic clam was collected from the main intake canal at Station MI. Densities were estimated to be 14 clams/$m^2$ at this location. This was the first year that an Asiatic clam was collected in the main intake canal.

- Samples collected during the annual shoreline survey in October indicated Asiatic clam densities increased at Station E3 (NC 42 boat ramp) from

14 clams/m$^2$ in 1989 to 58 clams/m$^2$ in 1990. Densities decreased at Station P1 (Holleman's Crossroads boat ramp) to 43 clams/m$^2$ (57 clams/m$^2$ in 1989).

- Harris Plant operations were not affected by Asiatic clams.

### Fisheries
(Appendices 13-24)

- Species composition of the fish community during 1990 (23 species representing 9 families) was similar to previous years (Appendix 13).

- The fish community was dominated by bluegill, pumpkinseed, largemouth bass, redear sunfish, black crappie, and gizzard shad (Appendices 14 and 15).

- Largemouth bass, bluegill, black crappie, pumpkinseed, redear sunfish, and channel catfish were the major sport fishes present in the reservoir (Appendices 14 and 15).

- Total biomass, as estimated by cove rotenone data, increased slightly over 1988 estimates (Appendix 15). Biomass estimates for bluegill, channel catfish, and largemouth bass increased while black crappie and gizzard shad decreased.

- Densities for all species of fish except redear sunfish decreased (Appendix 15; CP&L 1990a).

- Length-frequency distributions indicated good recruitment for most species of fish (Appendices 17-23). Generally, increased numbers of intermediate- to large- size sport fishes were collected indicating a good sport fishery existed in Harris Lake (Appendix 16).

- A survey of a largemouth bass fishing tournament during 1990 indicated that larger largemouth bass (> 355 mm) were more common than in a tournament conducted during 1987 (Appendix 24). Results from a tournament conducted during 1988 are provided for comparison only (anglers could not weigh-in fish $\leq$355 mm during this tournament).

- As in previous years, the Harris Nuclear Power Plant had no detectable impact on the Harris Lake fishery.

### Wildlife Management

- Wildlife management activities were conducted to monitor nesting activity in wood duck and bluebird nest boxes and to manage the Greentree Reservoir. No systematic terrestrial vertebrate sampling was conducted during 1990.

- Stoplogs were placed into the Greentree Reservoir spillway to create the seasonal impoundment. The Greentree basin was not flooded in 1989 due to inaccessibility caused by the poor condition of the access road. As part of the reservoir maintenance activities, the access road was improved during the spring of 1990.

- Wood duck nest boxes were checked once during March 1990 for nesting activity. Twenty-three (66 total boxes--35% occupancy) wood duck nests had been established at that time.

- Thirty-five additional wood duck nest boxes were installed in the Tom Jack arm of Harris Lake in November 1990 as a cooperative project between CP&L, the Apex Chapter of Ducks Unlimited, and a local Boy Scout troop.

- Fourteen bluebird nest boxes were checked during the spring of 1990 and old nests were removed. Boxes continued to be used regularly by bluebirds.

- The cavity trees in the red-cockaded woodpecker colony site were checked during March 1990 and no signs of activity were observed. Red-cockaded woodpeckers that occupied this colony site have not been observed since March 1987.

### Aquatic Vegetation
(Appendix 25)

- Aquatic vegetation in Harris Lake was dominated by hydrilla *Hydrilla verticillata*, a submersed, nonnative species. This species increased in areal coverage from an estimated 30 ha in 1989 to an estimated 240 ha in 1990.

- Monospecific stands of hydrilla dominated the littoral zone (less than 3 m deep) of the entire lake, except for the Buckhorn Creek arm. No hydrilla was observed in the Buckhorn Creek arm nor in the auxiliary reservoir (Area Z).

- Littoral areas of the lake not dominated by hydrilla supported moderate to dense stands of other submersed macrophytes. The dominant species were pondweed *Potamogeton berchtoldii*, spike-rush *Eleocharis baldwinii*, naiad *Najas minor*, and musk-grass *Chara* sp.

- Floating-leaf vegetation was dominated by creeping water primrose *Ludwigia uruguayensis* and lotus *Nelumbo lutea* both of which increased coverage since 1989. Large stands of creeping water primrose occurred in all major arms of the lake, primarily in coves. Coverage was greatest in the vicinity of the dam and least in the headwater areas. Lotus was restricted to several stands in the headwaters of the White Oak and Buckhorn Creek arms.

- Other species of floating-leaf plants were water shield *Brasenia schreberi* and water-lily *Nymphaea odorata*. These occurred mostly in the shallow (less than 2 m deep) portions of the headwaters of the White Oak Creek arm (Area S).

- The auxiliary reservoir continued to support only small quantities of submersed vegetation and no floating-leaf vegetation. Dominant species were musk-grass and variable leaf pondweed *Potamogeton diversifolius*.

- The species composition and distribution of emergent vegetation around both the main lake and the auxiliary reservoir remained essentially unchanged from that of previous years. The dominant species were cat-tail *Typha latifolia*, barnyard grass *Echinochloa crusgalli*, rush *Juncus effusus*, bulrushes *Scirpus cyperinus* and *S. atrovirens*, and spike-rush *Eleocharis obtusa*.

## CONCLUSIONS

During 1990, Harris Lake continued to have moderately high productivity, contain an excellent sport fishery, and support large amounts of aquatic vegetation in the littoral zone. These characteristics, as well as the colonization by Asiatic clams and hydrilla, are typical of lakes and reservoirs throughout the southeast.

The effluent discharges into the lake continued to influence certain water quality and chemistry variables. Concentrations of macronutrients, chloride, and sulfate continued to increasee throughout Harris Lake during 1990.

The increase in macronutrients, particularly phosphorus, was sufficient to elevate chlorophyll *a* concentrations at Station E2 (the station closest to the discharge point) and at Station H2. Total phosphorus and chlorophyll *a* concentrations at Stations P2 and S2 were much less than those at the stations nearer the dam. No algal blooms were observed in Harris Lake during 1990.

Alkalinity and hardness concentrations, including calcium concentrations, continued to decline but remained within the ranges typical for most North Carolina piedmont reservoirs. Water clarity increased from 1989 values, probably as a result of the decrease in precipitation during 1990.

The fish community in Harris Lake was similar to fish communities described for previous years. An abundant fishery existed dominated by bluegill, pumpkinseed, largemouth bass, redear sunfish, black crappie, and gizzard shad. Increased numbers of intermediate- to large-size sport fishes provided anglers with excellent fishing opportunities. The differences observed in biomass and densities of most species from 1988 probably reflected natural variation typically observed from year to year. The Harris Nuclear Power Plant had no measurable impact on the fish population in the lake.

Asiatic clams *Corbicula fluminea* were again found at low densities in Harris Lake during 1990. A single clam was collected in the main intake canal for the first time. Harris Plant operations were not affected by Asiatic clams.

Harris Lake continued to support large amounts of submersed aquatic vegetation in most areas less than 3 m deep. The dominant species covering most of the littoral portions of the lake (except for the Buckhorn Creek arm) during 1990 was hydrilla *Hydrilla verticillata*, a nonnative species. Areal coverage for this species was 8 times the areal coverage in 1989. Creeping water primrose *Ludwigia uruguayensis* also increased coverage from that observed during 1989. The vegetation in the auxiliary reservoir remained essentially unchanged from that of previous years and had no impact on power plant operations during 1990.

Limited wildlife management activities were continued during 1990. The monitoring of nesting activity in wood duck and bluebird boxes, the installation of additional wood duck nest boxes, and the flooding of the Greentree area were the significant activities for the year.

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**Appendix 1. Harris Lake environmental monitoring program for 1990 and changes from the 1989 program.**

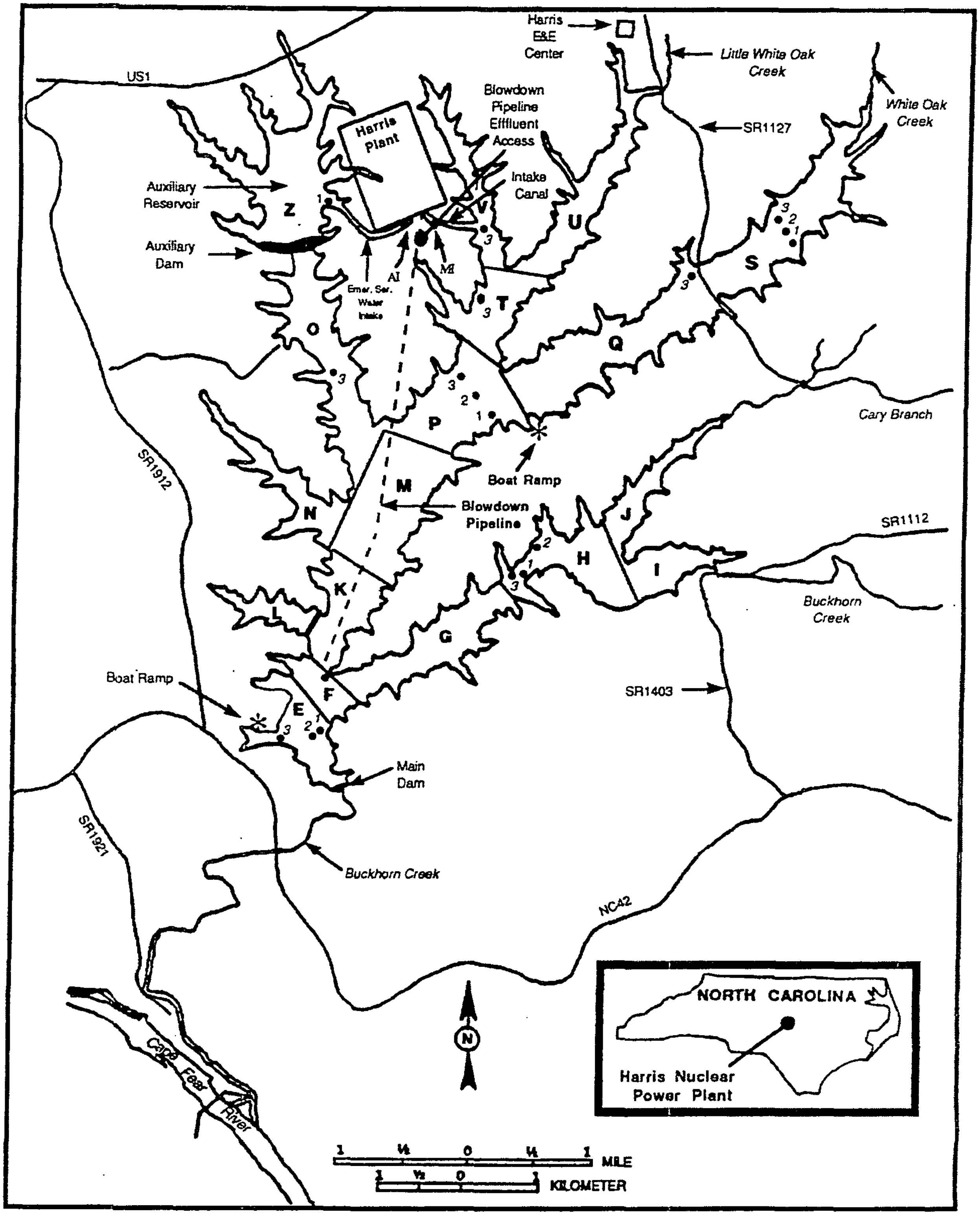
| Program | Frequency | Location |
|---|---|---|
| Water quality (temperature, DO, pH, conductivity, Secchi disk transparency) | Alternate months (Jan, Mar, May, Jul, Sep, Nov) | E2, H2, P2, S2 (surface to bottom at 1-m intervals) |
| Water chemistry | Alternate months (Jan, Mar, May, Jul, Sep, Nov) | E2 (surface and bottom); H2, P2, S2 (surface) |
| Plankton (phytoplankton+ and chlorophyll) | Alternate months (Jan, Mar, May, Jul, Sep, Nov) | E2, H2, P2, S2 |
| Asiatic clam monitoring | | |
| Shoreline survey | Once per year (Oct) | E3, H1, O3, P1, Q3, T3 |
| Survey of emergency service water and cooling tower makeup systems | Twice per year (Apr, Oct) | Emergency service water and cooling tower makeup system intake structures |
| Intake canal survey | Twice per year (Apr, Oct) | V3, Z1, MI, AI |
| Fisheries | | |
| Boat electrofishing | Once every three months (Feb, May, Aug, Nov) | E1, E3, H1, H3, P1, P3, S1, S3, V1, V3 |
| Cove rotenone | Once per year (Sep) | E, H, P |
| Aquatic vegetation survey | Spring, summer, fall | I, E, P, Q, S, V, Z |
| Wildlife management | As needed | Wildlife management areas |

+Phytoplankton samples were collected and preserved but identified only when needed to assess bloom conditions.

**Changes from the 1989 study plan to the 1990 study plan**

| Program | Change |
|---|---|
| Fisheries | Cove rotenone sampling scheduled; alternate year sampling. |
| Asiatic clam monitoring | Station designation changed from O1 to O3 and from Q1 to Q3. |

Appendix 2. Harris Lake sampling areas and stations for 1990.



**Appendix 3. Harris Lake environmental monitoring program methods for 1990.**

| Program | Methods |
|---|---|
| Water quality | Temperature, dissolved oxygen, pH, and conductivity were measured with a calibrated Martek Mark XV instrument, YSI dissolved oxygen meter, and YSI conductivity meter. Measurements were taken from surface to bottom at 1-m intervals. Secchi disk transparency was measured with a Secchi disk. |
| Water chemistry | Samples were taken with a nonmetallic Van Dorn sampler, transported to laboratory on ice, and analyzed according to USEPA (1979) and APHA (1986). |
| Phytoplankton | Equal amounts of water from surface, Secchi depth, and 2X Secchi depth were mixed and one 250-ml subsample was taken and preserved with 5 ml of "M3" fixative. |
| Chlorophyll *a* | A 1000-ml sample was taken from surface, Secchi depth, and 2X Secchi depth and then placed in dark bottles, stored on ice, and transported to the laboratory. In the lab, two 200-ml subsamples were filtered and then analyzed with a spectrophotometer. |
| Asiatic clam | In Harris Lake and the intake canal, three replicate samples were taken with a petite Ponar at 2-m depth. Samples were preserved whole with 5% formalin and returned to the lab where they were elutriated through 1000-, 500-, and 300-mesh sieves. Asiatic clams were counted, measured, and preserved.<br><br>In the intake structures, one sample was taken with a petite Ponar. The sample was taken to the lab and processed as described above.<br><br>In the fire protection sprinkler system, water from the port was sievved through a 500-mesh wash bucket for five minutes. Any accumulated material was preserved and taken to the lab for processing as described above. |
| Electrofishing | Fifteen-minute samples were collected at each station using a Smith-Root equipped Wisconsin design electrofishing boat with pulsed DC current. Fish were weighed, measured, and released. |
| Cove rotenone | Three 0.42- to 0.71-ha coves were isolated with block nets. Rotenone at the rate of 2 ppm was pumped or broadcast in the sampling area. Affected fish were collected for three consecutive days and were weighed and measured. Potassium permanganate was applied to oxidize rotenone. Subsampling was done for abundant taxa (e.g., bluegill and largemouth bass). |
| Fishing tournament | After tournament officials had recorded their necessary measurements, fish were weighed, measured, tagged, and released. |
| Aquatic vegetation | Portions of shoreline and/or littoral zone of lake and auxiliary reservoir were systematically surveyed by boat for the presence of aquatic vegetation. The location and extent of observed species were observed were shown on map and field notes. |

Appendix 4. **Statistical analyses performed on data collected in the 1990 Harris Lake environmental monitoring program.+**

| Program | Variable | Statistical tests model | Main effect(s) | Interaction term |
|---|---|---|---|---|
| Water quality | Conductivity, Secchi disk transparency | One-way | | |
| | | Two-way, block on month | Station, year | Station-by-year |
| Water chemistry | Chemical variables | One-way | | |
| | | Two-way, block on month | Station, year | Station-by-year |
| | | Paired t-test | Station: surface vs. bottom | |
| Phytoplankton | Chlorophyll *a* | One-way | | |
| | | 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 5. Water quality field data collected from Harris Lake during 1990.

### January 10, 1990

| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 6.1 | 6.4 | 5.9 | 6.9 | 10.6 | 10.0 | 10.5 | 10.2 | 6.9 | 6.6 | 6.6 | 6.3 | 61 | 66 | 71 | 59 |
| 1.0 | 6.1 | 6.4 | 5.9 | 6.8 | 10.7 | 10.1 | 10.6 | 10.2 | 6.9 | 6.7 | 6.6 | 6.3 | 63 | 66 | 71 | 60 |
| 2.0 | 6.1 | 6.3 | 5.8 | 6.8 | 10.7 | 10.1 | 10.7 | 10.2 | 6.9 | 6.7 | 6.7 | 6.3 | 63 | 66 | 72 | 60 |
| 3.0 | 6.1 | 6.3 | 5.8 | 6.8 | 10.7 | 10.2 | 10.7 | 10.3 | 6.9 | 6.7 | 6.7 | 6.3 | 63 | 68 | 72 | 61 |
| 4.0 | 6.1 | 6.2 | 5.8 | 6.8 | 10.7 | 10.0 | 10.7 | 10.3 | 7.0 | 6.7 | 6.7 | 6.3 | 64 | 68 | 72 | 61 |
| 5.0 | 5.8 | 6.1 | 5.8 | 6.7 | 10.4 | 10.0 | 10.8 | 10.2 | 7.0 | 6.7 | 6.7 | 6.4 | 65 | 68 | 72 | 61 |
| 6.0 | 5.7 | 6.1 | 5.8 | | 10.3 | 10.1 | 10.8 | | 7.0 | 6.7 | 6.7 | | 65 | 68 | 72 | |
| 7.0 | 5.5 | 6.1 | 5.8 | | 10.1 | 10.1 | 10.8 | | 6.9 | 6.7 | 6.7 | | 64 | 68 | 72 | |
| 8.0 | 5.4 | 6.1 | 5.8 | | 9.8 | 10.1 | 10.8 | | 6.9 | 6.7 | 6.7 | | 64 | 68 | 71 | |
| 9.0 | 5.4 | 6.1 | | | 9.7 | 10.0 | | | 6.9 | 6.7 | | | 64 | 67 | | |
| 10.0 | 5.4 | | | | 9.7 | | | | 6.9 | | | | 63 | | | |
| 11.0 | 5.4 | | | | 9.6 | | | | 6.9 | | | | 63 | | | |
| 12.0 | 5.3 | | | | 9.5 | | | | | | | | 62 | | | |
| 13.0 | 5.3 | | | | 9.6 | | | | 6.9 | | | | 62 | | | |
| 14.0 | 5.3 | | | | 9.1 | | | | 7.0 | | | | 63 | | | |

### March 12, 1990

| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 14.0 | 15.4 | 15.7 | 16.6 | 10.9 | 11.4 | 10.9 | 9.5 | 6.6 | 7.1 | 6.5 | 5.9 | 77 | 76 | 75 | 61 |
| 1.0 | 13.7 | 15.0 | 15.0 | 15.6 | 10.8 | 11.4 | 10.9 | 9.5 | 6.6 | 7.1 | 6.5 | 5.9 | 77 | 77 | 75 | 61 |
| 2.0 | 12.7 | 13.9 | 13.5 | 12.9 | 10.8 | 11.4 | 11.1 | 9.4 | 6.6 | 7.2 | 6.6 | 5.9 | 76 | 78 | 72 | 62 |
| 3.0 | 11.5 | 11.7 | 11.7 | 11.2 | 9.5 | 9.7 | 11.1 | 8.5 | 6.6 | 7.2 | 6.6 | 6.0 | 73 | 72 | 70 | 59 |
| 4.0 | 11.1 | 10.8 | 11.2 | 11.0 | 8.8 | 8.7 | 9.7 | 8.0 | 6.7 | 7.2 | 6.6 | 6.0 | 72 | 69 | 67 | 58 |
| 5.0 | 11.0 | 10.8 | 10.7 | | 8.4 | 8.5 | 9.1 | | 6.7 | 7.2 | 6.6 | | 71 | 70 | 67 | |
| 6.0 | 10.9 | 10.7 | 10.7 | | 8.3 | 8.5 | 8.8 | | 6.7 | 7.2 | 6.6 | | 71 | 68 | 68 | |
| 7.0 | 10.9 | 10.6 | 10.7 | | 8.2 | 8.3 | 8.6 | | 6.7 | 7.2 | 6.6 | | 72 | 67 | 67 | |
| 8.0 | 10.8 | 10.5 | 10.6 | | 8.2 | 7.5 | 8.5 | | 6.7 | 7.1 | 6.6 | | 72 | 72 | 67 | |
| 9.0 | 10.8 | | 10.6 | | 8.1 | | 8.4 | | 6.7 | | 6.6 | | 72 | | 67 | |
| 10.0 | 10.8 | | | | 8.1 | | | | 6.7 | | | | 72 | | | |
| 11.0 | 10.7 | | | | 7.9 | | | | 6.7 | | | | 72 | | | |
| 12.0 | 10.7 | | | | 7.5 | | | | 6.7 | | | | 72 | | | |
| 13.0 | 10.7 | | | | 7.3 | | | | 6.6 | | | | 72 | | | |

## Appendix 5 continued

### May 9, 1990

| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 20.6 | 22.4 | 21.9 | 22.3 | 8.0 | 8.5 | 8.2 | 7.8 | 6.4 | 7.2 | 6.1 | 6.3 | 71 | 68 | 68 | 65 |
| 1.0 | 20.5 | 22.2 | 21.9 | 22.2 | 7.8 | 8.3 | 8.0 | 7.7 | 6.4 | 7.2 | 6.1 | 6.3 | 71 | 68 | 68 | 65 |
| 2.0 | 20.0 | 22.1 | 21.8 | 21.9 | 7.5 | 8.1 | 8.0 | 7.7 | 6.4 | 7.3 | 6.1 | 6.3 | 71 | 68 | 68 | 65 |
| 3.0 | 19.5 | 21.5 | 21.7 | 21.2 | 5.4 | 6.9 | 7.9 | 6.2 | 6.3 | 7.3 | 6.2 | 6.3 | 71 | 68 | 69 | 66 |
| 4.0 | 19.2 | 20.4 | 21.6 | 19.2 | 4.7 | 5.8 | 7.7 | 5.1 | 6.3 | 7.2 | 6.2 | 6.2 | 72 | 68 | 68 | 66 |
| 5.0 | 18.5 | 19.6 | 20.1 | 19.1 | 4.3 | 4.3 | 5.1 | 4.8 | 6.2 | 7.1 | 6.1 | 6.1 | 72 | 70 | 68 | 67 |
| 6.0 | 17.4 | 17.0 | 17.5 | | 3.5 | 1.9 | 2.6 | | 6.1 | 7.0 | 6.0 | | 72 | 73 | 72 | |
| 7.0 | 16.6 | 16.1 | 16.4 | | 3.1 | 1.3 | 1.8 | | 6.1 | 7.0 | 6.0 | | 72 | 74 | 74 | |
| 8.0 | 16.1 | 15.8 | 15.7 | | 3.2 | 0.6 | 0.5 | | 6.1 | 7.0 | 5.9 | | 72 | 76 | 81 | |
| 9.0 | 15.5 | 15.2 | | | 3.2 | 0.5 | | | 6.1 | 6.9 | | | 72 | 89 | | |
| 10.0 | 14.8 | | | | 2.7 | | | | 6.0 | | | | 73 | | | |
| 11.0 | 14.4 | | | | 2.6 | | | | 6.1 | | | | 73 | | | |
| 12.0 | 13.4 | | | | 0.9 | | | | 6.0 | | | | 79 | | | |
| 13.0 | 12.0 | | | | 0.4 | | | | 6.0 | | | | 104 | | | |
| 14.0 | 11.8 | | | | 0.2 | | | | 6.3 | | | | 111 | | | |

### July 9, 1990

| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 29.5 | 29.8 | 29.2 | 29.2 | 6.1 | 6.6 | 6.9 | 6.5 | 6.6 | 6.8 | 6.7 | 6.8 | 71 | 72 | 70 | 69 |
| 1.0 | 29.2 | 29.7 | 29.2 | 29.1 | 6.0 | 6.5 | 6.7 | 6.2 | 6.6 | 6.8 | 6.7 | 6.8 | 72 | 72 | 70 | 70 |
| 2.0 | 28.5 | 29.0 | 29.1 | 29.0 | 4.2 | 5.9 | 6.7 | 6.0 | 6.6 | 6.7 | 6.7 | 6.7 | 73 | 72 | 71 | 70 |
| 3.0 | 27.5 | 28.6 | 28.7 | 28.0 | 2.0 | 5.5 | 6.1 | 0.4 | 6.4 | 6.6 | 6.7 | 6.7 | 74 | 72 | 71 | 75 |
| 4.0 | 26.1 | 27.4 | 28.6 | 25.7 | 1.0 | 4.9 | 5.6 | 0.1 | 6.3 | 6.5 | 6.7 | 6.3 | 79 | 72 | 72 | 92 |
| 5.0 | 25.5 | 26.8 | 28.4 | | 0.5 | 3.5 | 4.0 | | 6.2 | 6.4 | 6.6 | | 86 | 80 | 76 | |
| 6.0 | 23.8 | 23.2 | 26.0 | | 0.4 | 4.0 | 0.1 | | 6.2 | 6.3 | 6.5 | | 96 | 89 | 77 | |
| 7.0 | 21.4 | 21.3 | 22.0 | | 1.5 | 4.2 | 0.1 | | 6.2 | 6.3 | 6.3 | | 97 | 102 | 97 | |
| 8.0 | 20.1 | 19.9 | 20.0 | | 2.3 | 4.1 | 0.0 | | 6.3 | 6.4 | 6.3 | | 95 | 114 | 123 | |
| 9.0 | 18.9 | | | | 2.8 | | | | 6.4 | | | | 95 | | | |
| 10.0 | 17.2 | | | | 3.5 | | | | 6.4 | | | | 96 | | | |
| 11.0 | 15.9 | | | | 3.7 | | | | 6.5 | | | | 103 | | | |
| 12.0 | 14.8 | | | | 3.8 | | | | 6.6 | | | | 110 | | | |
| 13.0 | 13.4 | | | | 4.0 | | | | 6.7 | | | | 128 | | | |

## Appendix 5 continued

### September 5, 1990

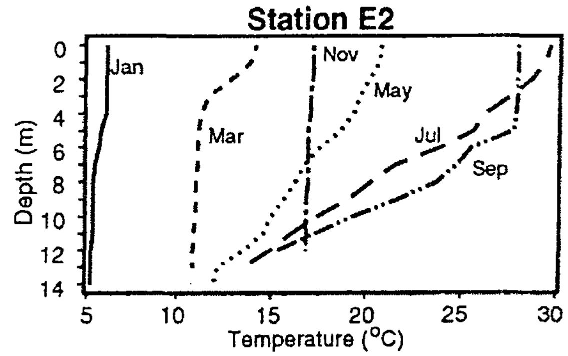
| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 27.8 | 27.3 | 27.3 | 26.8 | 6.2 | 5.3 | 5.5 | 6.1 | 7.1 | 7.6 | 6.7 | 6.6 | 77 | 75 | 77 | 75 |
| 1.0 | 27.8 | 27.2 | 27.1 | 26.6 | 6.2 | 5.2 | 5.2 | 6.0 | 7.1 | 7.5 | 6.7 | 6.6 | 77 | 75 | 77 | 75 |
| 2.0 | 27.8 | 27.2 | 26.8 | 26.0 | 6.1 | 5.0 | 4.8 | 5.6 | 7.0 | 7.4 | 6.7 | 6.6 | 77 | 75 | 77 | 76 |
| 3.0 | 27.8 | 27.2 | 26.7 | 25.7 | 6.1 | 4.8 | 4.4 | 5.3 | 7.0 | 7.3 | 6.7 | 6.6 | 77 | 75 | 77 | 76 |
| 4.0 | 27.7 | 27.1 | 26.7 | 25.6 | 5.0 | 4.3 | 4.4 | 5.0 | 7.0 | 7.3 | 6.6 | 6.6 | 77 | 76 | 78 | 76 |
| 5.0 | 27.6 | 27.0 | 26.6 | | 3.1 | 3.2 | 4.5 | | 7.0 | 7.3 | 6.6 | | 79 | 77 | 78 | |
| 6.0 | 25.4 | 26.1 | 26.2 | | 0.1 | 0.1 | 2.1 | | 6.9 | 7.0 | 6.6 | | 97 | 83 | 78 | |
| 7.0 | 24.6 | 24.7 | 23.3 | | 0.0 | 0.0 | 0.0 | | 6.8 | 6.9 | 6.5 | | 112 | 103 | 119 | |
| 8.0 | 23.6 | | | | 0.0 | | | | 6.8 | | | | 119 | | | |
| 9.0 | 21.5 | | | | 0.0 | | | | 6.8 | | | | 122 | | | |
| 10.0 | 19.1 | | | | 0.0 | | | | 6.8 | | | | 121 | | | |
| 11.0 | 17.1 | | | | 0.0 | | | | 6.9 | | | | 123 | | | |
| 12.0 | 15.2 | | | | 0.0 | | | | 6.9 | | | | 150 | | | |

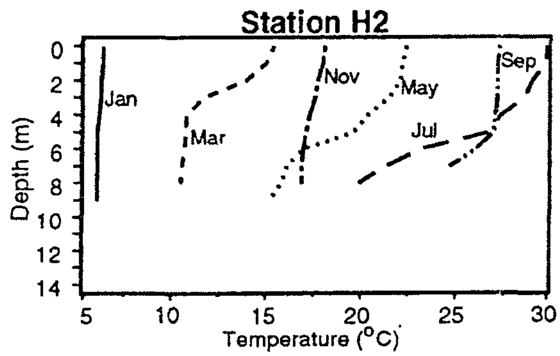
### November 6, 1990

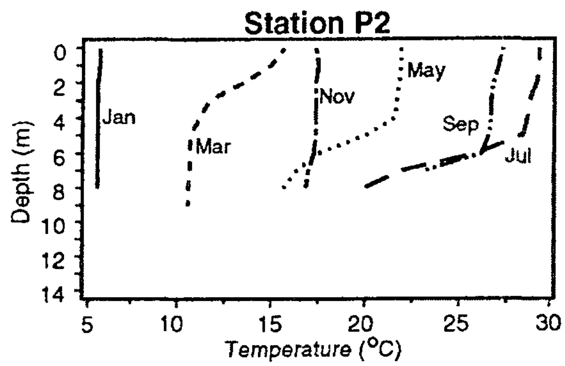
| | Temperature (°C) | | | | Dissolved oxygen (mg/liter) | | | | pH | | | | Conductivity (µS/cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth (m) | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 | E2 | H2 | P2 | S2 |
| 0.2 | 17.0 | 18.1 | 17.4 | 17.1 | 6.3 | 8.8 | 8.3 | 8.9 | 7.5 | 6.7 | 7.5 | 6.5 | 92 | 93 | 85 | 94 |
| 1.0 | 17.0 | 18.0 | 17.5 | 17.1 | 6.1 | 8.5 | 8.2 | 8.8 | 7.5 | 6.9 | 7.5 | 6.5 | 89 | 90 | 85 | 93 |
| 2.0 | 17.0 | 17.7 | 17.4 | 17.1 | 6.0 | 7.9 | 8.2 | 8.8 | 7.4 | 6.9 | 7.5 | 6.5 | 89 | 86 | 84 | 92 |
| 3.0 | 16.9 | 17.6 | 17.4 | 17.1 | 5.7 | 7.5 | 8.0 | 8.0 | 7.4 | 7.0 | 7.5 | 6.4 | 88 | 85 | 84 | 83 |
| 4.0 | 16.9 | 17.3 | 17.4 | | 5.7 | 6.5 | 7.9 | | 7.4 | 7.0 | 7.5 | | 88 | 85 | 84 | |
| 5.0 | 16.8 | 17.1 | 17.4 | | 5.4 | 6.0 | 7.9 | | 7.4 | 7.1 | 7.5 | | 87 | 84 | 84 | |
| 6.0 | 16.8 | 17.0 | 17.3 | | 5.3 | 5.4 | 7.5 | | 7.4 | 7.1 | 7.6 | | 87 | 84 | 83 | |
| 7.0 | 16.8 | 16.9 | 17.0 | | 5.3 | 5.2 | 4.0 | | 7.4 | 7.2 | 7.5 | | 87 | 84 | 83 | |
| 8.0 | 16.8 | 16.9 | 16.9 | | 5.2 | 5.5 | 3.7 | | 7.4 | 7.2 | 7.6 | | 87 | 84 | 83 | |
| 9.0 | 16.7 | | | | 5.0 | | | | 7.4 | | | | 88 | | | |
| 10.0 | 16.7 | | | | 4.9 | | | | 7.4 | | | | 87 | | | |
| 11.0 | 16.7 | | | | 5.0 | | | | 7.4 | | | | 87 | | | |
| 12.0 | 16.7 | | | | 2.3 | | | | 7.3 | | | | 88 | | | |

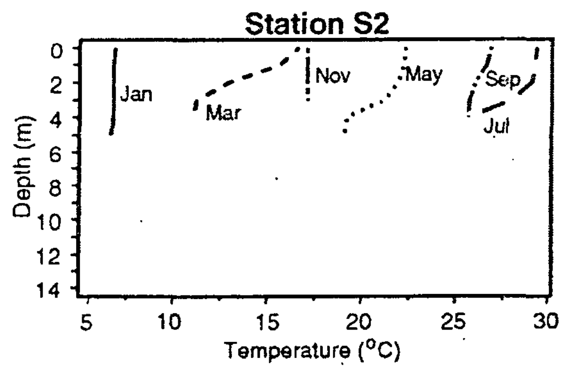
| | Secchi disk transparency (m) | | | |
|---|---|---|---|---|
| Month | E2 | H2 | P2 | S2 |
| January | 2.0 | 1.8 | 1.6 | 1.5 |
| March | 1.3 | 1.0 | 1.3 | 0.7 |
| May | 1.9 | 2.2 | 1.9 | 1.2 |
| July | 1.5 | 1.5 | 1.6 | 1.0 |
| September | 1.6 | 1.9 | 1.3 | 0.9 |
| November | 1.9 | 1.3 | 1.2 | 1.6 |

Appendix 6. Water temperature profiles at Stations E2, H2, P2, and S2 in Harris Lake during 1990.



**Appendix 7. Concentrations of chemical variables in Harris Lake during 1990. Units are in mg/liter except trace elements which are in µg/liter and turbidity which is in NTU.**

## Station E2, surface

| Month | Total Alkalinity ($CaCO_3$) | Hardness (calculated) | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | N | P | TOC | Turbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 11 | 15 | 6.2 | 10 | 3.2 | 1.8 | 7.3 | 0.75 | 0.069 | 7.7 | 3.3 |
| March | 10 | 14 | 6.1 | 10 | 2.9 | 1.6 | 7.2 | 0.42 | 0.075 | 7.1 | 4.8 |
| May | 9.1 | 14 | 5.6 | 9.2 | 2.8 | 1.6 | 6.8 | 0.75 | 0.120 | 8.0 | 2.1 |
| July | 9.0 | 13 | 6.3 | 9.3 | 2.4 | 1.7 | 7.4 | 0.49 | 0.027 | 6.3 | 2.9 |
| September | 11 | 13 | 6.7 | 9.3 | 2.3 | 1.8 | 8.0 | 0.50 | 0.042 | 6.6 | 2.5 |
| November | 13 | 15 | 7.4 | 10 | 2.7 | 2.0 | 9.7 | 0.76 | 0.035 | 7.2 | 0.6 |

| Month | TS | TSS | Al | As | Cd | Cr | Cu | Hg | Ni | Pb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | < 10 | 1 | 210 | < 1 | < 0.1 | < 2 | 6.4 | < 0.05 | < 5 | < 1 | < 1 | 40 |
| March | 60 | 3 | 25 | < 1 | < 0.1 | < 2 | 6.1 | < 0.05 | < 5 | < 1 | < 1 | 30 |
| May | 64 | < 1 | 37 | < 1 | < 0.1 | < 2 | 3.3 | < 0.05 | < 5 | < 1 | < 1 | 20 |
| July | 55 | 29 | 25 | < 1 | < 0.1 | < 2 | 4.2 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| September | 42 | 2 | < 20 | < 1 | < 0.1 | < 2 | 4.1 | 0.05 | < 5 | < 1 | < 1 | < 20 |
| November | 47 | 3 | 70 | < 1 | < 0.1 | < 2 | 3.6 | < 0.05 | < 5 | < 1 | < 1 | 20 |

## Station E2, bottom

| Month | Total Alkalinity ($CaCO_3$) | Hardness (calculated) | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | N | P | TOC | Turbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 11 | 14 | 6.2 | 10 | 3.0 | 1.7 | 7.2 | 0.76 | 0.088 | 7.4 | 4.0 |
| March | 11 | 14 | 5.9 | 10 | 2.9 | 1.6 | 6.9 | 0.47 | 0.067 | 7.0 | 7.5 |
| May | 10 | 14 | 5.6 | 9.0 | 2.9 | 1.6 | 6.7 | 0.46 | 0.070 | 7.7 | 2.0 |
| July | 29 | 18 | 6.2 | 6.7 | 4.0 | 2.0 | 7.3 | 1.6 | 0.230 | 7.5 | 4.3 |
| September | 37 | 18 | 6.1 | 3.8 | 3.9 | 1.9 | 7.0 | 1.8 | 0.430 | 7.7 | 6.6 |
| November | 13 | 14 | 7.4 | 10 | 2.6 | 1.9 | 9.7 | 0.79 | 0.033 | 7.1 | 0.6 |

| Month | TS | TSS | Al | As | Cd | Cr | Cu | Hg | Ni | Pb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 60 | 4 | 79 | < 1 | < 0.1 | < 2 | 5.5 | 0.16 | < 5 | < 1 | < 1 | 30 |
| March | 70 | 2 | 120 | < 1 | < 0.1 | < 2 | 5.4 | 0.08 | < 5 | < 1 | < 1 | 30 |
| May | 65 | < 1 | 54 | < 1 | < 0.1 | < 2 | 3.4 | 0.13 | < 5 | < 1 | < 1 | 20 |
| July | 71 | 30 | 51 | 1 | 0.2 | < 2 | 1.0 | < 0.05 | < 5 | < 1 | < 1 | 30 |
| September | 70 | 28 | 41 | 1 | < 0.1 | < 2 | 4.3 | 0.05 | < 5 | < 1 | < 1 | < 20 |
| November | 60 | 3 | 70 | < 1 | < 0.1 | < 2 | 4.2 | < 0.05 | < 5 | < 1 | < 1 | 20 |

## Appendix 7 continued

### Station H2, surface

| Month | Total Alkalinity ($CaCO_3$) | Hardness (calculated) | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | N | P | TOC | Turbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 10 | 14 | 5.7 | 8.6 | 2.9 | 1.6 | 6.3 | 0.47 | 0.020 | 6.4 | 3.3 |
| March | 10 | 14 | 6.0 | 10 | 2.8 | 1.6 | 6.9 | 0.81 | 0.110 | 6.8 | 6.0 |
| May | 9.2 | 13 | 5.4 | 8.4 | 2.6 | 1.6 | 6.5 | 0.57 | 0.066 | 8.2 | 2.1 |
| July | 4.7 | 14 | 6.3 | 9.2 | 2.5 | 1.8 | 7.2 | 0.50 | 0.027 | 6.5 | 3.1 |
| September | 11 | 12 | 6.7 | 9.1 | 2.2 | 1.7 | 7.6 | 0.43 | 0.025 | 6.7 | 2.0 |
| November | 12 | 14 | 7.4 | 10 | 2.5 | 1.8 | 9.8 | 0.86 | 0.033 | 7.2 | 1.0 |

| Month | TS | TSS | Al | As | Cd | Cr | Cu | Hg | Ni | Pb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 40 | 3 | 110 | < 1 | < 0.1 | < 2 | 2.3 | 0.06 | < 5 | < 1 | < 1 | < 20 |
| March | 70 | 6 | 20 | < 1 | < 0.1 | < 2 | 4.6 | < 0.05 | < 5 | < 1 | < 1 | 20 |
| May | 56 | < 1 | 50 | < 1 | < 0.1 | < 2 | 2.7 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| July | 55 | 35 | 22 | < 1 | < 0.1 | < 2 | 1.8 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| September | 37 | 18 | < 20 | < 1 | < 0.1 | < 2 | 7.0 | 0.05 | < 5 | < 1 | < 1 | < 20 |
| November | 56 | 2 | 30 | < 1 | < 0.1 | < 2 | 4.5 | < 0.05 | < 5 | < 1 | < 1 | < 20 |

### Station P2, surface

| Month | Total Alkalinity ($CaCO_3$) | Hardness (calculated) | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | N | P | TOC | Turbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 9.9 | 14 | 5.9 | 9.7 | 2.8 | 1.6 | 6.6 | 0.45 | 0.024 | 7.2 | 4.0 |
| March | 9.7 | 14 | 5.9 | 10 | 2.8 | 1.6 | 7.0 | 0.44 | 0.052 | 7.1 | 4.1 |
| May | 9.0 | 13 | 5.4 | 8.6 | 2.6 | 1.6 | 6.8 | 0.58 | 0.075 | 8.1 | 2.0 |
| July | 7.2 | 13 | 6.4 | 9.5 | 2.4 | 1.8 | 7.0 | 0.44 | 0.023 | 6.5 | 2.4 |
| September | 11 | 14 | 6.7 | 9.2 | 2.5 | 1.9 | 8.0 | 0.43 | 0.028 | 6.6 | 2.1 |
| November | 12 | 14 | | 10 | 2.5 | 1.8 | 10 | 0.79 | 0.032 | 7.2 | 0.8 |

| Month | TS | TSS | Al | As | Cd | Cr | Cu | Hg | Ni | Pb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 50 | 3 | 63 | < 1 | < 0.1 | < 2 | 2.7 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| March | 60 | 3 | 30 | < 1 | < 0.1 | < 2 | 4.6 | < 0.05 | < 5 | < 1 | < 1 | 20 |
| May | 85 | < 1 | 41 | < 1 | < 0.1 | < 2 | 2.4 | < 0.05 | < 5 | < 1 | < 1 | 20 |
| July | 53 | 1 | < 20 | < 1 | < 0.1 | < 2 | < 1.0 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| September | 38 | 18 | < 20 | < 1 | < 0.1 | < 2 | 3.2 | 0.05 | < 5 | < 1 | < 1 | < 20 |
| November | 135 | 3 | 40 | < 1 | < 0.1 | < 2 | 4.0 | < 0.05 | < 5 | < 1 | < 1 | < 20 |

## Appendix 7 continued

### Station S2, surface

| Month | Total Alkalinity ($CaCO_3$) | Hardness (calculated) | $Cl^-$ | $SO_4^{2-}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Na^+$ | N | P | TOC | Turbidity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 7.4 | 13 | 6.4 | 8.1 | 2.7 | 1.5 | 5.4 | 0.39 | 0.016 | 6.3 | 6.0 |
| March | 6.6 | 12 | 5.2 | 7.6 | 2.6 | 1.3 | 5.1 | 0.38 | 0.032 | 6.7 | 13 |
| May | 9.3 | 14 | 5.4 | 8.5 | 2.9 | 1.6 | 6.2 | 0.50 | 0.056 | 7.1 | 3.8 |
| July | 4.2 | + | 6.3 | 1.0 | | + | 6.8 | 0.49 | 0.031 | 6.5 | 5.4 |
| September | 12 | 14 | 6.8 | 8.7 | 2.5 | 1.8 | 7.6 | 0.41 | 0.026 | 6.6 | 4.5 |
| November | 12 | 13 | 7.2 | 9.7 | 2.4 | 1.7 | 10 | 0.59 | 0.020 | 7.0 | 0.8 |

| Month | TS | TSS | Al | As | Cd | Cr | Cu | | Ni | Pb | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 60 | 3 | 280 | < 1 | < 0.1 | < 2 | 2.8 | 0.11 | < 5 | < 1 | < 1 | < 20 |
| March | 60 | 6 | 140 | < 1 | < 0.1 | < 2 | 2.9 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| May | 70 | < 1 | 77 | < 1 | < 0.1 | < 2 | 2.3 | < 0.05 | < 5 | < 1 | < 1 | < 20 |
| July | 57 | 46 | 35 | < 1 | < 0.1 | < 2 | < 1.0 | < 0.05 | < 5 | < 1 | < 1 | + |
| September | 43 | 4 | 42 | < 1 | < 0.1 | < 2 | 1.3 | 0.05 | < 5 | < 1 | < 1 | < 20 |
| November | 45 | 4 | 140 | < 1 | < 0.1 | < 2 | 4.5 | < 0.05 | < 5 | < 1 | < 1 | < 20 |

+Sample was accidently discarded before analysis was performed.

Appendix 8. **Means and ranges of water quality and chemistry variables from the surface waters of Harris Lake during 1990.+**

| Variable | Station E2 | H2 | P2 | S2 |
|---|---|---|---|---|
| pH | 6.7 (6.4-7.5) | 6.9 (6.6-7.6) | 6.5 (6.1-7.5) | 6.3 (5.9-6.8) |
| Temperature (°C) | 19.2 (6.1-29.5) | 19.9 (6.4-29.8) | 19.6 (5.9-29.2) | 19.8 (6.9-29.2) |
| Turbidity (NTU) | 2.7[b] (0.6-4.8) | 2.9[b] (1.0-6.0) | 2.6[b] (0.8-4.1) | 5.6[a] (0.8-13) |
| Conductivity (µS/cm) | 75 (61-92) | 75 (66-93) | 74 (68-85) | 70 (59-94) |
| Dissolved oxygen (mg/liter) | 8.0 (6.1-10.9) | 8.4 (5.3-11.4) | 8.4 (5.5-10.9) | 8.2 (6.1-10.2) |
| Secchi disk transparency (m) | 1.7 (1.3-2.0) | 1.6 (1.0-2.2) | 1.5 (1.2-1.9) | 1.1 (0.7-1.6) |
| Total alkalinity¶ | 11[a] (9.0-13) | 9.5[ab] (4.7-12) | 9.8[ab] (7.2-12) | 8.6[b] (4.2-12) |
| Hardness (calculated)¶ | 14 (13-15) | 13 (12-14) | 14 (13-14) | 13 (12-14) |
| Solids (mg/liter) | | | | |
| Total solids | 45[b] (< 10-64) | 52[ab] (37-70) | 70[a] (38-135) | 56[ab] (43-70) |
| Total sususpended solids | 6 (< 1-29) | 11 (< 1-35) | 5 (< 1-18) | 11 (< 1-46) |
| Nutrients (mg/liter) | | | | |
| Total nitrogen (TN) | 0.61[a] (0.42-0.76) | 0.61[a] (0.43-0.86) | 0.52[ab] (0.43-0.79) | 0.46[b] (0.38-0.59) |
| Total phosphorus (TP) | 0.061[a] (0.027-0.12) | 0.047[ab] (0.020-0.11) | 0.039[b] (0.023-0.075) | 0.030[b] (0.016-0.056) |
| Total organic carbon | 7.1[a] (6.3-8.0) | 7.0[ab] (6.4-8.2) | 7.1[a] (6.5-8.1) | 6.7[b] (6.3-7.1) |
| TN:TP | 10 | 13 | 13 | 15 |

**Appendix 8 continued**

| Variable | Station E2 | H2 | P2 | S2 |
|---|---|---|---|---|
| Ions (mg/liter) | | | | |
| Calcium | 2.7 (2.3-3.2) | 2.6 (2.2-2.9) | 2.6 (2.4-2.8) | 2.6 (2.4-2.9) |
| Chloride | 6.4 (5.6-7.4) | 6.2 (5.4-7.4) | 6.2 (5.4-7.2) | 6.2 (5.2-7.2) |
| Magnesium | 1.7 (1.6-2.0) | 1.7 (1.6-1.8) | 1.7 (1.6-1.9) | 1.6 (1.3-1.8) |
| Sodium | 7.7[a] (6.8-9.7) | 7.4[a] (6.3-9.8) | 7.6[a] (6.6-10) | 6.8[b] (5.1-10) |
| Sulfate | 9.6[a] (9.2-10) | 9.2[a] (8.4-10) | 9.5[a] (8.6-10) | 7.3[b] (1.0-9.7) |

[+] 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 ($P > 0.05$). Sample size equaled 6 except at Station S2 for calcium, magnesium, and the associated calculated hardness where sample size equaled 5.

[¶] Total alkalinity units are mg/liter as $CaCO_3$ and hardness is calculated as mg equivalents $CaCO_3$/liter.

**Appendix 9. Means and ranges of trace elements in the surface waters of Harris Lake during 1990.[+]**

| Variable | Station E2 | Station H2 | Station P2 | Station S2 | N.C. Water Quality Standard[¶] |
|---|---|---|---|---|---|
| Aluminum | 63[b] (< 20-210) | 40[b] (< 20-110) | 32[b] (< 20-63) | 120[a] (35-280) | None |
| Arsenic | < 1 | < 1 | < 1 | < 1 | 50 |
| Cadmium | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 2 |
| Chromium | < 2 | < 2 | < 2 | < 2 | 50 |
| Copper | 4.6[a] (3.3-6.4) | 3.8[ab] (1.8-7.0) | 2.9[b] (< 1.0-4.6) | 2.4[b] (< 1.0-4.5) | 7 |
| Lead | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 25 |
| Mercury | < 0.05 (< 0.05-0.05) | < 0.05 (< 0.05-0.06) | < 0.05 (< 0.05-0.05) | < 0.05 (< 0.05-0.11) | 0.012[§] |
| Nickel | < 5.0 | < 5.0 | < 5.0 | < 5.0 | 88 |
| Selenium | < 1 | < 1 | < 1 | < 1 | 5 |
| Zinc | 22 (< 20-40) | < 20 (< 20-20) | < 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 ($P > 0.05$). Statistical analyses were run when mean concentrations were at or above the analytical reporting limits. Sample size equaled 6 (except at Station S2 for zinc and at Station H2 for lead where sample size equaled 5), and units are µg/liter.

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

[§] Laboratory detection level was 0.05 µg/liter.

**Appendix 10. Temporal trends of water quality and chemistry variables in the surface waters at Stations E2, H2, and P2 of Harris Lake, 1986-1990.[+¶]**

| Variable | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|
| pH | 6.8 | 6.5 | 6.7 | 6.8 | 6.7 |
| Temperature (°C) | 18.7 | 17.6 | 17.6 | 18.0 | 19.5 |
| Turbidity (NTU) | $3.6^{a}$ | $3.7^{a}$ | $2.8^{b}$ | $4.0^{a}$ | $2.7^{b}$ |
| Conductivity (µS/cm) | $64^{d}$ | $68^{cd}$ | $83^{a}$ | $73^{bc}$ | $75^{b}$ |
| Dissolved oxygen (mg/liter) | 8.0 | 7.5 | 8.9 | 8.4 | 8.3 |
| Secchi disk transparency (m) | $1.6^{a}$ | $1.4^{b}$ | $1.3^{b}$ | $1.4^{b}$ | $1.6^{a}$ |
| Total alkalinity (mg/liter as $CaCO_3$) | $16^{a}$ | $13^{c}$ | $15^{b}$ | $12^{c}$ | $10^{d}$ |
| Hardness (calculated)[§] | $16^{ab}$ | $15^{c£}$ | $17^{a}$ | $15^{bc£}$ | $14^{d}$ |
| Solids (mg/liter) | | | | | |
| Total solids | NS | NS | NS | $67^{a}$ | $56^{a}$ |
| Total suspended solids | NS | NS | NS | $3.0^{a}$ | $7.3^{a}$ |
| Nutrients (mg/liter) | | | | | |
| Total nitrogen (TN) | $0.35^{c}$ | $0.44^{b}$ | $0.47^{b}$ | $0.49^{b}$ | $0.58^{a}$ |
| Total phosphorus (TP) | $0.013^{c}$ | $0.024^{bc}$ | $0.028^{b}$ | $0.045^{a}$ | $0.049^{a}$ |
| Total organic carbon | $6.6^{bc}$ | $6.1^{c}$ | $6.7^{b}$ | $8.4^{a}$ | $7.1^{ab}$ |
| TN:TP | 27 | 18 | 17 | 11 | 12 |
| Ions (mg/liter) | | | | | |
| Calcium | $3.8^{a}$ | $3.5^{b}$ | $3.8^{a}$ | $3.3^{b}$ | $2.6^{c}$ |
| Chloride | $4.6^{c}$ | $4.3^{c}$ | $5.7^{b}$ | $5.5^{b}$ | $6.3^{a}$ |
| Magnesium | $1.5^{b}$ | $1.5^{b}$ | $1.7^{a}$ | $1.7^{a}$ | $1.7^{a}$ |
| Sodium | $4.9^{b}$ | $5.1^{b}$ | $7.8^{a}$ | $7.3^{a}$ | $7.6^{a}$ |
| Sulfate | $5.7^{d}$ | $6.8^{c}$ | $8.7^{ab}$ | $7.8^{b}$ | $9.4^{a}$ |
| Trace elements (µg/liter) | | | | | |
| Aluminum | $32^{b}$ | $56^{b}$ | $54^{b}$ | $84^{a}$ | $45^{b}$ |
| Arsenic | < 1 | < 1 | < 1 | < 1 | < 1 |
| Cadmium | 0.2 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Chromium | < 2 | < 2 | < 2 | < 2 | < 2 |
| Copper | $1.9^{b}$ | $3.5^{a}$ | $3.7^{a}$ | $3.1^{a}$ | $3.8^{a}$ |
| Lead | < 1 | < 1 | < 1 | < 1 | < 1 |
| Mercury | $0.05^{b}$ | $0.16^{a}$ | < 0.05 | < 0.05 | < 0.05 |
| Nickel | < 5 | < 5 | < 5 | < 5 | < 5 |
| Selenium | < 1 | < 1 | < 1 | < 1 | < 1 |
| Zinc | < 20 | < 20 | < 20 | < 20 | < 20 |

[+]Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Statistical analyses were run only when mean concentrations were at or above the analytical reporting limits. Means followed by the same superscript were not significantly different ($P > 0.05$).

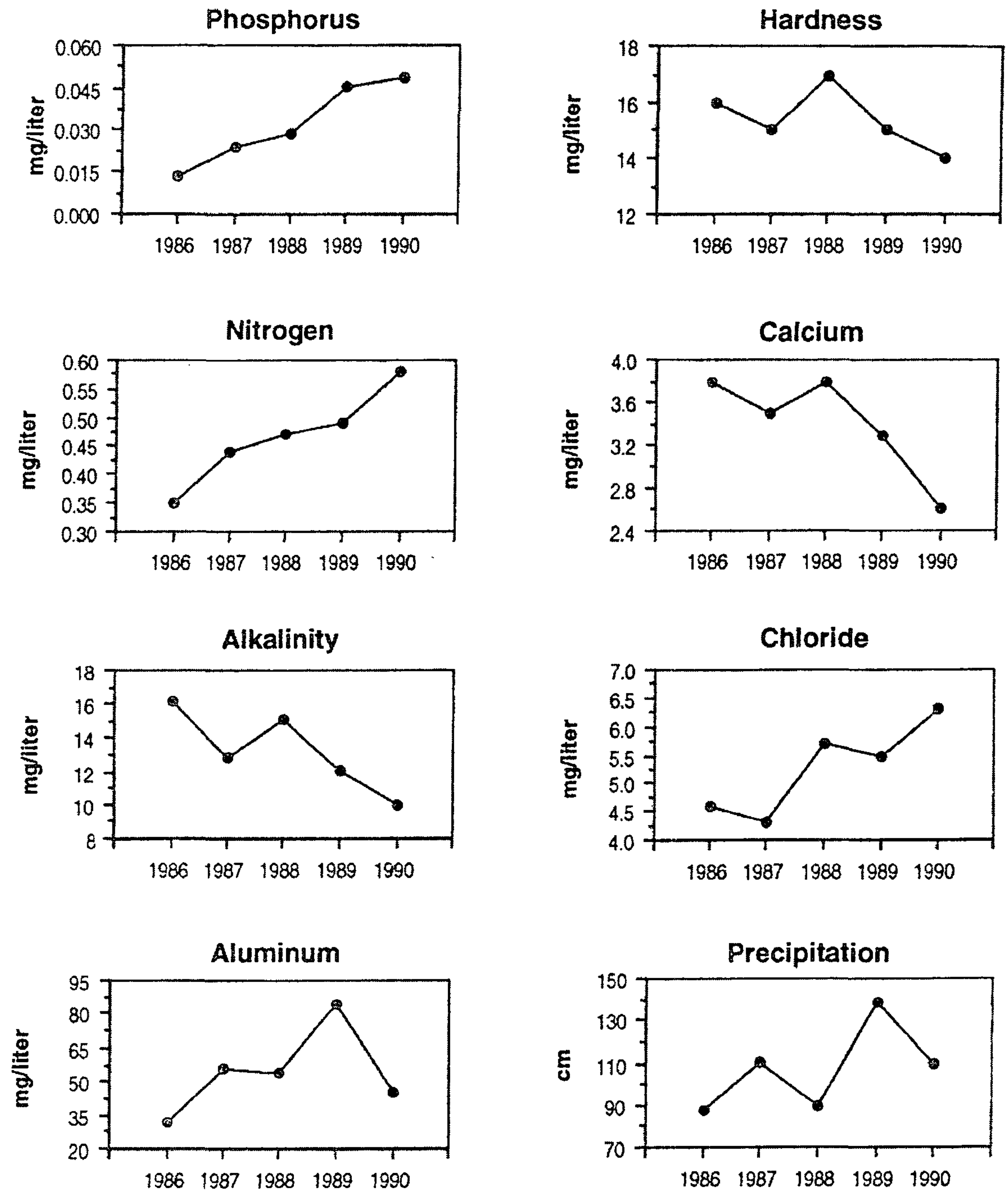
[¶]Station S2 was not sampled during 1987 and was sampled only twice in 1988; therefore, Station S2 was not included in these temporal trends.

[§]Calculated hardness as mg equivalents $CaCO_3$/liter.

[£]Data were rounded to conform to significant digit requirements. The mean separation technique may yield separations which are obscured by data rounding.

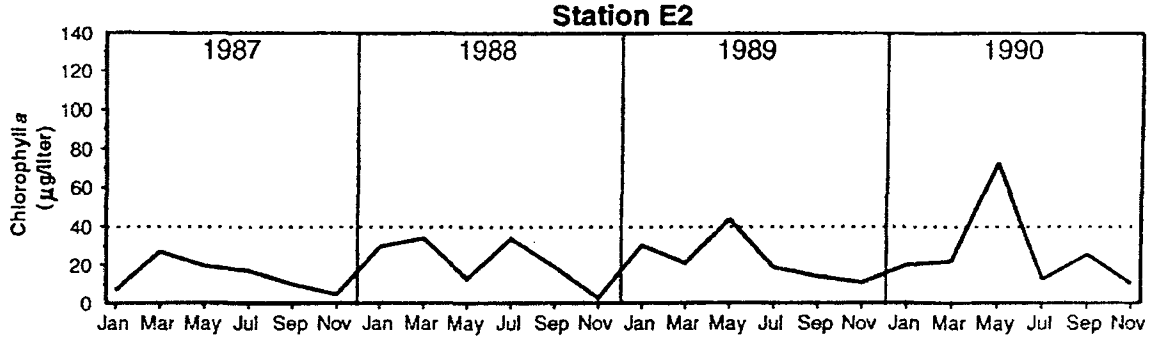
NS = Not Sampled

**Appendix 11.** **Trends of selected water quality and chemistry variables and precipitation for Harris Lake, 1986-1990.**

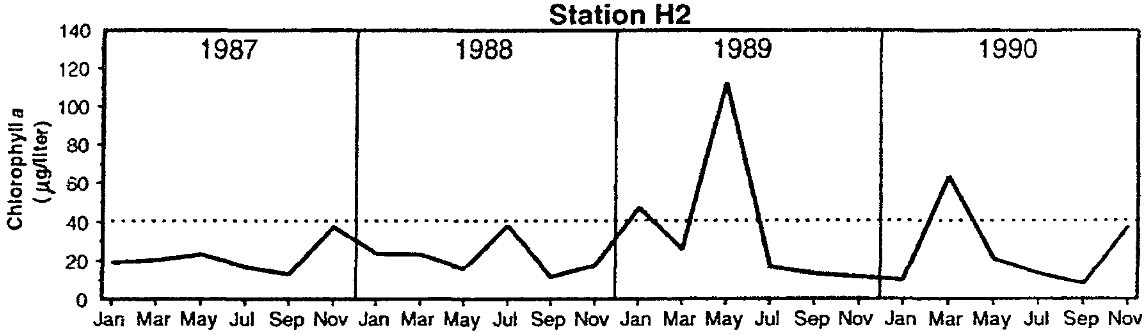


## Appendix 12. Chlorophyll *a* concentrations by station in Harris Lake, 1987-1990.

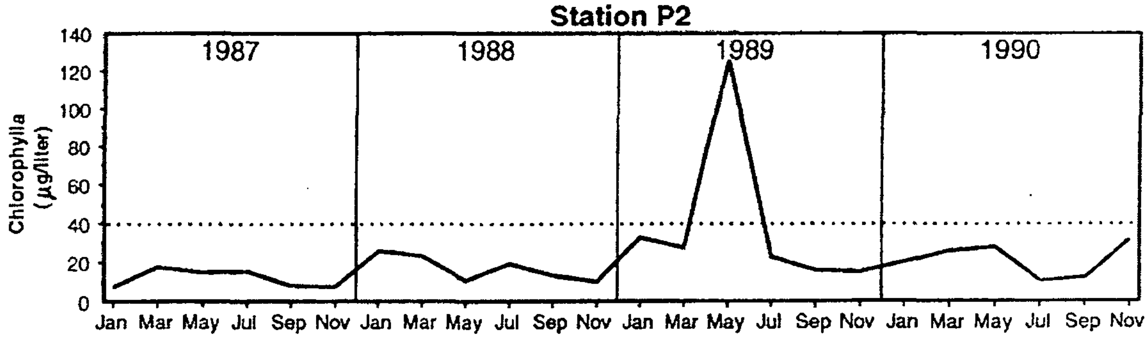
**Station E2**



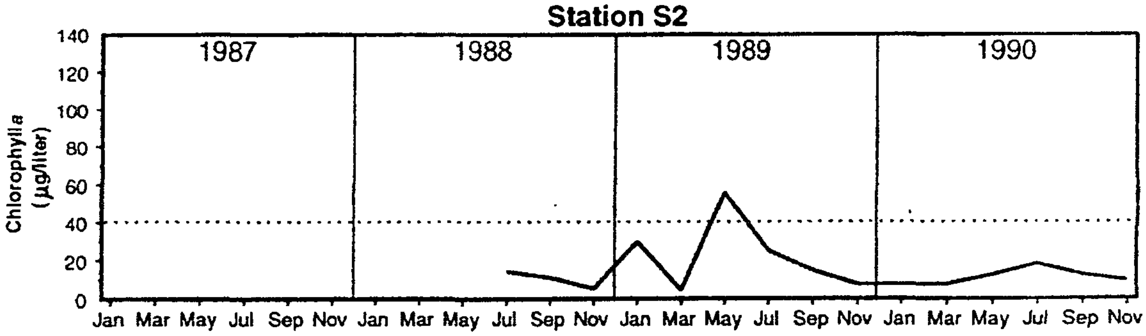

**Station H2**




**Station P2**




**Station S2**




The North Carolina water quality standard for chlorophyll a is 40 µg/liter.

**Appendix 13. Fish species collected from Harris Lake, 1985-1989 and 1990.**

| Scientific name | Common name | 1985-1989 | 1990 |
|---|---|---|---|
| **Amiidae** | **bowfins** | | |
| *Amia calva* | bowfin | X | X |
| **Anguillidae** | **freshwater eels** | | |
| *Anguilla rostrata* | American eel | X | |
| **Clupeidae** | **herrings** | | |
| *Dorosoma cepedianum* | gizzard shad | X | X |
| *D. petenense* | threadfin shad | X | X |
| **Esocidae** | **pikes** | | |
| *Esox americanus americanus* | redfin pickerel | X | X |
| *E. niger* | chain pickerel | X | X |
| **Cyprinidae** | **carps and minnows** | | |
| *Clinostomus funduloides* | rosyside dace | X | |
| *Notemigonus crysoleucas* | golden shiner | X | X |
| *Notropis petersoni* | coastal shiner | X | X |
| *N.* spp. | unidentified shiner | X | X |
| **Catostomidae** | **suckers** | | |
| *Erimyzonn oblongus* | creek chubsucker | X | X |
| *Moxostoma anisurum* | silver redhorse | X | |
| **Ictaluridae** | **bullhead catfishes** | | |
| *Ictalurus natalis* | yellow bullhead | X | X |
| *I. nebulosus* | brown bullhead | X | X |
| *I. platycephalus* | flat bullhead | X | X |
| *I. punctatus* | channel catfish | X | X |
| *I.* spp. | unidentified bullhead | X | X |
| *Noturus gyrinus* | tadpole madtom | X | |
| *N.* spp. | unidentified madtom | X | |
| *Plyodictis olivaris* | flathead catfish | X | |
| **Poeciliidae** | **livebearers** | | |
| *Gambusia affinis* | mosquitofish | X | X |
| **Centrarchidae** | **sunfishes** | | |
| *Acantharchus pomotis* | mud sunfish | X | |
| *Centrarchus macropterus* | flier | X | |
| *Enneacanthus gloriosus* | bluespotted sunfish | X | X |
| *Lepomis auritus* | redbreast sunfish | X | X |
| *L. cyanellus* | green sunfish | X | X |
| *L. gibbosus* | pumpkinseed | X | X |
| *L. gulosus* | warmouth | X | X |
| *L. macrochirus* | bluegill | X | X |
| *L. microlophus* | redear sunfish | X | X |
| *L.* sp. | hybrid sunfish | X | X |
| *L.* spp. | unidentified sunfish | X | X |
| *Micropterus salmoides* | largemouth bass | X | X |
| *Pomoxis annularis* | white crappie | X | |
| *P. nigromaculatus* | black crappie | X | X |
| *P.* spp. | unidentified crappie | X | |
| **Percidae** | **perches** | | |
| *Etheostoma fusiforme* | swamp darter | X | X |
| *E.* spp. | unidentified darter | X | X |

**Appendix 14. Fish (number/hour) collected by boat electrofisher sampling at Harris Lake during 1990.**

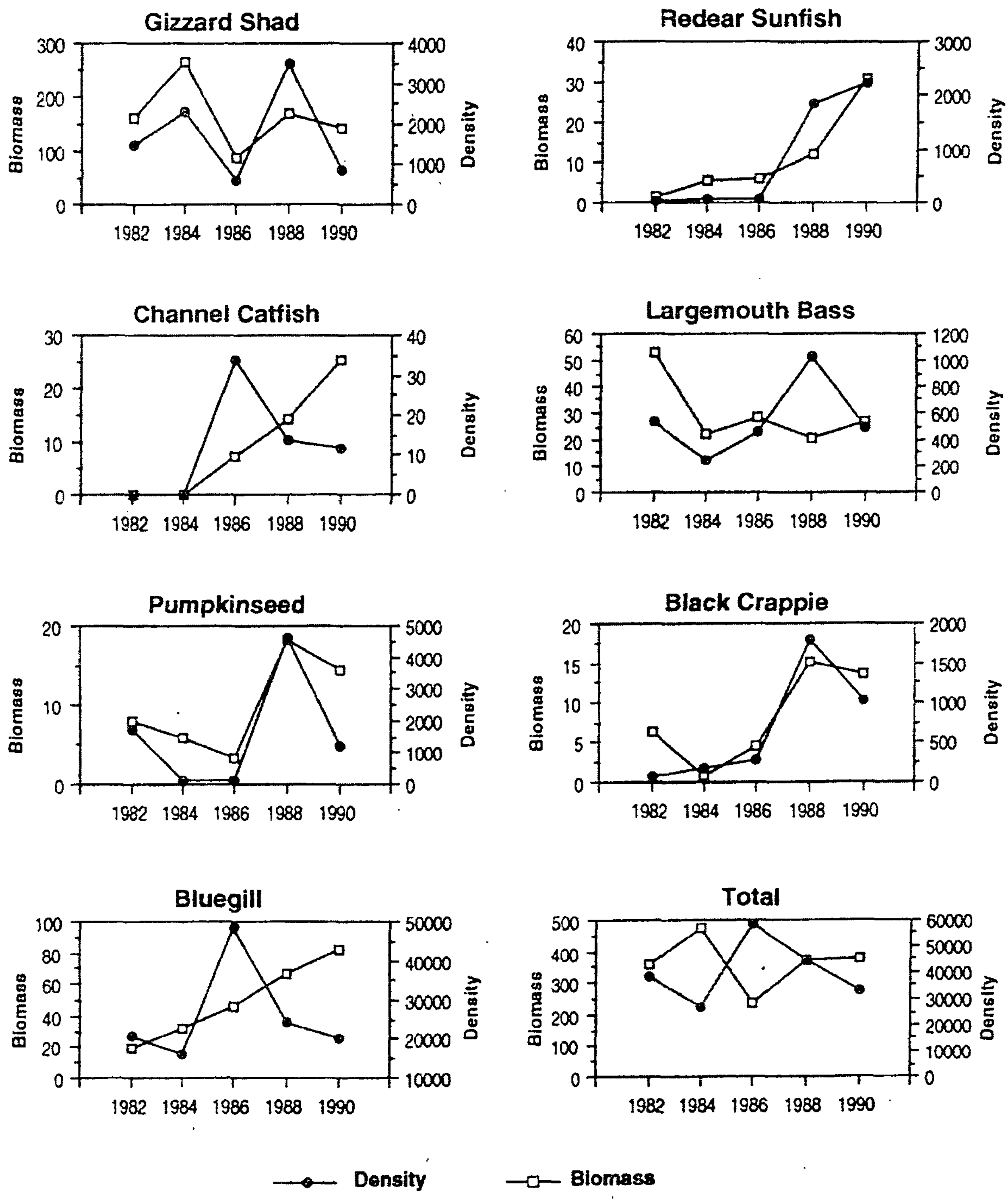
| Species | Area E | Area H | Area P | Area S | Area V | Mean |
|---|---|---|---|---|---|---|
| Bowfin | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.3 |
| Gizzard shad | 9.5 | 7.5 | 15.0 | 58.5 | 11.5 | 20.4 |
| Threadfin shad | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.1 |
| Chain pickerel | 2.0 | 1.0 | 3.0 | 4.0 | 1.0 | 2.2 |
| Golden shiner | 13.5 | 3.0 | 6.0 | 19.0 | 3.5 | 9.0 |
| Unidentified shiner | 0.5 | 0.0 | 2.5 | 0.0 | 1.0 | 0.8 |
| Coastal shiner | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| Creek chubsucker | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.1 |
| Yellow bullhead | 0.5 | 0.0 | 0.5 | 0.0 | 1.5 | 0.5 |
| Brown bullhead | 5.5 | 8.0 | 6.0 | 11.5 | 6.0 | 7.4 |
| Flat bullhead | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.2 |
| Channel catfish | 0.0 | 0.5 | 1.0 | 0.0 | 0.5 | 0.4 |
| Hybrid sunfish | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.1 |
| Bluespotted sunfish | 0.0 | 0.0 | 0.0 | 2.5 | 0.0 | 0.5 |
| Redbreast sunfish | 3.5 | 4.0 | 2.5 | 4.5 | 1.5 | 3.2 |
| Green sunfish | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.2 |
| Pumpkinseed | 18.0 | 28.5 | 13.0 | 43.0 | 50.5 | 30.6 |
| Warmouth | 1.0 | 2.0 | 5.5 | 20.5 | 9.0 | 7.6 |
| Bluegill | 19.5 | 83.0 | 53.0 | 84.0 | 285.5 | 105.0 |
| Redear sunfish | 12.0 | 21.5 | 14.5 | 28.0 | 29.0 | 21.0 |
| Largemouth bass | 25.5 | 15.5 | 26.5 | 23.0 | 28.5 | 23.8 |
| Black crappie | 5.0 | 2.0 | 6.5 | 38.5 | 24.0 | 15.2 |
| **Total** | **117.0** | **177.5** | **155.5** | **339.5** | **454.5** | **248.8** |

**Appendix 15 . Density (number/hectare) and biomass (kg/hectare) of fish collected by cove rotenone sampling at Harris Lake during 1990.**

| Species | Station E | | Station H | | Station P | | Mean | |
|---|---|---|---|---|---|---|---|---|
| | Density | Biomass | Density | Biomass | Density | Biomass | Density | Biomass |
| Bowfin | 7 | 4.4 | 0 | 0.0 | 6 | 3.5 | 5 | 2.6 |
| Gizzard shad | 765 | 113.2 | 951 | 173.2 | 875 | 134.9 | 864 | 140.4 |
| Threadfin shad | 5 | < 0.1 | 0 | 0.0 | 0 | 0.0 | 2 | < 0.1 |
| Redfin pickerel | 0 | 0.0 | 0 | 0.0 | 17 | 0.3 | 6 | 0.1 |
| Chain pickerel | 17 | 6.6 | 3 | 0.5 | 138 | 6.0 | 53 | 4.4 |
| Golden shiner | 386 | 2.0 | 96 | 1.8 | 778 | 5.5 | 420 | 3.1 |
| Unidentified shiner | 0 | 0.0 | 51 | 0.1 | 159 | 0.2 | 70 | < 0.1 |
| Coastal shiner | 284 | 0.4 | 76 | 0.1 | 73 | 0.1 | 145 | 0.2 |
| Creek chubsucker | 0 | 0.0 | 57 | 0.6 | 0 | 0.0 | 19 | 0.2 |
| Unidentified bullhead | 5 | < 0.1 | 0 | 0.0 | 5 | < 0.1 | 3 | < 0.1 |
| Yellow bullhead | 85 | 3.0 | 12 | 1.3 | 50 | 1.7 | 49 | 2.0 |
| Brown bullhead | 15 | 0.1 | 0 | 0.0 | 31 | 1.4 | 15 | 0.5 |
| Flat bullhead | 129 | 6.2 | 20 | 0.5 | 22 | 0.5 | 57 | 2.4 |
| Channel catfish | 12 | 23.9 | 0 | 0.0 | 23 | 52.8 | 12 | 25.6 |
| Mosquitofish | 190 | < 0.1 | 287 | 0.1 | 584 | 0.2 | 354 | 0.1 |
| Hybrid sunfish | 2 | < 0.1 | 0 | 0.0 | 0 | 0.0 | 1 | < 0.1 |
| Bluespotted sunfish | 19 | < 0.1 | 64 | 0.1 | 2,932 | 8.9 | 1,005 | 3.0 |
| Unidentified sunfish | 0 | 0.0 | 0 | 0.0 | 8,644 | 16.2 | 2,881 | 5.4 |
| Redbreast sunfish | 1,001 | 14.4 | 230 | 3.0 | 13 | < 0.1 | 415 | 5.8 |
| Green sunfish | 44 | 0.2 | 13 | < 0.1 | 0 | 0.0 | 19 | < 0.1 |
| Pumpkinseed | 974 | 10.5 | 584 | 15.1 | 2,140 | 17.2 | 1,233 | 14.3 |
| Warmouth | 1,113 | 15.9 | 1,075 | 8.9 | 739 | 9.2 | 976 | 11.3 |
| Bluegill | 10,555 | 91.1 | 37,824 | 76.2 | 13,094 | 79.9 | 20,491 | 82.4 |
| Redear sunfish | 1,523 | 34.1 | 3,874 | 38.4 | 1,314 | 19.6 | 2,237 | 30.7 |
| Largemouth bass | 452 | 26.1 | 226 | 23.0 | 794 | 32.1 | 490 | 27.1 |
| Black crappie | 799 | 17.8 | 484 | 8.2 | 1,775 | 14.4 | 1,019 | 13.5 |
| Unidentified darter | 0 | 0.0 | 0 | 0.0 | 6 | < 0.1 | 2 | < 0.1 |
| Swamp darter | 5 | < 0.1 | 0 | 0.0 | 63 | < 0.1 | 22 | < 0.1 |
| **Total** | **18,388** | **370.2** | **45,926** | **351.0** | **34,274** | **404.7** | **32,863** | **375.3** |

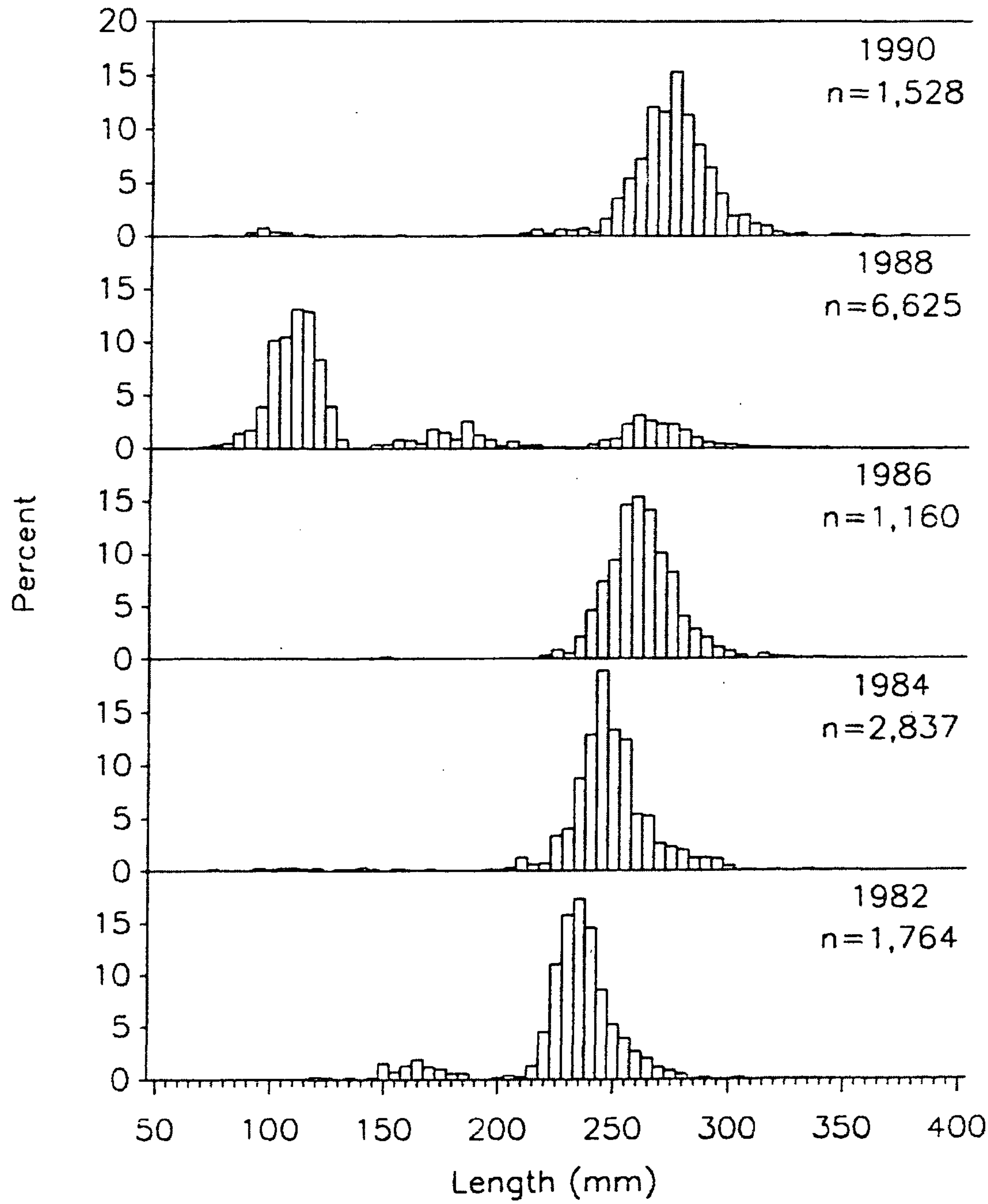
Summations may vary from column totals due to rounding.

**Appendix 16.** **Density (number/ha) and biomass (kg/ha) of selected fishes collected from Harris Lake, 1982-1990.+**

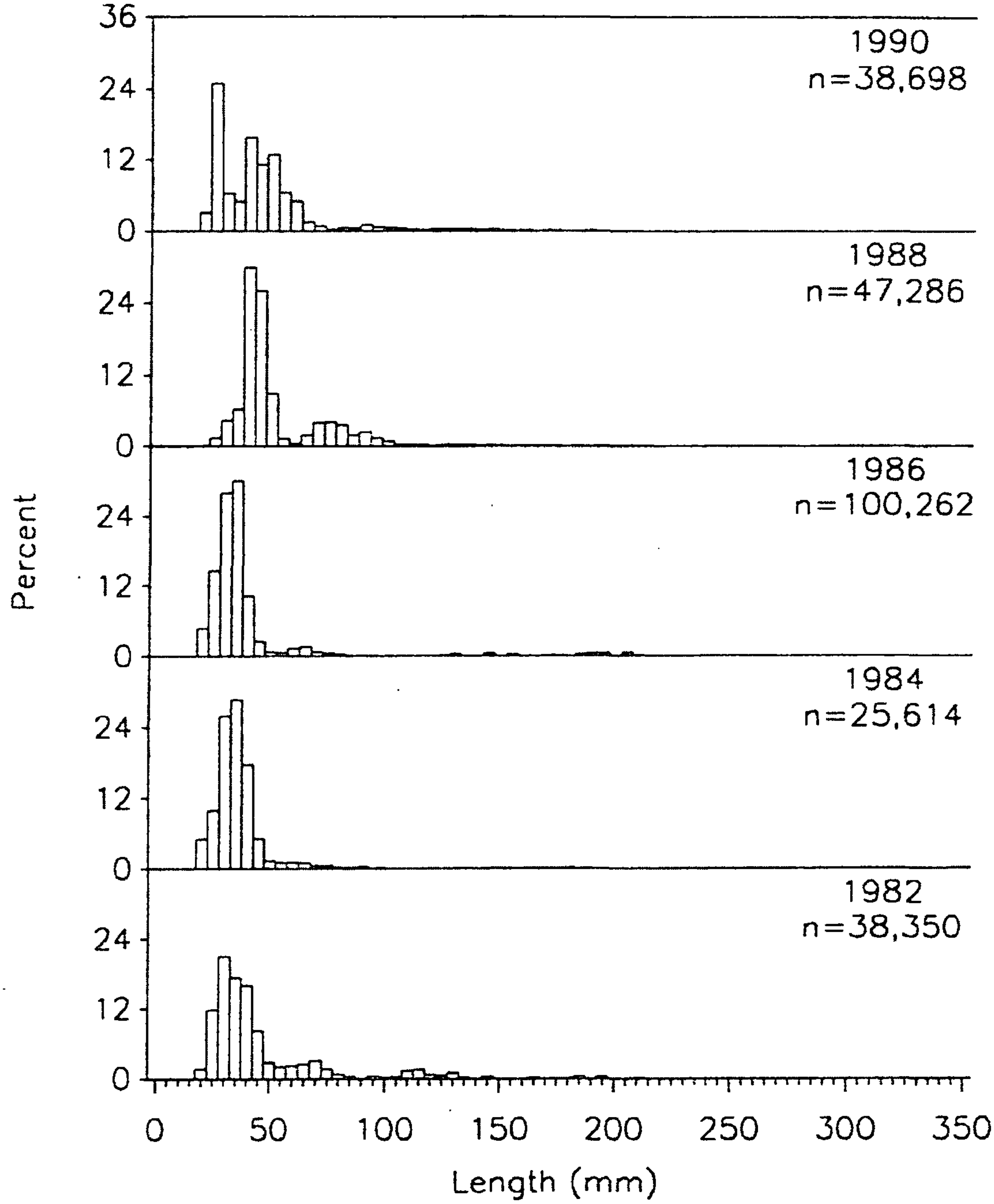



+During 1984 and 1986, pumpkinseed and redear sunfish less than 65 mm were not identified to the species level and are not included in these graphs.

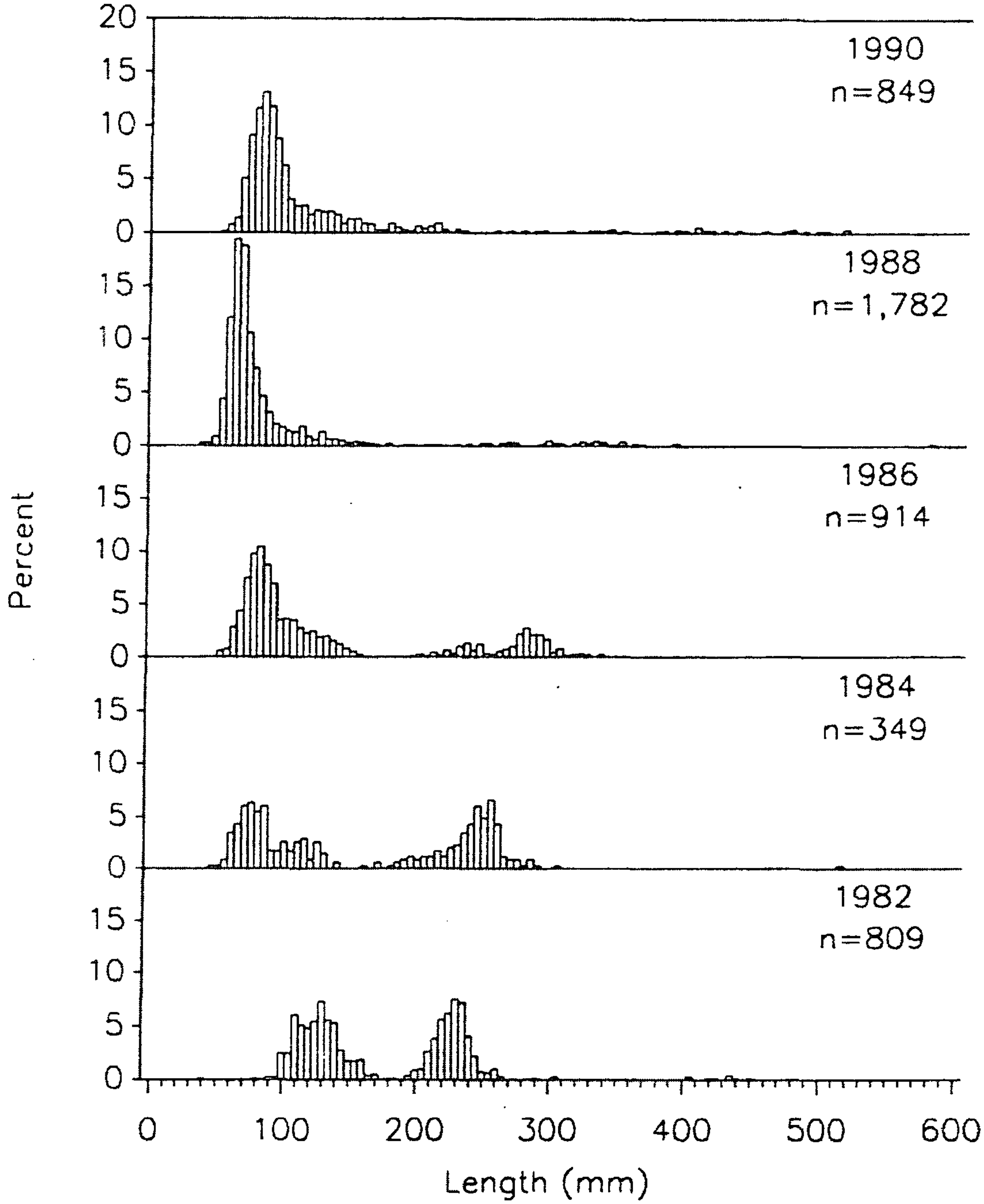
Appendix 17. Length-frequency distribution of gizzard shad collected by cove rotenone sampling at Harris Lake, 1982-1990.



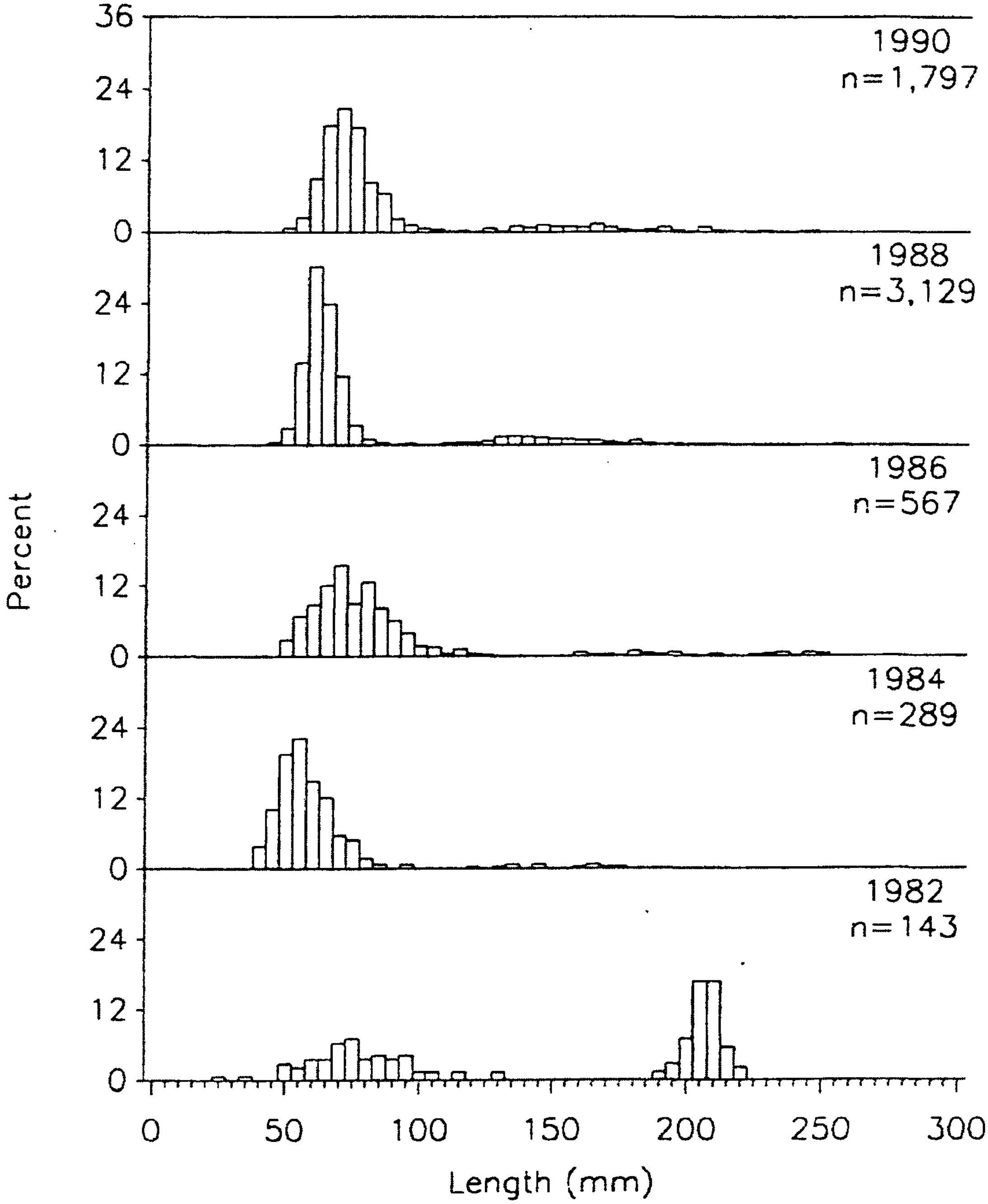
Appendix 18. Length-frequency distribution of bluegill collected by cove rotenone sampling at Harris Lake, 1982-1990.



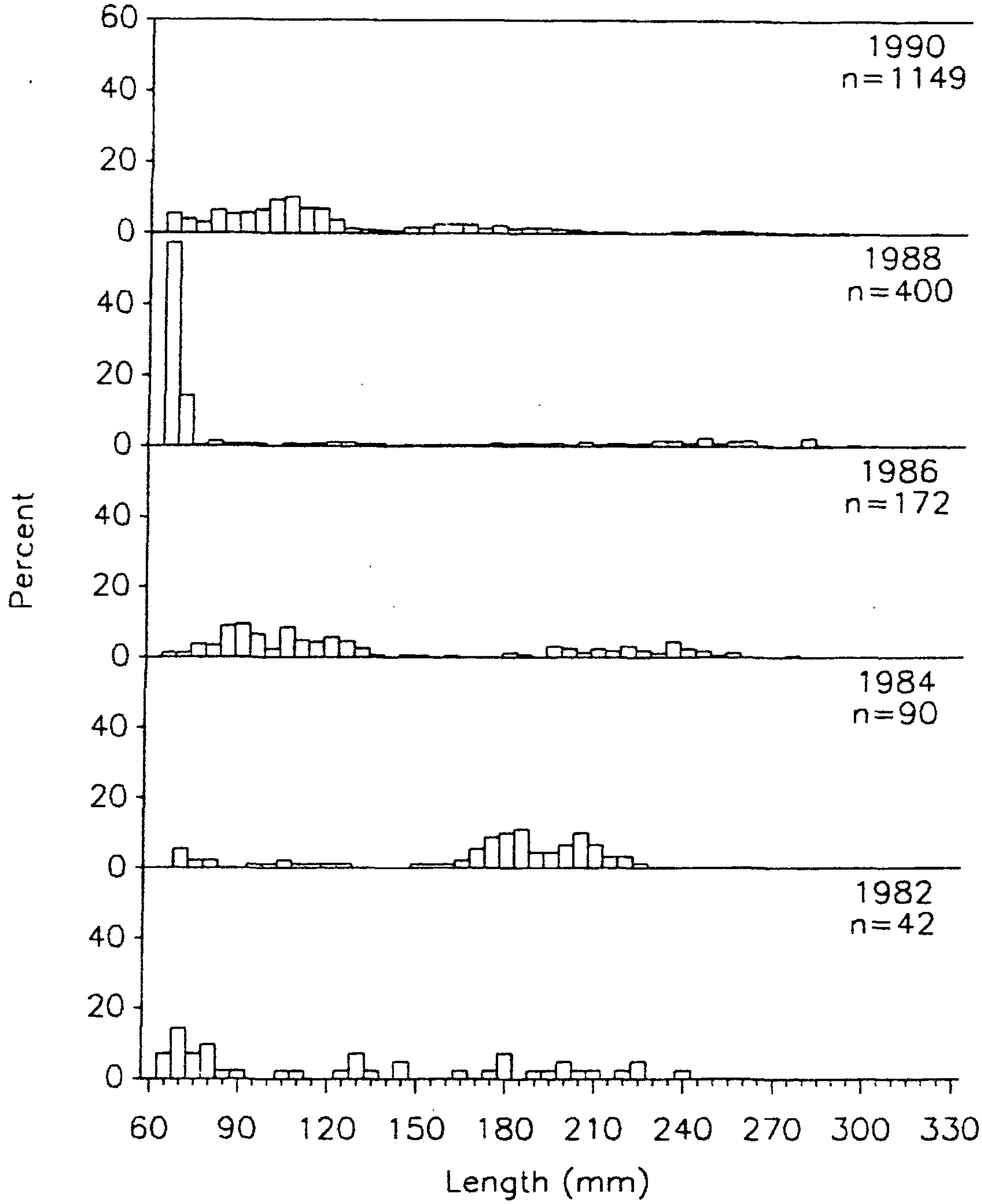
Appendix 19. Length-frequency distribution of largemouth bass collected by cove rotenone sampling at Harris Lake, 1982-1990.



Appendix 20. Length-frequency distribution of black crappie collected by cove rotenone sampling at Harris Lake, 1982-1990.

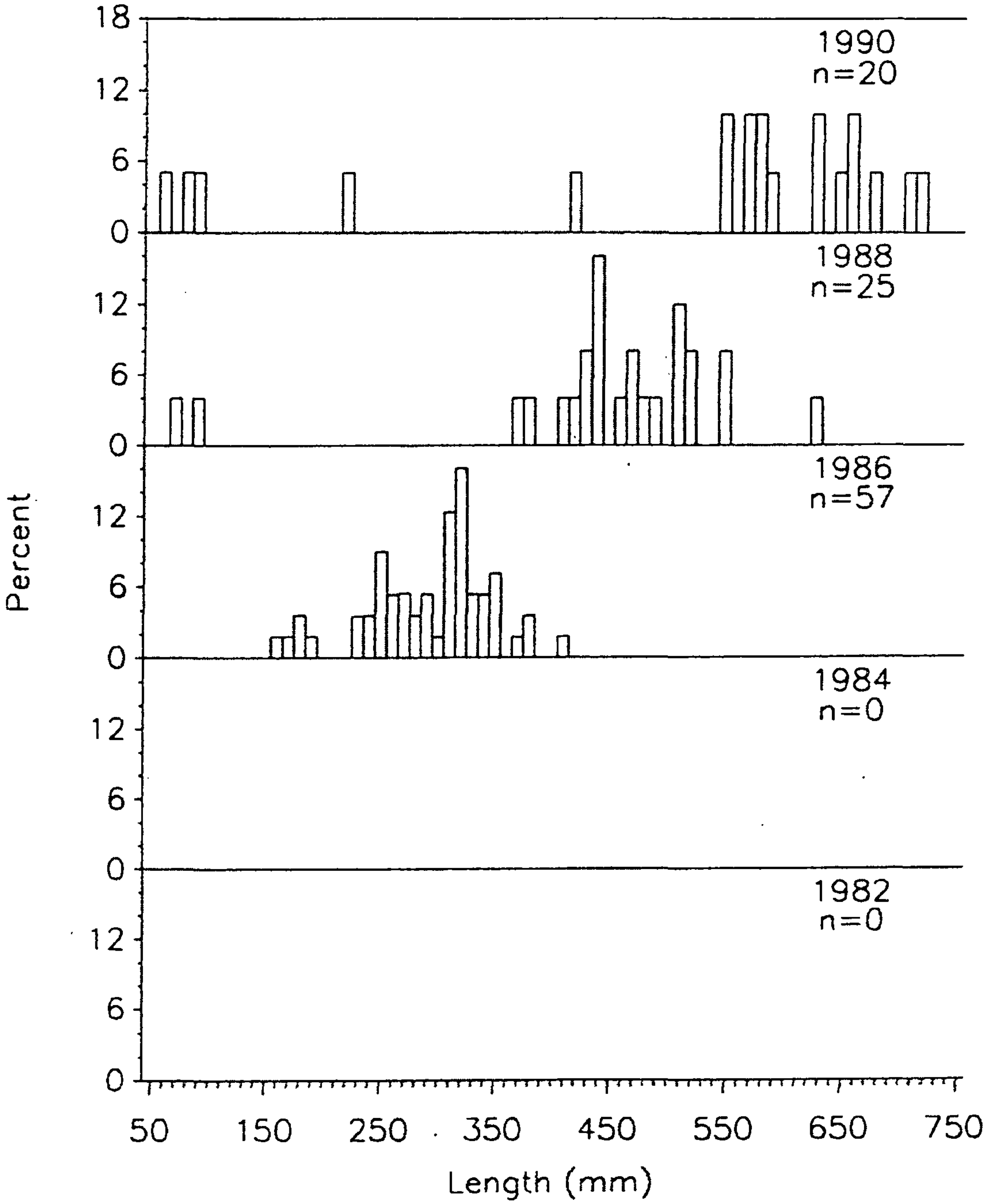


**Appendix 21. Length-frequency distribution of redear sunfish collected by cove rotenone sampling at Harris Lake, 1982-1990.**

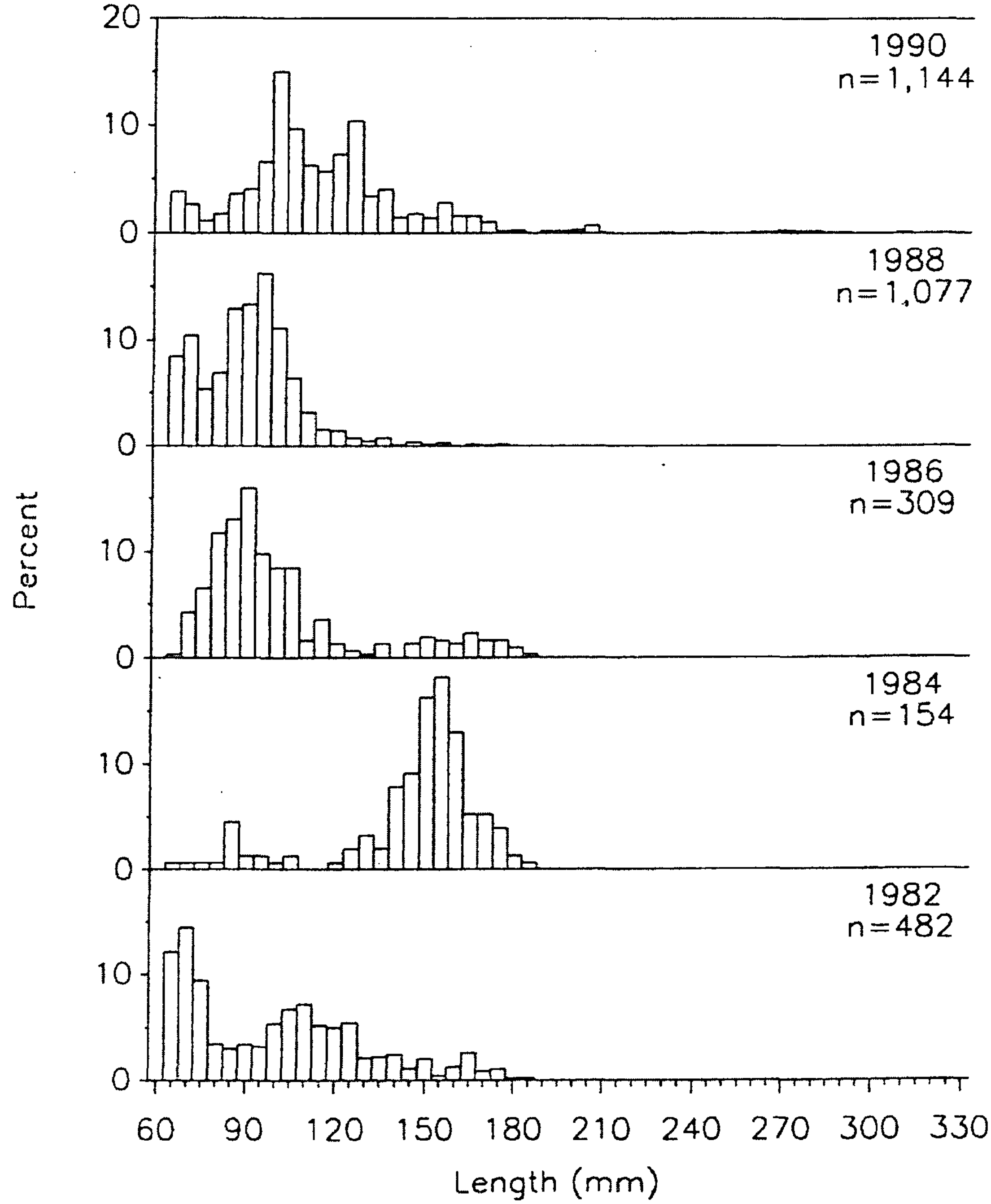



During 1984 and 1986, redear sunfish less than 65 mm were not identified to the species level and are not included in this graph.

Appendix 22. **Length-frequency distribution of channel catfish collected by cove rotenone sampling at Harris Lake, 1982-1990.**

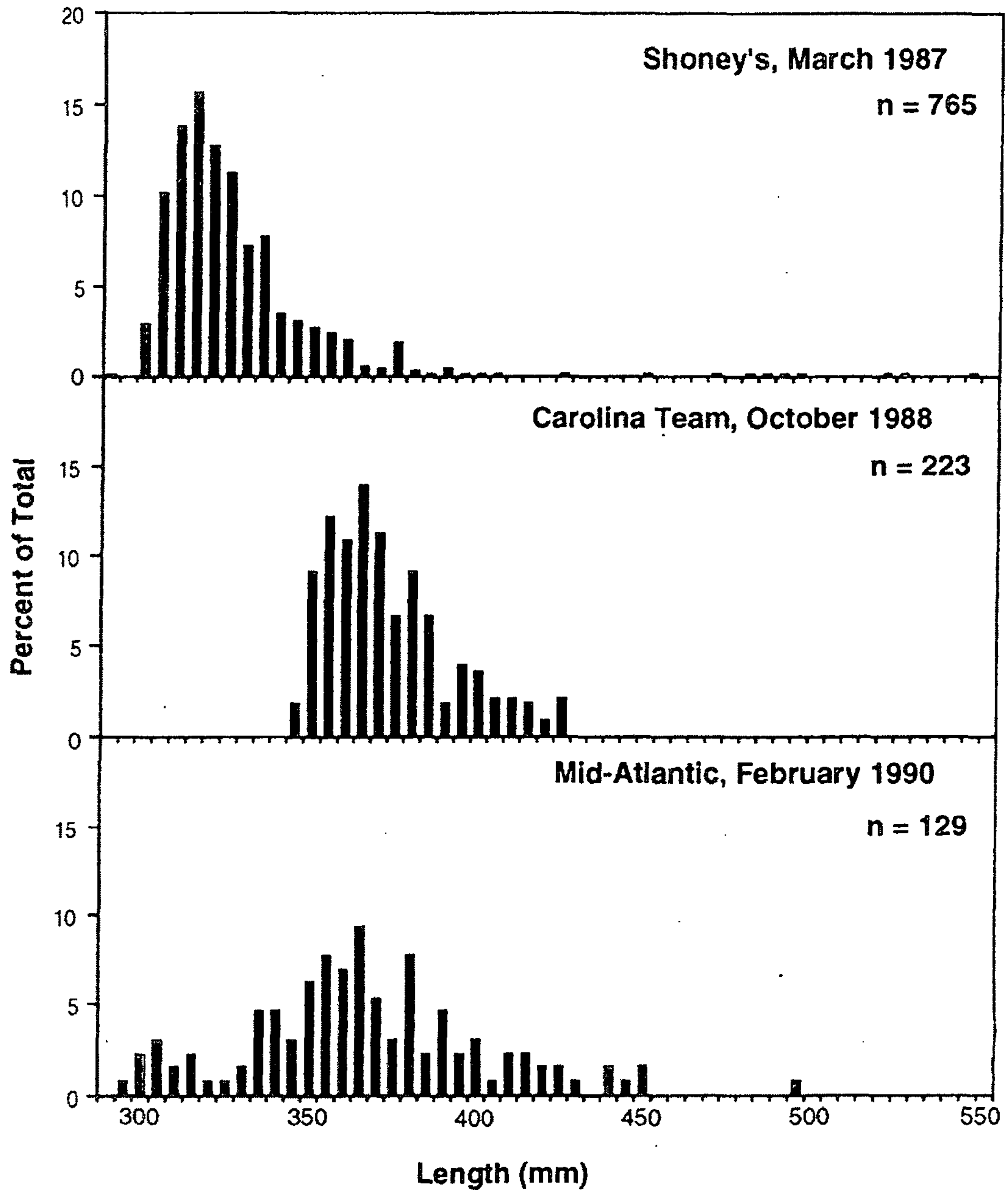


**Appendix 23. Length-frequency distribution of pumpkinseed collected by cove rotenone sampling at Harris Lake, 1982-1990.**




During 1984 and 1986, pumpkinseed less than 65 mm were not identified to the species level and are not included in this graph.

Appendix 24. Length-frequency distribution of largemouth bass collected during tournaments at Harris Lake, 1987-1990.



**Appendix 25. Dominant aquatic and wetland plants observed in or adjacent to Harris Lake and the auxiliary reservoir during 1990.**

| Submersed vegetation | Floating-leaf vegetation | Emergent vegetation |
|---|---|---|
| Characeae | Nymphaeaceae | Typhaeceae |
| *Chara* sp. | *Nymphaea odorata* | *Typha latifolia* |
| Potamogetonaceae | Nelumbonaceae | Poaceae |
| *Potamogeton berchtoldii* | *Nelumbo lutea* | *Echinocharis obtusa* |
| *P. diversifolius* | | |
| | Cabombaceae | Cyperaceae |
| Najadaceae | *Brasenia schreberi* | *Scirpis atrovirens* |
| *Najas minor* | | *S. cyperinus* |
| | Onagraceae | |
| Hydrocharitaceae | *Ludwigia uruguayensis* | Juncaeae |
| *Hydrilla verticillata* | | *Juncus effusus* |
| Cyperaceae | | Onagraceae |
| *Eleocharis baldwinii* | | *Lugwigia uruguayensis* |

Appendix 26. **Mean percent recovery and sample size of water chemistry standards for the CP&L Chemistry Laboratory for 1990.**

| Variable | Standard + | Known value | Units | n | Mean | Std.Dev. | Rec (%) | RSD (%) (1) |
|---|---|---|---|---|---|---|---|---|
| Chloride | LQC | 1.00 | mg/l | 11 | 1.00 | 0.0472 | 100 | 4.72 |
| | HQC | 2.00 | mg/l | 11 | 2.03 | 0.3328 | 102 | 16.37 |
| Total Phosphorus | QC 1 | 0.01 | mg/l | 1 | 0.011 | NA | 108 | NA |
| | QC 2 | 0.02 | mg/l | 2 | 0.021 | 0.0005 | 103 | 2.44 |
| | QC 3 | 0.005 | mg/l | 9 | 0.005 | 0.0004 | 109 | 6.53 |
| | QC 4 | 0.05 | mg/l | 8 | 0.051 | 0.0039 | 102 | 7.63 |
| Total Nitrogen | LQC | 0.10 | mg/l | 9 | 0.100 | 0.008 | 100 | 7.85 |
| | HQC | 0.20 | mg/l | 9 | 0.206 | 0.014 | 103 | 7.02 |
| | LSpike | 0.10 | mg/l | 2 | 0.086 | 0.004 | 86 | 4.65 |
| | HSpike | 0.20 | mg/l | 5 | 0.209 | 0.015 | 104 | 7.37 |
| Sulfate | LQC | 2.00 | mg/l | 11 | 2.02 | 0.037 | 101 | 1.85 |
| | HQC | 5.00 | mg/l | 10 | 4.93 | 0.097 | 99 | 1.98 |
| TOC (2) | LQC | 10.25 | mg/l | 30 | 9.88 | 0.479 | 96 | 4.85 |
| Aluminum | LQC | 50 | µg/l | 8 | 44.36 | 16.69 | 89 | 37.61 |
| | HQC | 75 | µg/l | 8 | 74.56 | 16.69 | 99 | 22.38 |
| | Spike | 75 | µg/l | 7 | 75.6 | 1.66 | 101 | 2.19 |
| Arsenic | LQC | 0.005 | mg/l | 32 | 0.0049 | 0.0002 | 98 | 3.87 |
| | Spike | 0.005 | mg/l | 62 | 0.0047 | 0.0003 | 94 | 5.51 |
| Cadmium | LQC | 0.25 | µg/l | 10 | 0.248 | 0.0094 | 99 | 3.78 |
| | HQC | 0.50 | µg/l | 10 | 0.528 | 0.0159 | 106 | 3.02 |
| | Spike | 0.25 | µg/l | 6 | 0.251 | 0.0015 | 100 | 0.59 |
| Calcium | LQC | 1.00 | mg/l | 8 | 0.99 | 0.0313 | 99 | 3.15 |
| | MQC | 5.00 | mg/l | 8 | 5.02 | 0.2071 | 100 | 4.13 |
| | HQC | 10.00 | mg/l | 8 | 10.12 | 0.2754 | 101 | 2.72 |
| | Spike | 5.00 | mg/l | 9 | 4.97 | 0.2685 | 99 | 5.40 |
| Chromium | LQC | 4.00 | µg/l | 7 | 4.28 | 0.1171 | 107 | 2.74 |
| | HQC | 6.00 | µg/l | 7 | 6.25 | 0.2015 | 104 | 3.22 |
| | Spike | 4.00 | µg/l | 6 | 4.01 | 0.0175 | 100 | 0.44 |
| Copper | LQC | 5.00 | µg/l | 6 | 5.12 | 0.148 | 102 | 2.9 |
| | HQC | 10.00 | µg/l | 6 | 10.25 | 0.424 | 102 | 4.14 |
| | Spike | 5.00 | µg/l | 8 | 4.99 | 0.021 | 100 | 0.43 |
| Lead | LQC | 2.00 | µg/l | 10 | 2.08 | 0.115 | 104 | 5.56 |
| | HQC | 5.00 | µg/l | 10 | 5.24 | 0.146 | 105 | 2.8 |
| | Spike | 2.00 | µg/l | 8 | 1.99 | 0.029 | 99 | 1.47 |
| Magnesium | LQC | 1.00 | mg/l | 9 | 1.04 | 0.025 | 104 | 2.41 |
| | MQC | 5.00 | mg/l | 9 | 5.22 | 0.154 | 104 | 2.96 |
| | HQC | 10.00 | mg/l | 9 | 10.20 | 0.263 | 102 | 2.58 |
| | MSpike | 5.00 | mg/l | 9 | 5.16 | 0.198 | 103 | 3.84 |

**Appendix 26 continued**

| Variable | Standard + | Known value | Units | n | Mean | Std.Dev. | Rec (%) | RSD (%) (1) |
|---|---|---|---|---|---|---|---|---|
| Mercury | LQC | 0.10 | µg/l | 24 | 0.103 | 0.008 | 103 | 8.15 |
| | HQC | 0.30 | µg/l | 24 | 0.296 | 0.027 | 99 | 9.12 |
| | Spike | 0.30 | µg/l | 6 | 0.303 | 0.009 | 101 | 3.13 |
| Nickel | LQC | 10.0 | µg/l | 7 | 9.86 | 0.342 | 99 | 3.46 |
| | HQC | 30.0 | µg/l | 7 | 30.26 | 10.723 | 101 | 35.44 |
| | Spike | 10.0 | µg/l | 9 | 9.66 | 0.850 | 97 | 8.8 |
| Selenium | LQC | 0.005 | mg/l | 51 | 0.0052 | 0.0001 | 103 | 2.57 |
| | Spike | 0.005 | mg/l | 115 | 0.0049 | 0.0004 | 98 | 8.01 |
| Sodium | LQC | 1.00 | mg/l | 11 | 1.01 | 0.046 | 101 | 4.55 |
| | HQC | 2.00 | mg/l | 11 | 2.20 | 0.064 | 101 | 3.19 |
| Zinc | LQC | 0.05 | mg/l | 9 | 0.046 | 0.008 | 93 | 17.08 |
| | MQC | 0.10 | mg/l | 9 | 0.099 | 0.006 | 99 | 6.51 |
| | HQC | 0.50 | mg/l | 9 | 0.509 | 0.013 | 102 | 2.49 |
| | LSpike | 0.05 | mg/l | 8 | 0.049 | 0.006 | 97 | 13.04 |

+LQC = Low-range quality control standard
MQC = Middle-range quality control standard
HQC = High-range quality control standard
Spike = Sample matrix spike

(1) RSD = Relative standard deviation = standard deviation/mean x 100

(2) Total Organic Carbon