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Harris Nuclear Plant

1994 Environmental Monitoring Report

Environmental Services Section

HARRIS NUCLEAR PLANT
1994 ENVIRONMENTAL MONITORING REPORT

Environmental Services Section

CAROLINA POWER & LIGHT COMPANY

Raleigh, North Carolina

January 1996

Reviewed and Approved by:

Superintendent
Biological Assessment Unit

Superintendent
Water & Natural Resources 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 *Environmental Services Section Biology Program 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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Thanks are also given to members of the Chemistry Laboratory Unit for conducting the chemical analyses.

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 m = 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)

Specific Conductance

Microsiemens/centimeter = μS/cm = μmhos/cm

Turbidity

NTU = Nephelometric Turbidity Unit

Water Chemistry Abbreviations

Cl^-	Chloride	TP	Total phosphorus	Cd	Total cadmium
SO_4^{2-}	Sulfate	TOC	Total organic carbon	Cu	Total copper
Ca^{2+}	Total calcium	TS	Total solids	Hg	Total mercury
Mg^{2+}	Total magnesium	TDS	Total dissolved solids	Se	Total selenium
Na^+	Total sodium	TSS	Total suspended solids	Zn	Total zinc
TN	Total nitrogen	Al	Total aluminum		
NH_3-N	Ammonia nitrogen	As	Total arsenic		

Executive Summary

Harris Reservoir was constructed by Carolina Power & Light Company to supply cooling tower makeup and auxiliary reservoir makeup water to the Harris Nuclear Plant. The Harris Nuclear Plant discharges primarily cooling tower blowdown along with low volume waste discharges into the reservoir near the main dam.

The aquatic monitoring program conducted in 1994 continued to provide an assessment of the effects of the Harris Nuclear Plant's operation on the various components of the aquatic environment. Water quality assessments in 1994 determined that total phosphorus concentrations have remained stable since 1991 and did not significantly differ from concentrations measured during 1987 and 1988. However, the annual mean total nitrogen concentrations continued to increase in 1994. The North Carolina Department of Environmental Management has recently described Harris Reservoir as "support-threatened" based on elevated nutrient levels (primarily total nitrogen).

An algal bloom (when chlorophyll *a* concentrations are ≥ 40 μg/liter) was observed in Harris Reservoir near the dam during the winter of 1994. A diatom contributed to most of the algal biomass and not the undesirable, noxious blue-green algae encountered in 1993. Algal blooms are not uncommon in Piedmont reservoirs, though they are indicators of elevated nutrient concentrations (i.e., phosphorus and nitrogen), and have occurred periodically in Harris Reservoir. Two or more algal blooms per year have been observed from 1989 to 1993. Reservoir wide algal biomass estimates have not changed significantly since 1989.

Biofouling by introduced nonnative organisms--the Asiatic clam and the aquatic plant hydrilla--did not affect Harris Plant operations. During 1994 Asiatic clams were collected for the first time from the auxiliary reservoir intake canal. No clams have been collected in the auxiliary intake structures or in the fire protection system. Hydrilla continued to be widespread throughout the reservoir and has become established in the auxiliary reservoir. Zebra mussels, another potentially nuisance biofouling organism, have not been collected in the main or the auxiliary reservoirs. To date, this organism has not been found in North Carolina waters.

During 1994 the fishery continued to be dominated by several species of sunfish and largemouth bass. The electrofishing catch rates of total fish in 1994 rebounded from a one year decrease in 1993 to rates comparable to catch rates from the previous five years. Size distribution and body condition indicators of the quality of several species in the Harris Reservoir fishery indicated a healthy population during 1994. For example, approximately 50% of the largemouth bass caught in 1994 by electrofishing were ≥ 380 mm which indicated a good fishery available for anglers. Young-of-year recruitment of largemouth bass was also good. However, estimates of sunfish young-of-year recruitment continued to be low. The specific causes for the apparent low young-of-year recruitment were unknown but may be an artifact of geartype sampling bias or the inability to effectively sample the shallow water areas infested with hydrilla which cover a substantial portion of the near-shore zone of the main reservoir.

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HARRIS NUCLEAR PLANT
1994 ENVIRONMENTAL MONITORING REPORT

Reservoir Description

The main body of Harris Reservoir has a surface area of 1680 ha; the auxiliary reservoir has a surface area of 130 ha (Appendix 1). The main reservoir has a maximum depth of 18 m, a mean depth of 5.3 m, a volume of 8.9×10^7 m^3, a full-pool elevation of 67.1 m (220 ft) National Geodetic Vertical Datum (NGVD), and an average residence time of 28 months. The reservoir began filling in December 1980, and full-pool elevation was reached in February 1983. The 64.5-km shoreline is mostly wooded, and the 183.9-km^2 drainage area is mostly rolling hills with land used primarily for forestry and agriculture.

Harris Reservoir has a "Class C" water quality classification (NCDEM 1994a). Class C waters are suitable for aquatic life propagation and maintenance of biological integrity (including fishing and fish), wildlife, secondary recreation, agriculture, and any other usage except for primary recreation or as a sources of water supply for drinking, culinary, or food processing purposes (NCDEM 1994b).

Historical Overview

Harris Reservoir was constructed to supply cooling tower makeup and auxiliary reservoir makeup water to the 900-MW Harris Nuclear Plant which began commercial operation in May 1987. In 1986 the bottom waters of the reservoir near the main dam began receiving National Pollution Discharge Elimination System (NPDES)-permitted wastewater discharges. Tributaries also receive NPDES-permitted discharges from the Harris Energy and Environmental Center and from wastewater treatment plants at Apex and Holly Springs.

The environmental monitoring programs that were conducted prior to commercial operation of the Harris Nuclear Plant determined that Harris Reservoir was a typical southeastern, moderately productive reservoir with environmental characteristics of the presence of oxygen-deficient subsurface waters, elevated nutrient and algal concentrations, an abundance of rooted shallow-water aquatic plants, and a productive sport fishery.

The years following impoundment, the reservoir became increasingly biologically productive. In 1987 macronutrients (as estimated by total phosphorus and total nitrogen concentrations) and ions (as estimated by total chloride and total sulfate concentrations) increased, particularly at the monitoring station closest to the dam. The increased nutrient loadings from all point and nonpoint sources accelerated the primary productivity of Harris Reservoir from low/moderate productivity to moderate/high productivity within the period 1986-1989.

Concomitantly, an increase in algal biomass (as estimated by chlorophyll *a* concentrations) was also observed throughout much of the reservoir. In May 1989 an algal bloom was observed throughout the reservoir for the first time, and chlorophyll *a* concentrations were measured above the North Carolina water quality standard (40 µg/liter) at each of the four monitoring stations. In 1990 chlorophyll *a* concentrations approached or exceeded the water quality standard on three separate occasions and in 1991, 1992, and 1993 on two separate occasions each year. In 1993 for the first time, a summertime algal bloom was dominated by undesirable blue-green algae and a nuisance species of filamentous blue-green algae *Lyngbya* sp. with the capability of causing future recreational problems was observed growing in several coves in the Buckhorn Creek Arm.

The shift in productivity has resulted in a greater volume of the bottom waters being oxygen-depleted during the summer months and diurnal fluctuations in the dissolved oxygen concentration in the shallow-water zone during the summer months. In June 1991 a die-off of freshwater mussels occurred, primarily in the Buckhorn Creek and White Oak Creek arms. This die-off was the first reported incident of this type in Harris Reservoir, and low dissolved oxygen concentrations in the shallow-water zone may have caused the die-off.

Another significant change to the reservoir's benthic invertebrate community since impoundment was the colonization of the reservoir by the Asiatic clam (*Corbicula fluminea*) in 1984. This nonnative organism has the potential to block power plant pipes and tubes in raw-water systems. Increases in population densities of the clam were not detected until 1988 when samples collected near the two public boat ramps indicated "moderate" densities. Although densities remained at low levels during 1991 and 1992 (based on results from the reservoirwide monitoring program), the presence of shells along the shoreline in many areas has indicated that the clam has continued to spread throughout the main reservoir. One clam was collected from the main intake canal in 1990. There have been no incidences of biofouling by the Asiatic clam within the Harris Nuclear Plant, and operations have not been affected by their presence in the main reservoir. The current standard and widely accepted chlorination practice and schedule and the use of other biocides have been effective solutions to control the species in the plant's circulating water system. Environmental conditions in the plant's fire protection system have not been conducive to the species' survival in that system.

The fishery has been dominated by the sport fishes--bluegill, pumpkinseed, largemouth bass, redear sunfish, and black crappie--and by the prey fish gizzard shad. Earlier studies of the age and growth of largemouth bass in Harris Reservoir documented slow growth rates during the mid-1980s. However, during 1988 and 1989 and since then, the size distributions shifted towards larger-size largemouth bass. This size shift was probably the result of the reservoir's increased primary productivity, the availability of suitable-size forage fish (due in part to the introduction of threadfin shad by the North Carolina Wildlife Resources Commission [NCWRC] in 1987), and an increased abundance of suitable-size gizzard shad. From a fisheries management perspective, the largemouth bass fishery has been considered "balanced" since the early 1990s with a shift towards intermediate- to large-size largemouth bass. No detrimental impacts on the fish community from power plant operations have been detected since the Harris Nuclear Plant became operational.

The aquatic plant hydrilla (*Hydrilla verticillata*) was initially found in 1988 growing in the White Oak Creek arm. Within a two-year period, this nonnative species had displaced the native species and had become the dominant littoral zone plant species. Since 1990 creeping water primrose (*Ludwigia uruguayensis*) has also increased its littoral zone coverage in the main reservoir. A few floating fragments of hydrilla were observed in the auxiliary reservoir in 1993. Despite these shifts in the structure of the aquatic macrophyte community, the community has not impacted Harris Nuclear Plant operations.

Objectives

The objectives of the 1994 nonradiological environmental monitoring program were to (1) provide an on-going assessment of the effects of the Harris Nuclear Plant's operations on the various components of the aquatic environment in Harris Reservoir, (2) document any natural changes or changes induced by sources within the reservoir's watershed other than the power plant, and (3) assess the impact of any introduced nonnative species. These objectives have also been addressed in previous reports (e.g., CP&L 1990, 1991, 1992, 1994a, 1994b).

Methods

The 1994 environmental program included monitoring: (1) the reservoir's limnological characteristics (water quality, chemistry, and phytoplankton [algae]), (2) the Asiatic clam and fish populations, (3) the distribution of aquatic vegetation, and (4) the possible introduction of the zebra mussel and the quagga mussel (Appendices 2 and 3). Sampling methods in 1994 were similar to those used in 1993 (CP&L 1994b), except that the aquatic vegetation survey during October focused only on the distribution of hydrilla. Supporting data summaries and appropriate statistical analyses were used to describe and interpret the environmental quality of the reservoir (Appendix 4). Key environmental 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 data were included as key indicators when there was environmental, public, or regulatory interest.

The accuracy and precision of laboratory analyses of water chemistry data were determined with analytical standards, spikes, and replicates (Appendix 5). Reservoir water surface elevations and the raw data collected as part of the limnological monitoring program may be found in Appendices 6-9. In this report where concentrations were less than the laboratory reporting limit, the concentrations were assumed to be at one-half the reporting limit for the calculation of the mean.

Simple linear regression models using a $\log_{10}$ transformation of individual lengths and weights were developed to determine length-weight relationships for largemouth bass, bluegill, redear sunfish, and pumpkinseed sunfish. Relative weight (W_r) indices were also calculated based upon standard weight equations developed for bluegill (Hillman [1982]), redear sunfish (Gabelhouse [1984]), and largemouth bass (Wege and Anderson [1980]) as listed in Murphy et al. (1991).

Key Indicators of Environmental Quality During 1994

Limnology

(Appendices 6-17)

Reservoir Elevations

- Reservoir water surface elevations ranged from 217.9 to 221.1 ft NGVD (66.4-67.4 m) in 1994 (Appendix 6). Water spillage occurred from late February 1994 through mid-May 1994, the fewest number of spillage days per year for the period 1989-1994. There was no spillage from the reservoir during the remainder of the year.

Temperature

- The waters at the deeper stations (E2, H2, and P2) in Harris Reservoir were generally stratified from April (Station H2 was stratified in March) through August (except for Station E2 which remained stratified through October) and were freely circulating from January through March and from September through December (Appendices 7 and 10).

Dissolved Oxygen

- A clinograde oxygen curve was observed from May through September (October for Station E2) (Appendices 7 and 11). [A clinograde oxygen curve is defined as an abrupt depletion and undersaturation of oxygen with a concomitant increase in depth.] As water temperature increased and a well-defined thermocline developed during the summer, dissolved oxygen concentrations in the hypolimnion (bottom waters) typically decreased to anoxic (where dissolved oxygen concentrations were < 1 mg/liter) conditions (Appendices 7 and 11).

Solids, Turbidity, and Water Clarity

- During 1994, as in 1993, there were no overall consistent spatial trends among the surface waters for solids (total, total dissolved, and total suspended) or Secchi disk transparency depth data (Appendix 12). The annual mean turbidity values at the upper reservoir station (Station S2) continued to be significantly greater than the values from the middle and lower reservoir stations (Stations P2 and E2) (Appendix 12).

- There were no consistent temporal trends for the solids, turbidity, or Secchi disk transparency during the period 1987-1994 (Appendices 13 and 14).

Algal Biomass

- Mean chlorophyll *a* concentrations (an algal pigment that is used as an approximate measure of algal biomass) continued to vary widely during 1994 ranging from 1.6 to 47.7 µg/liter (Appendices 8, 12, and 15). The annual mean concentration at the headwaters at Station S2 was significantly less than mean concentrations at stations in the middle and lower reservoir areas (Appendix 12). There were no significant spatial differences in mean chlorophyll *a* concentrations from 1987 to 1994 (Appendix 13), and the annual mean chlorophyll *a* concentrations for Stations E2, H2, and P2 have exhibited no consistent temporal trend since 1987 (Appendix 14).

- The mean chlorophyll *a* concentration for February 1994 at Station E2 (47.7 µg/liter) exceeded the North Carolina water quality standard of 40 µg/liter (Appendices 8 and 15) which indicated the occurrence of an algal bloom as defined by the NCDEM (1992). *Melosira distans* (a diatom) was the dominant taxon, accounting for approximately 73% of the total algal density of 16,566 units/ml. The remaining percentage of the density was composed mainly of flagellated cryptomids (16%), green algae (5%), and additional diatom taxa (4%). No blue-green algae were identified during this bloom. Occasional chlorophyll *a* concentrations greater than the water quality standard are not an uncommon occurrence in piedmont reservoirs and have occurred periodically in Harris Reservoir since 1989. Two or more algal blooms per year have been observed from 1989 to 1993; one bloom was observed in 1994.

Nutrients

- As in 1992 and 1993, there were no significant spatial differences in mean total phosphorus concentrations in Harris Reservoir during 1994 (Appendix 12). However, mean total phosphorus concentrations remained approximately 1.4-1.6 times greater at Station E2 than at either Station H2 or P2 during the 1987-1994 period (Appendix 13). Excluding two years of high concentrations (1989 and 1990), the annual mean total phosphorus concentrations were not significantly different than concentrations from 1987 to 1994 (Appendix 14).

- There were no significant spatial differences in annual mean total nitrogen concentrations among the stations during 1994 or for the 1987-1994 period (Appendices 12 and 13). There were, however, temporal differences where the total nitrogen concentration for 1994 was significantly greater than concentrations for the years 1987-1992. The total nitrogen concentrations for 1993 and 1994 were not significantly different. A recent study by Eglinton (1994) reported that Station E2 showed a clear upward trend in total nitrogen (0.04 mg/liter/year) between 1987 and 1993.

- Because of elevated nutrient levels (primarily total nitrogen), Harris Reservoir was recently described as "support-threatened" (NCDEM 1995). Nearby Jordan Reservoir was also classified as "support-threatened" based on nutrient levels. Support-threatened reservoirs are those that fully support their designated uses but may not fully support uses in the future (unless pollution control action is taken) because of anticipated sources or adverse pollution trends (NCDEM 1994a).

Specific Conductance, Ions, and Hardness

- Specific conductance (an estimate of the concentration of the dissolved ions) ranged from 46 to 243 µS/cm throughout the water column during 1994 and increased with depth during the summer months as the reservoir became thermally stratified (Appendix 7). When the bottom waters became increasingly devoid of oxygen during stratification, conditions were favorable for chemical reduction to occur and subsequent dissolution of ions.

- During 1994 mean specific conductance was significantly greater at the main reservoir stations than at the headwaters at Station S2 (Appendix 12). During the period 1987-1994, there were no significant spatial differences (Appendix 13) and no clear temporal trends (Appendix 14) in specific conductance values.

- Excluding 1992, sodium and chloride mean concentrations have increased significantly since 1987 (Appendix 14). Sulfate mean ion concentrations for 1994 were significantly greater than the concentrations for 1993. In 1994 concentrations of most ions were significantly greater near the dam (Station E2) than at the headwater station (Station S2) (Appendix 13).

Trace Metals and Metalloids

- Excluding mercury, all metal and metalloid concentrations measured in 1994 were less than the respective North Carolina water quality standard or action level (Appendices 9 and 16).

- All mercury concentrations, except for two samples collected from the bottom waters at Station E2 (0.45 µg/liter in March and 0.07 µg/liter in October) were below the laboratory detection level of 0.05 µg/liter (Appendices 9 and 16). The lower reporting limit was increased from 0.05 to 0.20 µg/liter in November 1994. The North Carolina water quality standard for mercury is 0.012 µg/liter.

- There were no significant spatial differences in the annual mean aluminum concentrations during 1994 (Appendix 16). Station S2 in the White Oak Creek headwaters had the greatest mean and maximum mean concentrations of aluminum in the reservoir with a maximum concentration of 1,000 µg/l in 1994. The maximum concentration occurred during March, as it had in 1992 and 1993, and is probably a result of runoff following precipiation events (Appendix 9). There were no significant spatial differences in the concentrations in the surface waters at Stations E2 and P2 for the period 1987-1994 (Appendix 13). There has been no clear change in the annual mean concentration since 1988 (Appendix 14).

Chemical Constituents from the Bottom Waters at Station E2

- The bottom waters at Station E2 were anoxic (dissolved oxygen < 1 mg/liter) from June through October (Appendices 7 and 11). Under the reducing and anoxic conditions found at the sediment-water interface at this time, concentrations of most chemical constituents (i.e., total alkalinity, hardness, the solids, turbidity, total nitrogen, ammonia, total calcium, and total magnesium) increased to a maximum concentration by September or October (Appendix 9). Sulfate concentrations decreased during the stratification period because the sulfate was probably reduced to hydrogen sulfide.

- At Station E2, the bottom waters had greater concentrations compared to the surface waters for total solids, total dissolved solids, total phosporus, and copper (Appendices 12 and 16).

- In the bottom waters at Station E2, there were no significant differences among years (1987-1994) for solids (total, dissolved, and suspended solids), turbidity, nutrients (total nitrogen, nitrate + nitrite-N, ammonia-N, and total phosphorus), total organic carbon, total alkalinity, specific conductance, and metals (Appendix 17). The extreme variability in the concentrations between periods of stratification and periods of uniform mixing throughout the water column was the probable cause for being unable to detect any significant temporal differences in the chemical constituents in the bottom waters.

- There were no evident trends for concentrations of calcium, magnesium, or hardness for the period 1987-1994 in the bottom waters at Station E2 (Appendix 17). Between 1993 and 1994 concentrations of sodium, chloride, and sulfate increased to concentrations similar to values in 1992.

Biofouling Monitoring Surveys
(Appendix 18)

Asiatic Clam

- On April 6, 1994, a single Asiatic clam was collected downstream of the Bay 6 traveling screen of the Emergency Service Water intake structure. Additionally, one Asiatic clam was collected immediately downstream of the Bay 6 traveling screen for the Emergency Service Water screening structure. The density at each location was estimated to be 14 clams/m^2. No Asiatic clams were collected from the main intake canal, the Service Building fire protection system, or the auxiliary reservoir intake canal.

- On October 6, 1994, two Asiatic clams were collected from each of three locations: (1) immediately downstream of the Bay 6 traveling screen for the Emergency Service Water intake structure, (2) cooling tower makeup pump Bay C of the Emergency Service Water intake structure, and (3) intake pump Bay 8 of the Emergency Service Water screening structure. The estimated density at each location was 86 clams/m^2. Additionally, Asiatic clams were collected from a location within the main intake canal, approximately 50 m from the main intake structure, and from a location within the auxiliary reservoir intake canal, approximately 20 m from the Emergency Service Water screening structure. Estimated densities at these locations were 14 and 144 clams/m^2, respectively. Asiatic clams were also collected at the mouth of the main intake canal with densities estimated at 14 clams/m^2. No clams were collected at the mouth of the auxiliary reservoir intake canal or in the Service Building fire protection system.

- Additional samples were collected on August 22, 1994, and on October 6, 1994, in the auxiliary reservoir intake canal and near the point of discharge of a make-up water pipe at the Emergency Service Water screening structure. In August, estimated densities were greatest (603 to 3,577 clams/m^2) near the make-up water pipe and decreased with distance from this discharge. Densities on October 6, 1994, were estimated to be 3,500 clams/m^2 near the make-up water pipe.

Zebra Mussel and Quagga Mussel

- Zebra mussels (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*), potentially serious biofouling organisms to power plant operations, were not found in Harris Reservoir or the auxiliary reservoir. Although these species have yet to be reported from North Carolina, they have the potential to colonize the state during the next few years. Zebra mussels and quagga mussels are not expected to thrive in Harris Reservoir due to the suboptimal concentrations of alkalinity, calcium, total hardness, and pH (Appendix 18). These variables have been shown to be good indicators for the potential of a body of water to support these two species (Claudi and Mackie 1993).

Fisheries
(Appendices 19-25)

Community Structure (Electrofishing)

- Based upon electrofishing catch rates, bluegill was the most abundant species (118 fish/hr) during 1994 (Appendix 19). Bluegill catch rates at Areas P and V increased from 47 to 118 fish/hr and from 72 to 239 fish/hr, respectively, compared to rates in 1993. Except for 1993, the mean catch rates for bluegill have not changed significantly since 1988 (Appendices 20 and 21). Other recreationally important species (i.e., redear sunfish, largemouth bass, pumpkinseed, redbreast sunfish, and black crappie) had mean catch rates ranging from 5 to 38 fish/hr in 1994, all greater than their respective values for 1993 (Appendix 20). However, the mean catch rate for gizzard shad (4 fish/hr), a forage fish, was the lowest value since 1983.

- In 1994, areal catch rates of total fish ranged from 133 fish/hr at Area S to 388 fish/hr at Area V. Between 1993 and 1994, catch rates increased the most at Area V (2.6 times) (Appendix 19 and CP&L 1994b). The mean catch rate of total fish was significantly greater (approximately 1.5 times) during 1994 than the catch rates from 1993 and comparable to the catch rates since 1983 (except for 1989) (Appendix 21).

- The quality of the bluegill fishery was further evaluated with four fishery management length and weight indices: (1) weight-length regression relationships, (2) length-frequency index based on the concept of total lengths as a percentage of world record lengths (Gabelhouse 1984), (3) relative weight index (W_r) (Wege and Anderson (1978) in Murphy et al. 1991), and (4) length-frequency distributions:
  (1) The weight-length relationship was $Log_{10}Weight = -12.03 + 3.21 \times Log_{10}Length$, $r^2 = 0.967$, n = 622. The condition factor (the slope of the regression line) in a population of "healthy and plump" fish tends to be ≥3, whereas a less robust fish population tends to have a condition factor < 3. Based upon these criteria, this bluegill population was considered to be healthy.
  (2) The catch rates of the smaller stock-length fish have generally increased since 1986 and the 1994 catch rate (86 fish/hr) was the greatest ever recorded in Harris Reservoir (Appendix 22). The catch rate of the quality-length fish increased slightly in 1994 to 12 fish/hr.
  (3) Ideally, the relative weight index (W_r) for a well-fed healthy population of bluegill should have a mean W_r value approximating 100. A mean W_r value well below 100 would indicate an inadequate food supply or other related problems. In Harris Reservoir, although the young bluegill (total length 80-100 mm) tended to have widely variable relative weights indicative of competition for food, the population was considered healthy (Appendix 23).
  (4) The length-frequency distributions for bluegill continued to indicate low young-of-year recruitment during 1994 (Appendix 24). Bluegill young-of-year recruitment continued to be as low as that observed in 1992-1993 as indicated by few fish < 60 mm (CP&L 1994a and CP&L 1994b).

- Except for 1993, the mean catch rates for redear sunfish have not changed significantly since 1990 (Appendix 21). Like bluegill, the quality of the redear sunfish fishery was further evaluated with the four fishery management indices described earlier:
  (1) The weight-length relationship was: $Log_{10} Weight = -11.55 + 3.10 Log_{10}Length$, $r^2 = 0.991$, n = 214. Based upon the criteria described above, this redear population was considered to be healthy.
  (2) The catch rates of stock-, quality-, and preferred-length fish all increased between 1993 and 1994 (Appendix 22). The catch rates of the smaller stock-length fish in 1994 (19 fish/hr) was the greatest ever recorded in Harris Reservoir (Appendix 22). The catch rate for preferred-length fish has fluctuated between 1-6 fish/hr since 1984, while the catch rate for memorable-length fish peaked in 1990 and has subsequently declined.
  (3) With a few exceptions, the relative weight of the redear sunfish population was > 90 but below optimal (Appendix 23).
  (4) The length-frequency distribution for redear sunfish continued to indicate low young-of-year (< 60 mm) recruitment during 1994 (Appendix 24).

- The mean catch rate for pumpkinseed peaked during 1989 and has declined since then (Appendix 21). The length-weight relationship was: $Log_{10}Weight = -11.23 + 3.07 \times Log_{10} Length$, $r^2 = 0.939$, n = 59, indicative of a healthy population. However, similar to the other species of sunfish, the length-frequency histogram for pumpkinseed sunfish also continued to indicate low recruitment during 1994 as indicated by few fish < 60 mm (Appendix 24).

Largemouth Bass Population Structure

- The mean catch rate of largemouth bass increased significantly between 1993 and 1994 (Appendices 20 and 21). However, the catch rates during the early 1990s were still less than the catch rates during the late 1980s (Appendix 21). The quality of the largemouth bass fishery was further evaluated:
  (1) The weight-length relationship ($Log_{10}Weight = -12.39 + 3.21 \times Log_{10}Length$, $r^2 = 0.994$, n = 141) was indicative of a healthy population.
  (2) The length-frequency index based on world record lengths showed that the overall quality of the fishery in 1994 was similar to the fishery in 1993 as measured by this index (Appendix 22). The catch rates of stock-length, quality-length, and preferred-length fish continued to be slightly less than 3 fish/hr.
  (3) The relative weight index showed that the population was robust and healthy (mean $W_r = 100$) (Appendix 23).
  (4) The length-frequency distribution indicated good young-of-year recruitment in 1994 in contrast to the low recruitment in 1993 (Appendix 24 and CP&L 1994b). The histogram also showed a wide range (approximately 30-600 mm) in total lengths in the population.

- The quality of the largemouth bass fishery also was assessed with two interrelated indices--Proportional Stock Density (PSD) and Relative Stock Density (RSD). The PSD is a measure of the proportion of quality-size fish (fish ≥ 300 mm) in the population (all fish collected ≥ 200 mm), and the RSD is the proportion of fish of any designated size group in a population (Anderson and Gutreuter 1983). For example, an RSD-380 (i.e., preferred-length) is the proportion of the population that was ≥ 380 mm.
  (1) The PSD of largemouth bass in 1994 continued to be in the optimal range for a low density management objective (Appendix 25), indicating that the population contained quality-length fish (Gabelhouse 1984). [A low density objective is defined by Gabelhouse (1984) as where largemouth bass is the single most important species with large individuals desired.] This fishery structure was opposite the situation which occurred during the period 1983-1987, when the PSD was below the optimal level indicating that the population contained few quality-size fish.
  (2) Since 1989, the RSD-380 of largemouth bass has been in the optimal range for a moderate density objective (Appendix 25). In 1994 the RSD-380 climbed into the range of low density objective indicating that about half of the largemouth bass in Harris Reservoir was ≥ 380 mm. This proportion of the total population was the greatest since impoundment.

Aquatic Vegetation

- A visual survey made during October 1994 revealed that hydrilla (*Hydrilla verticillata*), a non-native submersed plant, was established in the littoral zone (< 3 m deep) throughout the entire reservoir, including the Buckhorn Creek arm. The total areal coverage was estimated to be approximately 445 ha (77% of the available habitat)--an increase of 12 ha since the October 1993 survey. Much of the increased acreage occurred in the Buckhorn Creek arm, and this was the first time hydrilla had been observed in this arm of the reservoir.

- As in 1993, a few floating fragments of hydrilla were observed in the auxiliary reservoir in October 1994. As a management option to control hydrilla in the auxiliary reservoir, 800 grass carp (*Ctenopharyngodon idella*) were stocked on October 13, 1994. The stocked fish were approximately 300 mm total length.

- Although hydrilla continued to expand in the main reservoir and recently colonized the auxiliary reservoir, no impacts to the Harris Plant have occurred nor are they expected because of the low velocity of water drawn from the main reservoir into the cooling tower makeup water intake structure.

Conclusions

During 1994 Harris Reservoir was a typical southeastern, biologically productive reservoir with environmental characteristics of seasonally occuring oxygen-deficient subsurface waters, elevated nutrient and algal concentrations, an abundance of rooted shallow-water aquatic plants, and a productive sport fishery.

Water quality assessments determined that reservoirwide total phosphorus concentrations were stable for the period 1991-1994. In fact, concentrations have decreased slightly during the last three years in contrast to concentrations measured during 1989-1990. However, annual mean total nitrogen concentrations continued to increase during this same period.

One algal bloom occurred during February 1994 in Harris Reservoir and consisted primarily of the diatom *Melosira distans*. It did not result in a fish kill. Algal blooms are not uncommon in Piedmont reservoirs though they do indicate elevated nutrient levels.

Biofouling by the Asiatic clam and the aquatic plant hydrilla did not impact Harris Plant operations. No clams were collected in the intake structures, or in the fire protection system. During October 1994, an estimated density of 144 clams/m^2 were collected within the auxiliary intake canal -- the first time clams have been collected there. The zebra mussel and the quagga mussel, other potentially biofouling organisms, were not found in the main or the auxiliary reservoirs.

During 1994 the fishery continued to be dominated by bluegill, redear and pumpkinseed sunfish, and largemouth bass. The electrofishing catch rates of total fish in 1994 rebounded from a one year decrease in 1993 to rates comparable to catch rates from the previous 5 years due to significant increases in abundance of bluegill, redear sunfish, and largemouth bass. Catches of gizzard shad were the lowest observed since impoundment.

Indicators of quality for the largemouth bass sport fishery in Harris Reservoir suggested a healthy population and good young-of-year recruitment during 1994. Although the numbers of largemouth bass increased during 1994, the number of fish caught per hour remains low (slightly less than 3 fish/hour). Indicators of quality for the bluegill, redear sunfish, and pumpkinseed fishery during 1994 also suggested a healthy populations although young-of-year recruitment continued to be low for these species. The specific causes for the low young-of-year recruitment were unknown but was probably influenced by electrofishing geartype bias against small fish (< 60 mm) and the inability to effectively sample the shallow water areas containing hydrilla which cover a substanial portion of the near-shore zone of the main reservoir.

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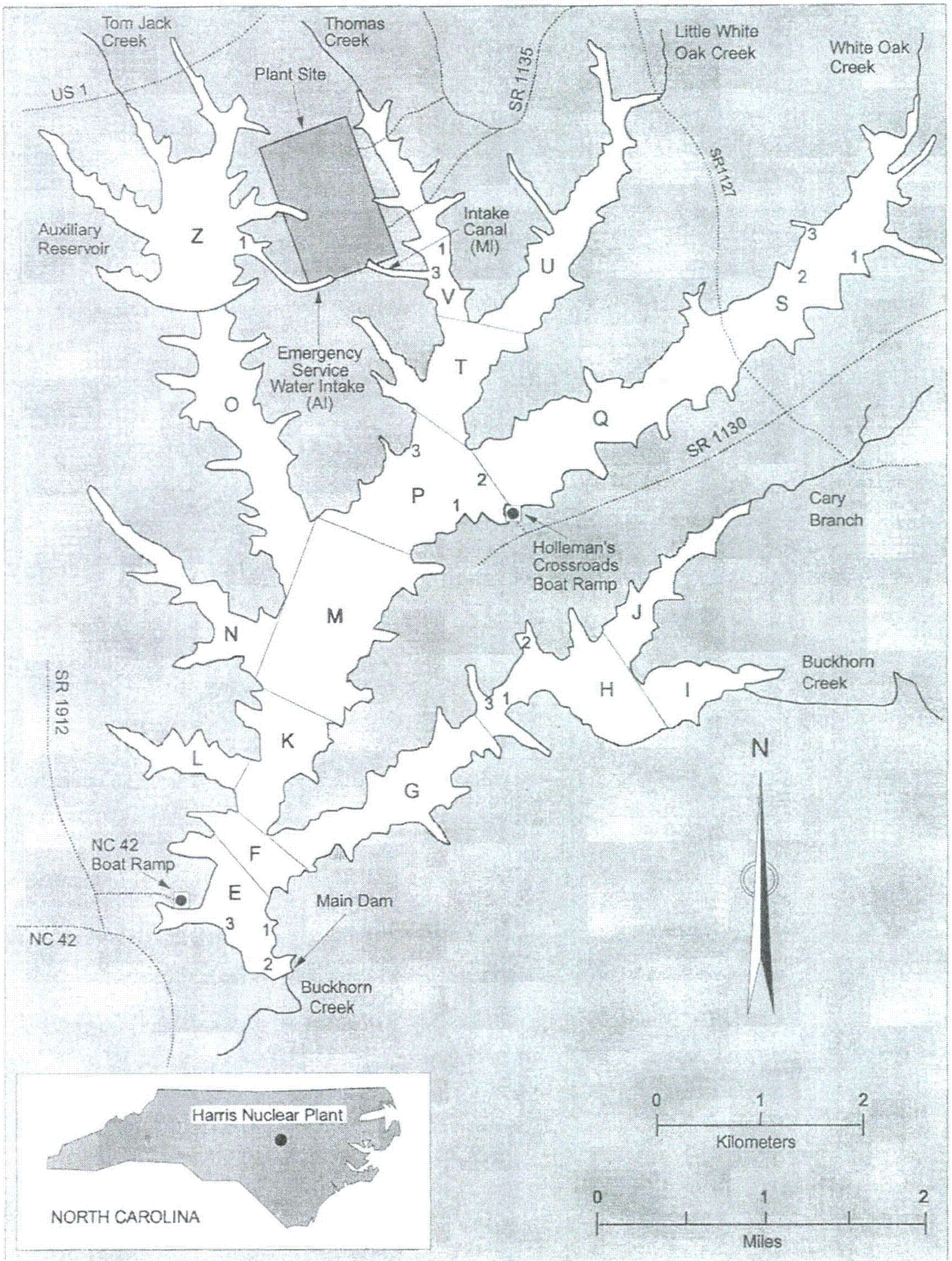


Appendix 1. Sampling areas and stations at Harris Reservoir during 1994.

Appendix 2. **Environmental monitoring program at Harris Reservoir for 1994.**

Program	Frequency	Location
Limnology		
Water quality (temperature, dissolved oxygen, pH, specific conductance, and Secchi disk transparency)	Once per calendar month	Stations E2, H2, P2, and S2 (surface to bottom at 1-m intervals)
Water chemistry +		
Monitoring	Alternate months¶	Stations E2 (surface and bottom); H2, P2, and S2 (surface)
Nutrients (turbidity, solids, total phosphorus, ammonia-nitrogen, nitrate + nitrite-nitrogen, and total nitrogen)	Once per calendar month	Stations E2 (surface and bottom); H2, P2, and S2 (surface)
Plankton (phytoplankton and chlorophyll *a*)	Once per calendar month	Stations E2, H2, P2, and S2
Biofouling monitoring surveys		
Asiatic clam	Twice per calendar year (Apr, Oct)	Emergency service water and cooling tower makeup system intake structures and Stations V3, Z1, MI, and AI
Zebra mussel and quagga mussel	Once per calendar month	Intake structure, water quality station buoys, or Holleman's Crossroads boat ramp
Fisheries		
Fish community structure	Twice per calendar year (May, Nov)	Areas E1, E3, H1, H3, P1, P3, S1, S3, V1, and V3
Aquatic vegetation survey	Oct	Areas I, E, P, Q, S, V, and Z

+Chromium, nickel, and lead analyses were discontinued in 1994. Between 1986 and 1992, all concentrations resulting from 240 analyses for each metal were less than its North Carolina water quality standard of 50, 25, and 88 μg/liter, respectively. Only 1.3% (chromium), 15.8% (lead), and 3.8% (nickel) of the samples had concentrations greater than the laboratory detection limits of 2, 1, and 5 μg/liter, respectively.

¶Alternate months are January, March, May, July, September, and November.

Appendix 3. Field sampling and laboratory methods followed in the 1994 environmental monitoring program at Harris Reservoir.

Program	Method
Limnology	
Water quality	Temperature, dissolved oxygen, pH, and specific conductance were measured with a calibrated Martek Mark XV* instrument. Measurements were taken from surface to bottom at 1-m intervals. Water clarity was measured with a Secchi disk.
Water chemistry	Surface and bottom samples were collected with a nonmetallic Van Dorn sampler, transferred to appropriate containers, transported to the laboratory on ice, and analyzed according to USEPA (1979) and APHA (1992).
Phytoplankton	Equal amounts of water from the surface, the Secchi disk transparency depth, and twice the Secchi disk transparency depth were obtained with a Van Dorn sampler and mixed in a plastic container. If the water column depth was less than twice the Secchi disk transparency, then samples were collected from the surface, one-half the distance to the bottom, and just above the bottom. A 250-ml subsample was taken and preserved with 5 ml of "M3" fixative. Subsamples were identified and enumerated in the laboratory only when the concentration of chlorophyll *a* was ≥ 40 μg/liter to assess bloom conditions.
Chlorophyll *a*	Three 1000-ml samples were collected from the surface, the Secchi disk transparency depth, and twice the Secchi disk transparency depth with a Van Dorn sampler, placed in dark bottles, and transported to the laboratory on ice. If the water column depth was less than twice the Secchi disk transparency, then samples were collected from the surface, one-half the distance to the bottom, and just above the bottom. In the laboratory, one 250-ml subsample from each depth was analyzed according to Strickland and Parsons (1972) and APHA (1992).
Biofouling monitoring surveys	
Asiatic clam	At Stations V3, Z1, MI, and AI, three replicate samples were collected with a petite Ponar at the 2-m depth. In the emergency service water and cooling tower makeup intake structures, seven samples were collected with a petite Ponar. Samples were preserved with 5% formalin and returned to the laboratory where they were elutriated through 1000-, 500-, and 300-μ mesh sieves. Asiatic clams were counted, measured, and preserved.
Zebra mussel and quagga mussel	An artificial substrate sampler, constructed of a PVC frame and fitted with removable PVC plates, was placed near the cooling tower makeup intake structure. This sampler, the dock at the Holleman's boat ramp, or the water quality station marker buoys were visually inspected for the presence of mussels during routine water quality or Asiatic clam survey monitoring.
Fisheries	
Community structure	Fifteen-minute samples were collected at each station using a Smith-Root equipped Wisconsin-design electrofishing boat with pulsed DC current. Fish were identified, weighed to the nearest gram, measured to the nearest millimeter (total length), and released.
Aquatic vegetation survey	Portions of the shoreline and/or littoral zone of the reservoir and auxiliary reservoir were systematically surveyed by boat for the presence of hydrilla. Estimation of areal coverage of hydrilla was made by measuring the maximum depth of its growth at 49 transects throughout the reservoir and applying these data to topographic maps.

Appendix 4. **Statistical analyses performed on data collected in the 1994 and 1983-1994 environmental monitoring programs at Harris Reservoir.**

Variable	Statistical test/model[+]	Main effect(s)	Interaction term
For 1994 data only			
Secchi disk transparency depth, specific conductance, selected chemical variables, and chlorophyll *a*[¶]	One-way ANOVA, block on month	Station	
	Paired t-test	Station E2 - surface *vs.* bottom waters	
For 1983-1994 data[§]			
Secchi disk transparency depth, specific conductance, selected chemical variables, and chlorophyll *a*[¶]	Multi-factor ANOVA, block on month	Station, year	Station-by-year
Specific conductance and selected chemical variables	One-way ANOVA, block on month	Station E2 - bottom, year	
Catch rate of select individual fish species and total catch[¥]	Multi-factor ANOVA, block on month	Area, year	Area-by-year

[+]A Type I error rate of 5% ($\alpha = 0.05$) was used to judge the significance of all tests. Fisher's protected least significant difference test was applied to determine where differences in means occurred if the overall F test from the analysis of variance (ANOVA) indicated that the main effect was significant.

[¶]Chlorophyll *a* ANOVA models were structured using the mean station-by-month concentration based on three paired replicate samples.

[§]Water quality and chemistry data were analyzed for the 1987-1994 period. Only fisheries data was analyzed for the 1983-1994 period.

[¥]Fisheries data were transformed using the $\log_e$ (number of fish/hour + 1) transformation.

Appendix 5. **Mean percent recovery and sample size of water chemistry standards for the CP&L Chemistry Laboratory during 1994.**

Variable	Standard+	Known value	Units	n	Mean	Standard deviation	Recovery (%)	RSD¶ (%)
Chloride	LQC	1.0	mg/l	17	0.986	0.043	98.6	4.38
	HQC	2.0	mg/l	17	1.885	0.066	94.3	3.54
	Spike	2.0	mg/l	15	2.096	0.122	104.8	5.82
Total Phosphorus	LQC	0.005	mg/l	12	0.0048	0.0014	96.0	28.3
	HQC	0.05	mg/l	22	0.0487	0.00258	97.5	5.3
	MQC	0.02	mg/l	8	0.0191	0.00132	95.6	6.9
	Spike	0.0125	mg/l	11	0.0111	0.00217	88.6	19.6
TKN§	QC	1.00	mg/l	34	1.035	0.111	103.5	10.76
Nitrate-Nitrogen§	QC	0.80	mg/l	34	0.764	0.042	104.7	5.48
Nitrite-Nitrogen§	QC	0.4	mg/l	34	0.391	0.017	97.8	4.46
Sulfate	LQC	2.0	mg/l	17	2.036	0.0514	101.8	2.52
	HQC	5.0	mg/l	17	4.827	0.0640	96.5	1.33
	Spike	5.0	mg/l	15	4.949	0.292	98.9	5.90
TOC (1)¥	QC	9.96	mg/l	8	9.57	0.189	96.1	1.98
(2)¥	QC	7.38	mg/l	12	7.34	0.406	99.5	5.53
(3)¥	QC	9.84	mg/l	8	9.45	0.217	96.0	2.30
(4)¥	QC	10.40	mg/l	8	9.77	0.217	93.9	2.22
Aluminum	LQC	50.0	µg/l	3	51.5	0.87	103	1.7
	HQC	500.0	µg/l	11	504	16.9	108	3
	Spike	50.0	µg/l	4	49	7.64	98	16
	Spike	500.0	µg/l	3	463	28	93	6
	Spike	100.0	µg/l	4	98.5	16.5	98	17
Arsenic	QC	5.0	µg/l	49	4.973	0.269	99.5	5.41
	Spike	50	µg/l	9	4.8766	0.3708	97.5	7.60
Cadmium	LQC	0.2	µg/l	4	0.188	0.171	94.0	9.08
	HQC	0.5	µg/l	40	0.488	0.047	97.6	9.63
	Spike	0.5	µg/l	13	0.594	0.063	118.9	10.62
	LQC	2.44	µg/l	12	2.369	0.300	97.1	12.68
	HQC	4.0	µg/l	30	4.270	0.424	106.7	9.93
	Spike	4.0	µg/l	40	3.879	0.885	96.99	22.8
	Spike	4.0	µg/l	14	3.938	0.319	98.5	8.10
Calcium	LQC	1.0	mg/l	13	0.973	0.041	97.3	4.23
	MQC	5.0	mg/l	13	4.847	0.229	96.9	4.72
	HQC	10.0	mg/l	13	9.728	0.377	97.3	3.88
	Spike	5.0	mg/l	10	4.570	0.234	91.4	5.12
Chromium	LQC	5.0	µg/l	44	5.43	0.349	108.6	6.43
	HQC	10.0	µg/l	8	10.15	0.474	101.5	4.68
	Spike	5.0	µg/l	14	5.27	0.535	105.4	10.16
	QC	3.8	µg/l	12	4.24	0.406	112.0	9.55
	QC	4.0	µg/l	30	4.36	0.472	109.0	10.82

Appendix 5 (continued)

Variable	Standard+	Known value	Units	n	Mean	Standard deviation	Recovery (%)	RSD† (%)
Chromium	Spike	4.0	µg/l	40	4.008	0.664	100.2	16.58
	Spike	4.0	µg/l	27	3.710	0.170	92.8	4.60
Copper	QC	4.46	µg/l	12	4.332	0.895	97.1	20.6
	QC	4.0	µg/l	30	3.899	0.962	97.5	24.69
Copper	Spike	4.0	µg/l	37	3.774	0.679	94.3	17.94
	Spike	4.0	µg/l	22	3.636	0.255	90.9	7.01
Lead	LQC	2.0	µg/l	4	1.92	0.232	96.4	12.03
	HQC	5.0	µg/l	46	4.96	0.330	99.3	6.64
	Spike	5.0	µg/l	15	4.95	0.671	99.1	13.55
	HQC	7.06	µg/l	12	6.47	0.269	91.7	4.162
	LQC	4.0	µg/l	26	4.00	0.148	99.9	3.71
	Spike	4.0	µg/l	39	4.27	0.394	106.8	9.24
	Spike	4.0	µg/l	10	3.96	0.358	99.2	9.04
Magnesium	LQC	1.0	mg/l	13	0.983	0.034	98.3	3.50
	MQC	5.0	mg/l	13	4.909	0.204	98.2	4.16
	HQC	10.0	mg/l	13	9.820	0.319	98.2	3.24
	Spike	5.0	mg/l	10	4.679	0.160	93.6	3.44
Mercury	LQC	0.10	µg/l	33	0.123	0.0181	123.4	14.7
	MQC	0.30	µg/l	85	0.312	0.051	104.0	16.40
	HQC	0.50	µg/l	16	0.525	0.044	105.0	8.44
	Spike	0.30	µg/l	18	0.280	0.028	93.5	10.2
	Spike	0.50	µg/l	5	0.480	0.041	96.0	8.5
Nickel	LQC	10.0	µg/l	41	10.22	0.804	102.2	7.87
	HQC	20.0	µg/l	6	21.70	0.337	108.5	1.55
	Spike	10.0	µg/l	14	10.52	1.284	105.2	12.21
	HQC	8.0	µg/l	11	8.58	0.425	107.0	4.96
	LQC	4.0	µg/l	30	4.44	0.297	111.0	6.70
	Spike	4.0	µg/l	31	3.53	0.788	88.3	22.32
	Spike	4.0	µg/l	18	3.804	0.190	95.1	4.99
Selenium	QC	5.0	µg/l	57	5.072	0.253	101.5	4.99
	Spike	50	µg/l	9	5.0211	0.1962	100.4	3.91
Sodium	LQC	1.0	mg/l	12	0.993	0.076	99.3	7.70
	HQC	2.0	mg/l	11	1.952	0.058	97.6	3.02

Appendix 5 (continued)

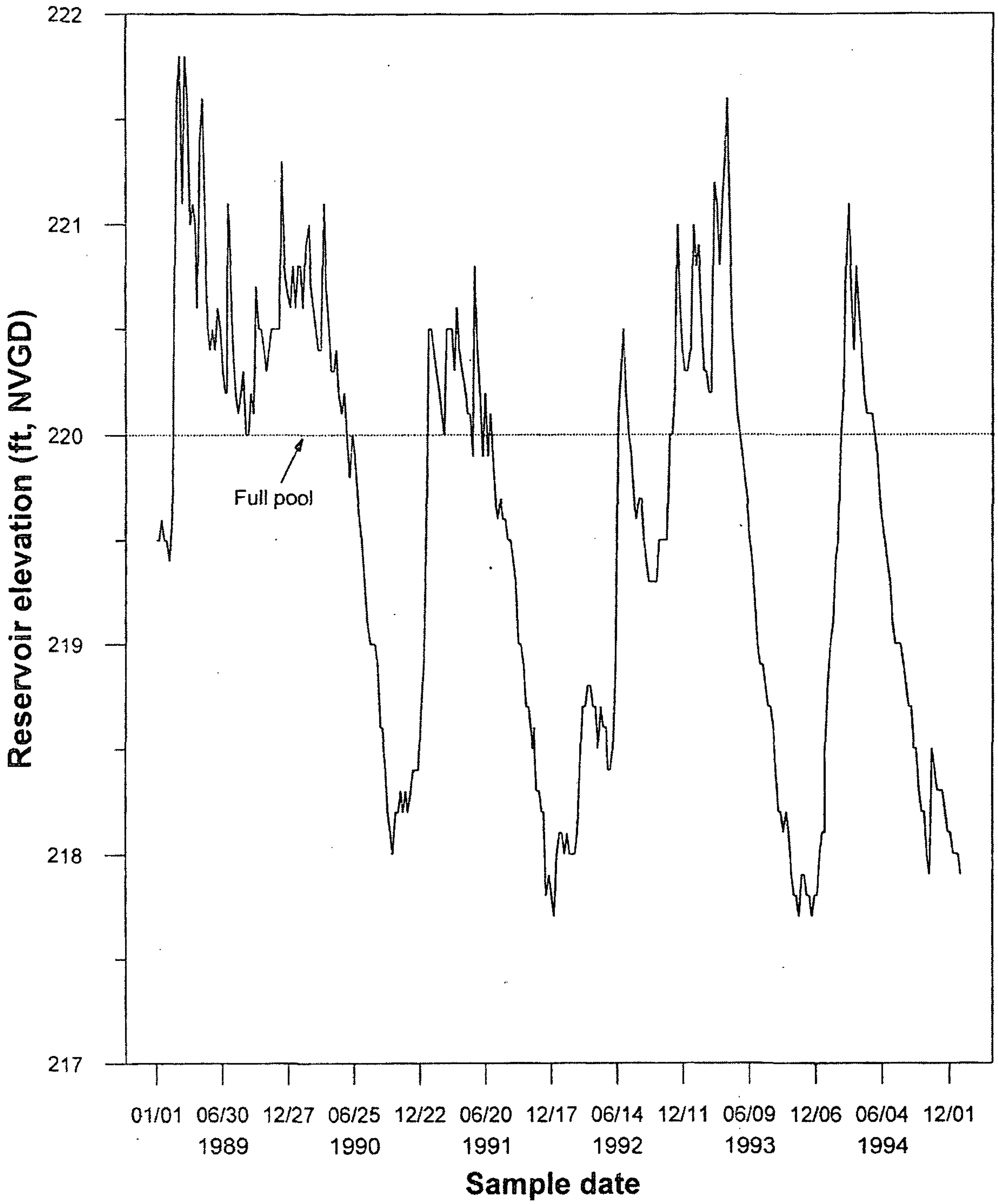
Variable	Standard[+]	Known value	Units	n	Mean	Standard deviation	Recovery (%)	RSD[¶] (%)
Zinc	LQC	0.05	mg/l	6	0.052	0.0045	104.0	8.67
	MQC	0.10	mg/l	6	0.995	0.0086	99.5	8.74
	HQC	0.50	mg/l	6	0.496	0.0127	99.2	2.56
	Spike	0.05	mg/l	3	0.048	0.003	97.3	0.06
	HQC	14.78	μg/l	11	16.00	1.277	108.0	8.0
	LQC	4.0	μg/l	28	5.18	1.883	129.0	36.3
	Spike	4.0	μg/l	37	3.74	1.130	93.7	30.2
	Spike	4.0	mg/l	1	3.750	0.277	93.8	7.39

[+]LQC = low-range quality control standard, MQC = midrange quality control standard, HQC= high-range quality control standard, QC = quality control standard, and Spike = sample matrix spike.

[¶]Relative standard deviation (RSD) = standard deviation ÷ mean x 100.

[§]The total nitrogen analysis was performed by the Webb Technical Group Laboratory, Raleigh, NC. The values reported for total Kjeldahl nitrogen (TKN), nitrate-nitrogen and nitrite-nitrogen reflect Webb Laboratory's quality control data for the given analysis. The total nitrogen concentrations were calculated by summing the TKN, nitrate-nitrogen, and nitrite-nitrogen concentrations.

[¥]There were four different concentrations used for the known values of total organic carbon in the laboratory analyses.



Appendix 6. **Seven-day mean water surface elevations at Harris Reservoir, 1989-1994. NGVD = National Geodetic Vertical Datum (formerly called mean sea level by the U.S. Geological Survey).**

Appendix 7. **Water temperature, dissolved oxygen, specific conductance, and pH data collected from Harris Reservoir during 1994.**

January 12, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	6.8	6.2	6.2	5.4	10.3	11.0	10.6	10.0	96	92	89	75	7.0	7.1	6.6	7.2
1.0	6.8	6.2	6.2	5.4	10.3	10.9	10.5	10.0	96	84	87	75	7.0	7.1	6.6	7.2
2.0	6.8	6.1	6.2	5.4	10.3	10.9	10.5	10.0	96	84	87	75	7.0	7.1	6.6	7.2
3.0	6.8	5.9	6.2	5.4	10.2	10.3	10.6	9.8	96	83	87	75	7.0	7.1	6.6	7.2
4.0	6.8	5.9	6.1		10.2	10.2	10.6		96	83	87		7.0	7.1	6.6	
5.0	6.8	5.8	6.1		10.2	10.1	10.4		96	83	86		7.0	7.1	6.6	
6.0	6.8	5.8	6.0		10.2	10.1	10.3		96	83	86		7.0	7.2	6.6	
7.0	6.8		5.9		10.2		10.0		96		86		7.0		6.6	
8.0	6.8		5.9		10.1		9.8		96		86		7.0		6.6	
9.0	6.7				10.1				96				7.0			
10.0	6.7				10.1				96				6.9			
11.0	6.7				10.0				96				6.8			
12.0	6.7				10.0				96				6.8			

February 3, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	5.6	5.4	4.9	4.8	12.8	12.6	12.3	11.0	96	83	93	75	7.2	6.9	7.2	7.3
1.0	5.6	5.3	4.9	4.8	12.9	12.5	12.4	11.0	96	82	90	75	7.2	6.9	7.2	7.3
2.0	5.6	5.3	4.9	4.8	12.9	12.5	12.6	11.0	96	82	89	75	7.2	6.9	7.2	7.3
3.0	5.5	5.3	4.9	4.8	13.1	12.5	12.6	11.0	95	83	88	75	7.2	6.9	7.2	7.3
4.0	5.0	5.3	4.8	4.8	13.1	12.6	12.7	11.0	96	83	87	75	7.2	6.9	7.2	7.3
5.0	5.0	5.3	4.8	4.8	13.1	12.7	12.7	11.1	96	83	87	75	7.2	6.9	7.3	7.3
6.0	5.0	5.2	4.8		13.1	12.7	12.8		96	82	87		7.2	6.9	7.3	
7.0	4.9		4.8		13.1		12.8		96		87		7.2		7.3	
8.0	4.9		4.8		13.2		12.8		95		87		7.2		7.4	
9.0	4.9				13.2				95				7.2			
10.0	4.9				13.2				95				7.2			
11.0	4.9				13.2				95				7.2			
12.0	4.9				13.2				95				7.2			
13.0	4.9				13.2				95				7.2			
14.0	4.9				13.2				95				7.2			

Appendix 7 (continued)

March 11, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	9.7	11.5	10.3	12.1	10.8	10.4	10.2	8.9	88	80	90	54	7.0	7.0	6.5	6.4
1.0	9.7	11.5	10.3	12.0	10.8	10.5	10.2	8.9	88	72	85	50	7.0	7.0	6.5	6.3
2.0	9.6	11.3	10.3	12.0	10.7	10.4	10.4	8.9	88	72	84	47	6.9	6.9	6.5	6.2
3.0	9.5	11.3	10.3	12.0	10.7	10.5	10.5	8.9	88	73	84	46	6.9	6.9	6.5	6.2
4.0	9.4	11.2	10.2	12.0	10.8	10.5	10.6	8.9	88	73	84	46	6.8	6.9	6.5	6.1
5.0	9.3	10.7	10.0	11.9	10.8	9.5	10.5	8.8	89	81	84	46	6.8	6.8	6.5	6.1
6.0	9.2	8.4	9.7		10.8	9.2	10.5		89	82	86		6.8	6.7	6.5	
7.0	9.2	8.2	9.4		10.8	9.3	10.4		89	82	87		6.8	6.7	6.5	
8.0	9.1	8.2	9.3		10.9	9.2	10.2		89	84	87		6.8	6.5	6.5	
9.0	9.0				10.9				89				6.8			
10.0	8.9				10.5				89				6.8			
11.0	8.7				10.5				90				6.7			
12.0	8.7				10.5				90				6.7			
13.0	8.2				9.9				90				6.7			
14.0	7.9				9.6				92				6.6			

April 7, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	15.2	17.5	16.2	17.6	8.6	8.6	8.9	7.6	83	79	83	58	6.7	6.9	6.4	6.5
1.0	15.2	17.2	16.2	17.6	8.4	8.9	8.8	7.5	83	78	83	58	6.7	6.9	6.4	6.4
2.0	15.2	16.9	16.2	17.5	8.5	8.7	8.8	7.5	83	78	83	58	6.7	6.9	6.5	6.4
3.0	15.1	16.3	16.2	17.4	8.2	7.7	8.9	7.5	83	77	83	58	6.7	6.8	6.5	6.4
4.0	15.0	15.9	16.2	17.4	8.3	7.0	8.9	7.4	83	75	83	59	6.7	6.6	6.5	6.4
5.0	14.8	15.2	16.2		8.2	6.5	8.8		83	75	82		6.7	6.6	6.5	
6.0	14.8	13.0	16.1		8.2	4.8	8.7		83	82	82		6.7	6.4	6.5	
7.0	14.7		16.1		8.1		8.6		82		82		6.7		6.5	
8.0	14.3		14.2		7.7		5.8		82		85		6.7		6.2	
9.0	14.3				7.7				82				6.6			
10.0	14.2				7.6				83				6.6			
11.0	13.4				7.1				83				6.6			
12.0	11.7				5.0				90				6.5			
13.0	11.1				3.2				91				6.4			

Appendix 7 (continued)

May 5, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	20.1	19.8	19.1	18.9	8.0	7.6	7.4	6.5	80	77	79	76	7.0	7.0	7.2	7.0
1.0	20.1	19.8	19.1	18.8	8.1	7.6	7.5	6.5	79	78	79	76	7.0	7.0	7.2	7.0
2.0	20.1	19.8	19.1	18.7	8.1	7.6	7.4	6.4	79	76	79	76	7.0	7.0	7.2	7.0
3.0	20.1	19.7	19.1	18.8	8.2	7.2	7.4	6.4	77	77	79	75	7.0	7.0	7.2	7.0
4.0	20.0	19.7	19.1	18.8	8.2	7.2	7.4	6.2	77	77	79	75	7.0	7.0	7.1	7.0
5.0	20.0	19.2	19.1		8.1	4.5	7.4		77	78	79		6.9	6.9	7.1	
6.0	20.0	18.2	19.0		8.1	2.8	7.4		76	80	79		6.9	6.8	7.1	
7.0	20.0	16.6	17.2		8.1	0.1	2.2		76	84	83		6.9	6.6	7.0	
8.0	19.8		16.4		8.1		0.7		76		89		6.9		6.9	
9.0	17.2				3.8				80				6.9			
10.0	16.2				3.7				80				6.8			
11.0	15.6				3.2				80				6.7			
12.0	14.2				2.2				85				6.6			

June 3, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	26.7	25.9	24.6	25.5	7.6	8.0	7.3	7.6	88	87	87	85	8.3	8.5	7.2	7.7
1.0	26.7	25.8	24.6	25.5	7.6	8.1	7.4	7.4	89	87	87	86	8.3	8.5	7.2	7.7
2.0	26.4	25.7	24.5	24.4	7.7	8.0	7.3	5.7	88	87	87	87	8.3	8.4	7.2	7.6
3.0	26.2	22.3	21.7	23.4	7.7	5.0	4.1	3.0	88	89	87	88	8.3	8.0	7.2	7.8
4.0	25.4	20.4	20.6	22.3	7.6	1.0	3.0	0.6	87	92	90	91	8.3	7.6	6.6	6.5
5.0	23.0	19.9	20.4		6.1	0.7	2.7		89	92	89		7.9	7.4	6.5	
6.0	20.9	19.4	19.8		3.5	0.1	1.9		89	92	91		6.2	6.3	6.5	
7.0	20.0		19.5		2.2		1.4		90		91		6.0		6.4	
8.0	19.6		18.9		2.0		0.2		92		97		6.0		6.3	
9.0	19.5				1.9				94				5.9			
10.0	18.2				1.0				98				5.9			
11.0	18.0				0.3				100				6.1			
12.0	16.6				0.0				103				6.2			
13.0	13.9				0.0				118				6.4			
14.0	13.0				0.0				133				6.5			
15.0	12.2				0.2				151				6.6			

Appendix 7 (continued)

July 5, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	29.4	31.6	29.5	29.9	7.6	7.3	7.1	4.9	105	97	97	91	8.9	8.6	8.6	8.4
1.0	28.8	30.0	29.2	29.6	6.7	7.2	6.2	4.2	99	95	97	91	8.9	8.7	8.7	8.4
2.0	28.3	28.8	28.9	28.9	6.0	5.9	5.1	3.7	98	96	97	90	8.9	8.7	8.7	8.2
3.0	27.9	26.9	27.8	27.7	4.6	3.3	4.9	2.3	98	95	96	90	8.7	8.6	8.4	7.9
4.0	26.2	25.8	26.1	26.3	2.1	1.4	2.4	0.1	99	101	98	101	8.4	8.2	7.9	7.5
5.0	24.5	24.3	23.3	25.2	0.3	0.2	0.0	0.0	104	99	108	121	8.1	8.1	7.7	7.3
6.0	22.1	22.6	22.1		0.1	0.0	0.0		124	117	115		7.8	7.8	7.5	
7.0	21.6	21.0	21.3		0.1	0.0	0.0		124	125	117		7.7	7.5	7.1	
8.0	20.9	20.3	19.6		0.0	0.0	0.0		124	131	137		7.5	7.0	7.0	
9.0	20.3				0.0				122				7.4			
10.0	18.8				0.0				121				7.4			
11.0	17.5				0.0				120				7.4			
12.0	17.0				0.0				127				7.4			
13.0	15.5				0.0				130				7.3			

August 4, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	28.8	29.8	29.4	29.8	6.9	6.5	7.9	7.6	103	102	101	99	8.4	8.1	7.8	8.6
1.0	28.8	29.8	29.4	29.8	7.0	6.7	7.9	7.5	103	102	101	99	8.4	8.1	7.8	8.5
2.0	28.3	29.5	29.3	29.7	7.1	6.3	7.9	7.5	103	102	103	99	8.4	8.0	7.8	8.5
3.0	27.9	28.0	28.4	27.7	6.2	3.1	6.3	1.7	103	102	103	99	8.2	7.9	7.8	7.7
4.0	27.2	27.3	27.3	27.5	3.3	1.2	3.0	1.3	103	103	103	99	7.7	7.6	7.8	7.8
5.0	26.2	25.5	26.6		0.6	0.2	0.8		108	119	103		7.4	7.3	7.6	
6.0	24.5	25.5	25.2		0.6	0.1	0.6		126	124	118		7.2	7.0	7.3	
7.0	23.1		23.3		0.5		0.5		136		132		7.0		7.2	
8.0	22.6		21.6		0.5		0.3		137		156		6.6		6.9	
9.0	21.2				0.5				136				6.6			
10.0	20.1				0.4				133				6.6			
11.0	18.7				0.4				131				6.5			
12.0	17.2				0.4				142				6.4			
13.0	15.5				0.3				169				6.4			
14.0	14.6				0.2				178				6.3			

Appendix 7 (continued)

September 8, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	25.9	25.7	24.9	25.0	7.2	7.4	7.5	8.8	108	104	101	99	7.3	7.2	6.8	7.4
1.0	25.7	25.7	24.8	25.0	7.0	7.4	7.1	8.2	102	100	101	99	7.2	7.2	6.8	7.5
2.0	25.5	25.5	24.7	23.8	6.8	7.4	7.0	7.5	102	100	101	97	7.2	7.1	6.7	7.5
3.0	25.3	25.3	24.6	22.5	6.3	6.6	7.0	3.0	102	100	101	86	7.2	7.1	6.7	7.3
4.0	24.8	25.0	24.6	21.9	4.0	4.8	6.8	0.9	103	100	101	86	7.2	7.1	6.7	6.9
5.0	24.7	24.6	24.6		3.8	2.0	6.3		103	100	101		7.1	7.1	6.6	
6.0	24.6	24.4	24.5		3.1	1.2	5.1		104	101	101		7.0	6.4	6.6	
7.0	24.4		24.2		1.2		2.7		110		105		7.0		6.7	
8.0	24.0		23.5		0.1		0.1		124		111		6.9		6.2	
9.0	23.1				0.1				141				6.8			
10.0	23.1				0.0				145				6.8			
11.0	21.9				0.0				153				6.6			
12.0	18.2				0.0				161				6.6			
13.0	17.6				0.0				169				6.5			

October 7, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	21.7	21.5	20.9	19.0	7.3	6.0	6.1	7.5	110	103	103	101	7.2	7.1	6.9	7.1
1.0	21.5	21.5	20.9	18.8	6.6	5.8	6.1	7.5	110	105	103	100	7.1	7.0	6.9	7.1
2.0	21.5	21.4	20.9	18.7	6.5	5.7	5.6	7.5	110	105	103	100	7.0	6.9	6.9	7.1
3.0	21.4	21.3	20.9	18.6	5.7	5.6	5.6	7.5	110	105	103	100	7.0	7.0	6.9	7.1
4.0	21.4	21.2	20.8	18.6	5.7	5.4	5.6	7.3	110	106	103	98	7.0	6.9	6.9	7.0
5.0	21.4	20.9	20.8		5.7	5.2	5.6		110	105	103		6.9	6.9	6.9	
6.0	21.4	20.8	20.8		5.7	5.2	5.6		109	105	103		6.9	6.9	6.9	
7.0	21.4		20.8		5.7		5.6		109		103		6.9		6.9	
8.0	21.4		20.9		5.6		5.3		109		104		6.9		6.9	
9.0	21.3				5.6				109				6.8			
10.0	21.3				5.5				109				6.8			
11.0	21.3				5.5				110				6.8			
12.0	21.2				5.4				113				6.8			
13.0	19.2				0.3				207				6.7			
14.0	15.2				0.0				243				6.7			

Appendix 7 (continued)

November 3, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	17.4	17.9	17.1	15.3	6.8	8.5	7.8	8.5	107	104	103	96	6.5	6.7	7.2	6.8
1.0	16.9	17.8	17.1	15.2	6.6	8.6	7.8	8.5	107	104	103	95	6.5	6.6	7.1	6.8
2.0	16.8	17.7	16.9	15.0	6.7	8.5	7.7	8.2	106	103	102	95	6.5	6.6	7.1	6.7
3.0	16.7	17.2	16.8	15.0	6.5	8.4	7.6	8.4	107	103	102	95	6.5	6.5	7.1	6.7
4.0	16.6	17.1	16.8		6.5	8.1	7.6		107	103	103		6.5	6.5	7.0	
5.0	16.6	16.9	16.8		6.5	7.2	7.6		107	103	103		6.4	6.4	7.0	
6.0	16.6	16.9	16.8		6.6	6.3	7.6		107	105	103		6.4	6.4	7.0	
7.0	16.6		16.7		6.6		7.3		107		103		6.4		7.0	
8.0	16.6		16.7		6.6		7.2		107		103		6.4		7.0	
9.0	16.5				6.5				107				6.4			
10.0	16.5				6.5				107				6.4			
11.0	16.5				6.5				107				6.4			
12.0	16.5				6.5				107				6.4			
13.0	16.5				3.2				109				6.5			

December 2, 1994

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Specific conductance (µS/cm)				pH			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	13.2	12.4	12.4	10.1	8.6	8.7	9.1	11.7	117	103	100	95	6.8	6.8	7.1	6.6
1.0	13.2	12.4	12.4	10.1	8.5	8.6	9.2	11.8	109	103	100	95	6.7	6.7	7.1	6.6
2.0	12.9	12.2	12.4	10.0	8.4	8.4	9.1	11.7	109	103	100	95	6.7	6.7	7.0	6.6
3.0	12.9	12.2	12.4	10.0	8.3	8.4	9.1	11.7	109	103	100	94	6.7	6.7	7.0	6.6
4.0	12.9	12.2	12.4	10.4	8.4	8.5	9.1	11.0	109	104	100	94	6.7	6.6	6.9	6.2
5.0	12.9	12.2	12.4		8.4	8.5	9.2		109	102	100		6.7	6.6	6.9	
6.0	12.9	12.1	12.3		8.4	8.8	9.3		109	102	100		6.7	6.5	6.8	
7.0	12.9		12.3		8.4		9.3		109		100		6.7		6.7	
8.0	12.9		12.3		8.5		9.5		109		100		6.7		6.7	
9.0	12.9				8.5				109				6.6			
10.0	12.9				8.5				109				6.6			
11.0	12.9				8.5				109				6.6			
12.0	12.9				8.5				109				6.6			
13.0	12.8				8.5				108				6.6			

Appendix 8. **Secchi disk transparency depth and chlorophyll *a* data collected from Harris Reservoir during 1994.**

Date	Station E2	H2	P2	S2
Secchi disk transparency depth (m)				
January 12	1.6	1.4	1.8	0.8
February 3	1.2	1.3	1.9	1.0
March 11	1.1	0.7	1.0	0.3
April 7	1.3	1.1	1.0	0.4
May 5	1.6	1.7	1.3	0.8
June 3	1.9	1.9	1.6	1.8
July 5	1.3	1.5	1.7	2.0
August 4	2.7	2.3	2.7	2.6
September 8	1.3	1.7	1.1	1.2
October 7	1.3	1.5	1.3	3.3
November 3	1.7	1.5	1.6	2.3
December 2	1.4	1.8	1.3	4.5⁺
Annual mean	**1.5**	**1.5**	**1.5**	**1.8⁺**
Chlorophyll *a* (µg/liter)				
January 12	30.7	38.5	16.6	8.8
February 3	47.7	30.2	23.6	10.2
March 11	24.9	23.4	15.0	6.5
April 7	3.2	6.1	5.1	8.9
May 5	4.5	4.8	5.1	7.4
June 3	6.8	7.9	8.3	9.0
July 5	23.1	22.3	15.9	6.0
August 4	7.7	14.2	6.8	5.0
September 8	19.1	11.1	17.9	7.7
October 7	16.1	8.4	7.4	2.4
November 3	7.4	24.9	12.2	3.2
December 2	9.6	10.2	11.0	1.6
Annual mean	**16.7**	**16.8**	**12.1**	**6.4**

⁺Secchi disk was visible resting on the bottom; therefore the annual mean was very slightly underestimated.

Appendix 9. Concentrations of chemical variables in Harris Reservoir during 1994. Units are in mg/liter except trace metals and metalloids 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^+	TN	NH_3-N	Nitrate + nitrite-N	TP	TOC
Jan	12	17	9.4	17	3.8	1.9	12	0.84	0.04	0.18	0.068	6.4
Feb								0.80	< 0.02	0.10	0.062	
Mar	12	16	10	16	3.6	1.8	11	0.63	0.02	0.04	0.043	7.2
Apr								0.67	0.10	0.06	0.033	
May	11	13	10	14	2.8	1.4	11	0.58	0.09	0.07	0.022	5.7
Jun								0.36	< 0.02	< 0.02	0.024	
Jul	12	17	8.8	13	4.0	1.8	11	0.59	< 0.02	< 0.02	0.032	5.7
Aug								0.57	< 0.02	< 0.02	0.017	
Sep	16	18	11	13	3.9	1.9	12	0.75	< 0.02	< 0.02	0.030	6.8
Oct								0.89	0.08	0.02	0.042	
Nov	17	20	11	15	4.5	2.2	14	0.67	0.10	0.06	0.024	6.1
Dec								0.64	0.12	0.13	0.072	

Month	Turbidity	TS	TDS	TSS	Al^+	As	Cd	Cu	Hg[¶]	Se	Zn
Jan	3.5	79	74	5	60	< 1	< 0.1	< 1.0	< 0.05	< 1	20
Feb	1.8	76	70	5							
Mar	5.6	88	75	6	120	< 1	< 0.1	3.0	< 0.05	< 1	< 20
Apr	6.5	74	69	3							
May	3.0	72	63	2	90	< 1	< 0.1	1.0	< 0.05	< 1	< 20
Jun	2.0	72	63	2							
Jul	1.8	59	66	1	40	< 1	< 0.1	1.9	< 0.05	< 1	< 20
Aug	1.0	71	66	1							
Sep	2.4	74	68	1	< 50	< 1	< 0.1	< 1.0	< 0.05	< 1	< 20
Oct	2.2	82	78	3							
Nov	2.1	79	74	2	60	< 1	0.2	1.0	< 0.20	< 1	< 20
Dec	3.2	78	71	2							

Appendix 9 (continued)

Station E2, bottom

Month	Total Alkalinity ($CaCO_3$)	Hardness (calculated)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	TN	NH_3-N	Nitrate + nitrite-N	TP	TOC
Jan	13	18	11	17	3.9	2.0	12	0.88	0.03	0.18	0.067	6.6
Feb								0.80	< 0.02	0.10	0.059	
Mar	12	17	9.2	16	3.8	1.9	12	0.60	0.05	0.05	0.039	7.2
Apr								0.75	0.20	0.07	0.069	
May	18	15	9.7	14	3.2	1.6	12	0.72	0.38	0.05	0.21	6.6
Jun								0.69	0.33	0.11	0.10	
Jul	28	20	9.0	12	4.7	2.1	11	1.5	0.58	0.02	0.080	7.7
Aug								2.2	1.7	< 0.02	0.35	
Sep	42	22	11	9.8	5.4	2.2	13	1.8	1.0	< 0.02	0.22	6.6
Oct								5.1	3.5	< 0.02	0.070	
Nov	17	20	11	15	4.4	2.1	14	1.1	0.10	0.06	0.034	6.3
Dec								0.71	0.15	0.11	0.066	

Month	Turbidity	TS	TDS	TSS	Al^+	As	Cd	Cu	Hg¶	Se	Zn
Jan	1.8	82	76	6	50	< 1	< 0.1	3.0	< 0.05	< 1	20
Feb	1.8	84	79	5							
Mar	5.1	80	72	6	90	< 1	< 0.1	3.0	0.45	< 1	< 20
Apr	12	70	66	4							
May	20	88	72	14	160	1	< 0.1	2.0	< 0.05	< 1	< 20
Jun	2.1	75	72	2							
Jul	1.7	75	80	1	40	1	< 0.1	3.1	< 0.05	< 1	< 20
Aug	9.1	106	96	3							
Sep	4.1	102	92	1	< 50	1	< 0.1	2.1	0.07	< 1	20
Oct	7.5	137	125	5							
Nov	2.8	77	72	4	70	< 1	< 0.1	1.0	< 0.20	< 1	< 20
Dec	3.4	81	70	4							

Appendix 9 (continued)

Station H2, surface

Month	Total Alkalinity ($CaCO_3$)	Hardness (calculated)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	TN	NH_3-N	Nitrate + nitrite-N	TP	TOC
Jan	12	16	8.3	14	3.6	1.8	10	0.84	< 0.02	0.04	0.052	4.7
Feb								0.62	< 0.02	0.04	0.033	
Mar	9.3	15	7.6	13	3.3	1.6	8.6	0.64	< 0.02	0.06	0.044	7.1
Apr								0.67	0.03	0.07	0.033	
May	11	13	8.8	14	2.7	1.4	11	0.60	0.08	0.06	0.025	6.0
Jun								0.33	< 0.02	< 0.02	0.022	
Jul	13	17	8.8	13	3.8	1.8	11	0.62	< 0.02	< 0.02	0.019	5.5
Aug								0.60	< 0.02	< 0.02	0.020	
Sep	15	17	11	13	3.7	1.9	12	0.70	< 0.02	< 0.02	0.013	6.7
Oct								0.64	0.02	< 0.02	0.043	
Nov	17	20	11	14	4.4	2.1	14	1.1	< 0.02	0.02	0.026	6.0
Dec								0.61	0.06	0.10	0.035	

Month	Turbidity	TS	TDS	TSS	Al^+	As	Cd	Cu	Hg¶	Se	Zn
Jan	3.2	77	69	8	90	< 1	< 0.1	2.0	< 0.05	< 1	< 20
Feb	3.1	74	68	6							
Mar	15	86	71	10	330	< 1	< 0.1	2.0	< 0.05	< 1	< 20
Apr	8.2	71	61	3							
May	2.7	59	54	2	80	< 1	< 0.1	1.0	< 0.05	< 1	< 20
Jun	2.0	63	57	2							
Jul	2.2	61	62	2	50	< 1	< 0.1	1.7	< 0.05	< 1	< 20
Aug	1.3	76	70	1							
Sep	1.9	71	64	< 1	< 50	< 1	< 0.1	< 1.0	< 0.05	< 1	< 20
Oct	2.3	71	73	2							
Nov	2.8	76	68	2	80	< 1	< 0.1	1.0	< 0.20	< 1	< 20
Dec	2.5	80	69	4							

Appendix 9 (continued)

Station P2, surface

Month	Total Alkalinity ($CaCO_3$)	Hardness (calculated)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	TN	NH_3-N	Nitrate + nitrite-N	TP	TOC
Jan	12	16	8.7	14	3.5	1.8	11	0.65	< 0.02	0.11	0.032	6.5
Feb								0.61	< 0.02	0.07	0.028	
Mar	9.5	16	8.7	16	3.5	1.8	9.0	0.52	< 0.02	0.03	0.037	7.6
Apr								0.69	0.07	0.06	0.037	
May	11	12	8.8	14	2.7	1.4	11	0.60	0.12	0.07	0.028	5.9
Jun								0.36	< 0.02	< 0.02	0.019	
Jul	13	17	8.8	13	3.8	1.8	11	0.68	< 0.02	< 0.02	0.021	7.4
Aug								0.49	< 0.02	< 0.02	0.018	
Sep	16	18	10	13	4.1	1.9	11	0.61	< 0.02	< 0.02	0.023	6.2
Oct								0.64	0.04	< 0.02	0.016	
Nov	16	19	11	14	4.3	2.1	9.4	0.78	< 0.02	0.04	0.018	5.8
Dec								0.53	0.02	0.10	0.016	

Month	Turbidity	TS	TDS	TSS	Al^+	As	Cd	Cu	Hg¶	Se	Zn
Jan	1.8	72	69	4	60	< 1	< 0.1	1.0	< 0.05	< 1	< 20
Feb	1.6	73	68	3							
Mar	6.3	83	69	6	140	< 1	< 0.1	2.0	< 0.05	< 1	< 20
Apr	7.7	74	65	2							
May	3.4	65	61	3	90	< 1	< 0.1	2.0	< 0.05	< 1	< 20
Jun	2.3	65	63	2							
Jul	1.5	59	65	1	30	< 1	< 0.1	1.8	< 0.05	< 1	< 20
Aug	1.1	79	68	1							
Sep	2.6	74	69	1	< 50	< 1	< 0.1	1.2	< 0.05	< 1	< 20
Oct	2.2	74	72	2							
Nov	2.4	77	67	2	60	< 1	0.1	1.0	< 0.20	< 1	< 20
Dec	2.4	76	67	4							

Appendix 9 (continued)

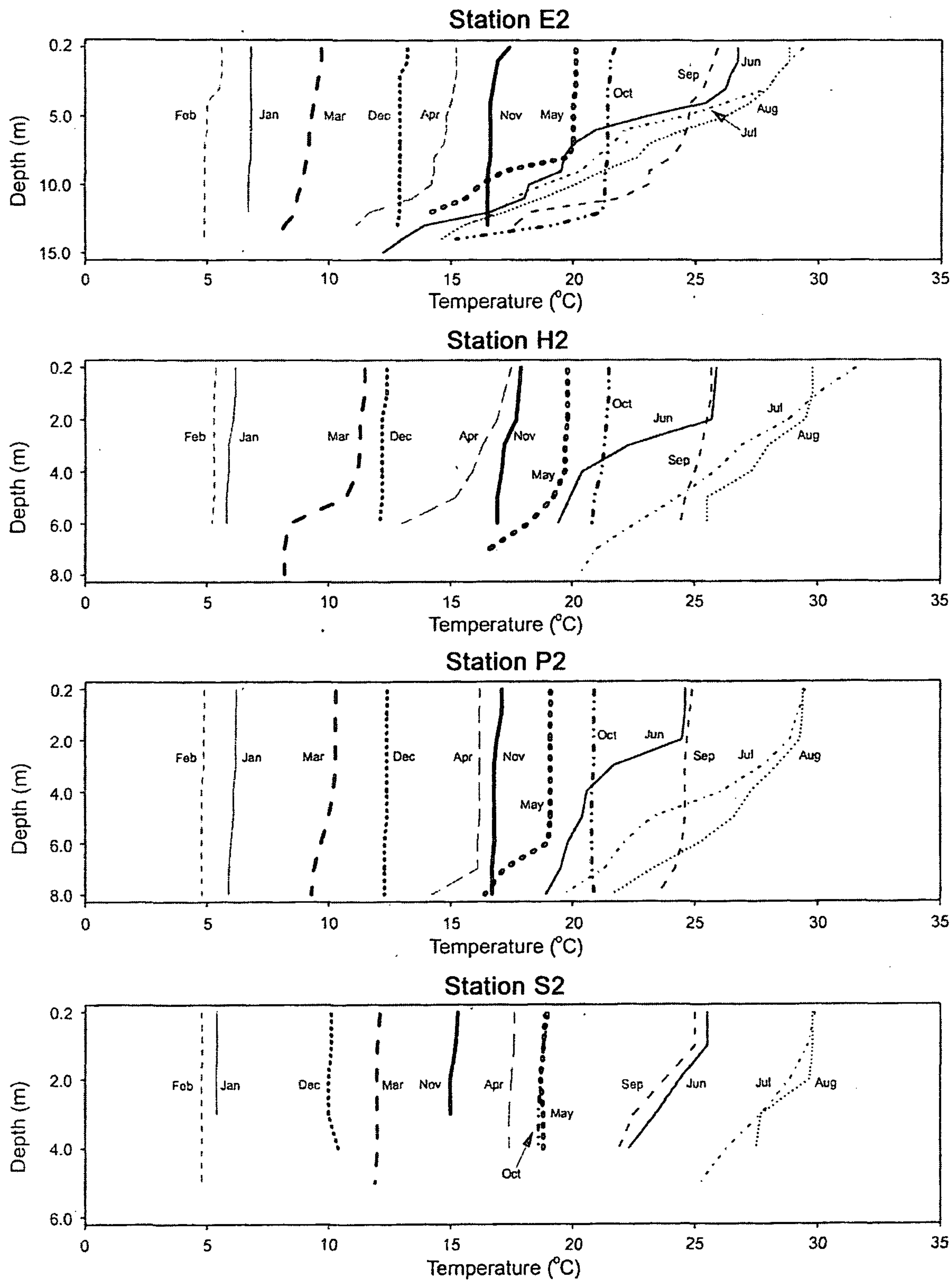
Station S2, surface

Month	Total Alkalinity ($CaCO_3$)	Hardness (calculated)	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	TN	NH_3-N	Nitrate + nitrite-N	TP	TOC
Jan	9.8	16	8.6	12	3.6	1.7	8.5	0.49	< 0.02	0.04	0.030	7.3
Feb								0.52	0.02	< 0.02	0.039	
Mar	4.8	12	4.5	8.5	2.6	1.3	4.5	0.63	0.05	0.06	0.056	9.8
Apr								0.61	0.08	0.05	0.049	
May	9.6	12	8.7	14	2.6	1.3	11	0.71	0.13	0.04	0.034	6.1
Jun								0.33	< 0.02	< 0.02	0.022	
Jul	12	16	8.5	13	3.7	1.7	10	0.75	< 0.02	< 0.02	0.060	7.0
Aug								0.56	< 0.02	< 0.02	0.015	
Sep	16	17	10	12	4.0	1.8	11	0.52	< 0.02	< 0.02	0.015	6.4
Oct								0.65	< 0.02	< 0.02	0.011	
Nov	15	18	10	13	4.0	1.9	13	0.54	< 0.02	< 0.02	0.016	5.9
Dec								0.49	< 0.02	< 0.02	0.015	

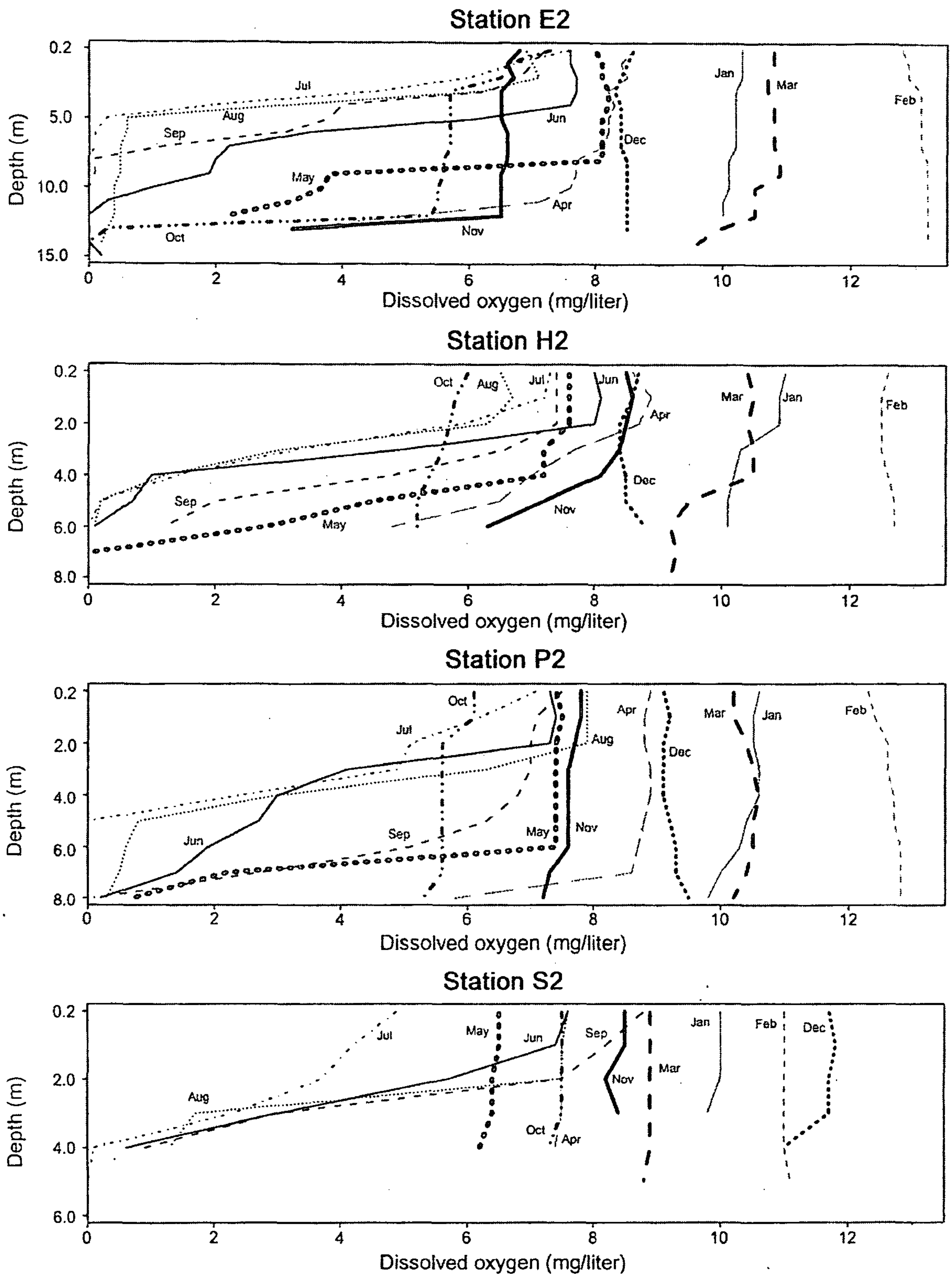
Month	Turbidity	TS	TDS	TSS	Al⁺	As	Cd	Cu	Hg¶	Se	Zn
Jan	14	83	71	8	80	< 1	< 0.1	1.0	< 0.05	< 1	< 20
Feb	8.2	72	52	9							
Mar	38	104	70	20	1000	< 1	< 0.1	2.0	< 0.05	< 1	< 20
Apr	24	86	66	13							
May	5.3	69	61	7	150	< 1	< 0.1	1.0	< 0.05	< 1	< 20
Jun	2.9	72	61	2							
Jul	1.6	53	59	< 1	40	< 1	< 0.1	1.6	< 0.05	< 1	< 20
Aug	1.2	69	64	< 1							
Sep	2.9	70	67	< 1	< 50	< 1	< 0.1	< 1.0	< 0.05	< 1	< 20
Oct	1.2	73	65	1							
Nov	3.6	70	64	1	120	< 1	0.1	1.0	< 0.20	< 1	< 20
Dec	1.0	68	62	< 1							

⁺The lower reporting limit was changed from 20 to 50 μg/liter when the September 1994 samples were being analyzed.

¶The lower reporting limit was changed from 0.05 to 0.20 μg/liter when the November 1994 samples were being analyzed.



Appendix 10. Water temperature profiles at Harris Reservoir during 1994.



Appendix 11. Dissolved oxygen profiles at Harris Reservoir during 1994.

Appendix 12. **Means, ranges, and spatial trends of selected limnological variables from the surface and bottom waters of Harris Reservoir during 1994.+**

	Station				
Variable	**E2 (surface)**	**E2 (bottom)**	**H2**	**P2**	**S2**
Solids (mg/liter)					
Total	75 (59-88)	88§ (70-137)	72 (59-86)	73 (59-83)	74 (53-104)
Total dissolved	70[a] (63-78)	81§ (66-125)	66[bc] (54-73)	67[b] (61-72)	64[c] (52-71)
Total suspended	3 (1-6)	5 (1-14)	4 (< 1-10)	3 (1-6)	5 (< 1-20)
Turbidity (NTU)	2.9[b] (1.0-6.5)	6.0 (1.7-20)	3.9[b] (1.3-15)	2.9[b] (1.1-7.7)	8.7[a] (1.0-38)
Secchi disk transparency (m)	1.5 (1.1-2.7)	NA	1.5 (0.7-2.3)	1.5 (1.0-2.7)	---¥
Chlorophyll *a* (µg/liter)	16.7[a] (3.2-47.7)	NA	16.8[a] (4.8-38.5)	12.1[a] (5.1-23.6)	6.4[b] (1.6-10.2)
Nutrients (mg/liter)					
Total nitrogen (TN)	0.67 (0.36-0.89)	1.4 (0.60-5.1)	0.66 (0.33-1.1)	0.60 (0.36-0.78)	0.57 (0.33-0.75)
Ammonia-N	0.05[a] (< 0.02-0.12)	0.67 (< 0.02-3.5)	0.02[b] (< 0.02-0.08)	0.03[b] (< 0.02-0.12)	0.03[b] (< 0.02-0.13)
Nitrate + Nitrite-N	0.06[a] (< 0.02-0.18)	0.07 (< 0.02-0.18)	0.04[b] (< 0.02-0.10)	0.04[ab] (< 0.02-0.11)	0.02[c] (< 0.02-0.06)
Total phosphorus (TP)	0.039 (0.017-0.072)	0.11§ (0.034-0.35)	0.030 (0.013-0.052)	0.024 (0.016-0.037)	0.030 (0.011-0.060)
TN:TP	17	13	22	25	19
Total organic carbon (mg/liter)	6.3 (5.7-7.2)	6.8 (6.3-7.7)	6.1 (4.7-7.1)	6.6 (5.8-7.6)	7.1 (5.9-9.8)
Ions (mg/liter)					
Cations					
Calcium	3.8[a] (2.8-4.5)	4.2 (3.2-5.4)	3.6[ab] (2.7-4.4)	3.7[ab] (2.7-4.3)	3.4[b] (2.6-4.0)
Magnesium	1.8[a] (1.4-2.2)	2.0 (1.6-2.2)	1.8[a] (1.4-2.1)	1.8[a] (1.4-2.1)	1.6[b] (1.3-1.9)
Sodium	12 (11-14)	12 (11-14)	11 (8.6-14)	10 (9.0-11)	9.7 (4.5-13)

Appendix 12 (continued)

	Station				
Variable	E2 (surface)	E2 (bottom)	H2	P2	S2
<u>Anions</u>					
Chloride	10[a] (8.8-11)	10 (9.0-11)	9.2[ab] (7.6-11)	9.3[ab] (8.7-11)	8.4[b] (4.5-10)
Sulfate	15[a] (13-17)	14 (9.8-17)	14[ab] (13-14)	14[a] (13-16)	12[b] (8.5-14)
Total alkalinity[¶]	13[a] (11-17)	22 (12-42)	13[a] (9.3-17)	13[a] (9.5-16)	11[b] (4.8-16)
Hardness (calculated)[¶]	17[a] (13-20)	19 (15-22)	16[a] (13-20)	17[a] (12-19)	15[b] (12-18)
Specific conductance (µS/cm)	98[a] (80-117)	129[§] (85-243)	93[b] (77-104)	94[b] (79-103)	84[c] (46-101)

[+]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 12 for all variables except for total alkalinity, hardness, and all ions which equaled 6. The variable TN:TP was not subjected to statistical analyses.

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

[§]The difference between the surface and bottom concentrations was significantly different than zero ($P > 0.05$).

[¥]Data were not analyzed, refer to Appendix 8 for the range.

NA = Not applicable.

Appendix 13. Spatial trends of selected limnological variables from the surface waters of Harris Reservoir at Stations E2, H2, and P2, 1987-1994.[+]

Variable[¶]	Station E2	Station H2	Station P2
Solids (mg/liter)			
Total (126)	63	61	67
Total dissolved (72)	58	51	57
Total suspended (108)	3.8	5.5	3.8
Turbidity (NTU)	2.6[b]	3.6[a]	2.9[ab]
Secchi disk transparency (m)	1.5[a]	1.4[b]	1.4[ab]
Chlorophyll *a* (μg/liter)	21.1	23.8	19.3
Nutrients (mg/liter)			
Total nitrogen	0.56	0.53	0.52
Ammonia-N (108)	0.07[a]	0.04[b]	0.04[b]
Nitrate + nitrite-N (108)	0.08	0.06	0.06
Total phosphorus	0.046[a]	0.032[b]	0.028[b]
TN:TP[£]	11	16	18
Total organic carbon (mg/liter)	6.8	6.6	6.8
Ions (mg/liter)			
Cations			
Calcium	3.4	3.3	3.3
Magnesium	1.8[a]	1.7[b]	1.7[ab]
Sodium	8.8[a]	8.1[b]	8.3[b]
Anions			
Chloride	7.2[a]	6.8[b]	7.0[ab]
Sulfate	11[a]	10[b]	11[ab]
Total alkalinity[§]	12.5[a]	11.7[b]	11.8[b]
Hardness[§]	16	15	15
Specific conductance (μS/cm)	79	77	76
Metals (μg/liter)			
Aluminum	57[b]	79[a]	54[b]
Copper	3.1	2.5	2.6

[+]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 ($P > 0.05$). Data were rounded to conform to significant digit requirements. The mean separation technique may yield separations which are obscured by data rounding.

[¶]Sample size (*n*) equaled 144 unless otherwise noted in parentheses.

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

[£]Variable was not subjected to statistical analyses.

Appendix 14. Temporal trends of selected limnological variables from the surface waters of Harris Reservoir at Stations E2, H2, and P2, 1987-1994.⁺

	Year							
Variable¶	1987	1988	1989	1990	1991	1992	1993	1994
Solids (mg/liter)								
Total (126)	57[b]	NS	67[ab]	56[b]	56[b]	73[a]	64[ab]	73[a]
Total dissolved (72)	47[b]	NS	NS	NS	NS	53[b]	52[b]	67[a]
Total suspended (108)	NS	NS	3.0	7.3	3.3	5.1	4.2	3.3
Turbidity (NTU)	3.7[ab]	2.8[bc]	4.0[a]	2.5[bc]	2.5[bc]	2.1[c]	3.1[abc]	3.6[ab]
Secchi disk transparency (m)	1.4	1.3	1.4	1.6	1.5	1.4	1.4	1.4
Chlorophyll *a* (µg/liter)	15.8[b]	20.2[b]	33.6[a]	24.7[ab]	18.3[b]	20.1[b]	21.0[b]	17.6[b]
Nutrients (mg/liter)								
Total nitrogen	0.44[c]	0.47[c]	0.49[c]	0.58[b]	0.58[b]	0.43[c]	0.62[ab]	0.69[a]
Ammonia-N (108)	0.05	0.05	NS	NS	0.06	0.06	0.03	0.03
Nitrate + nitrite-N (108)	0.06[b]	0.07[b]	NS	NS	0.11[a]	0.06[b]	0.06[b]	0.05[b]
Total phosphorus	0.024[d]	0.029[cd]	0.045[ab]	0.049[a]	0.037[bc]	0.036[bc]	0.031[cd]	0.031[cd]
TN:TP£	18	16	11	12	16	12	20	22
Total organic carbon (mg/liter)	6.1[d]	6.7[bc]	7.4[a]	7.1[ab]	6.3[cd]	7.0[ab]	7.0[ab]	6.3[cd]
Ions (mg/liter)								
Cations								
Calcium	3.5[bc]	3.8[a]	3.3[c]	2.6[d]	2.7[d]	3.4[c]	3.5[bc]	3.7[ab]
Magnesium	1.5[e]	1.7[d]	1.7[d]	1.7[cd]	1.8[b]	1.9[a]	1.8[bc]	1.8[bc]
Sodium	5.1[e]	7.8[d]	7.3[d]	7.6[d]	8.5[c]	11[a]	9.3[b]	11[a]
Anions								
Chloride	4.3[g]	5.7[f]	5.5[f]	6.3[e]	7.4[d]	9.1[b]	8.1[c]	9.5[a]
Sulfate	6.8[e]	8.7[c]	7.8[d]	9.5[c]	12[b]	14[a]	12[bc]	14[a]
Total alkalinity§	13[bc]	15[a]	12[cd]	9.9[e]	10[e]	11[d]	12[d]	13[b]
Hardness§	15[cd]	17[a]	15[bc]	14[e]	14[de]	16[a]	16[ab]	16[a]
Specific conductance (µS/cm)	68[de]	83[b]	73[cd]	75[c]	69[dc]	95[a]	63[e]	94[a]
Metals (µg/liter)								
Aluminum	21[c]	55[abc]	84[a]	45[bc]	71[ab]	80[a]	71[ab]	81[a]
Copper	3.5[a]	3.7[a]	3.1[ab]	3.8[a]	2.2[bcd]	2.4[bc]	2.1[cd]	1.4[d]

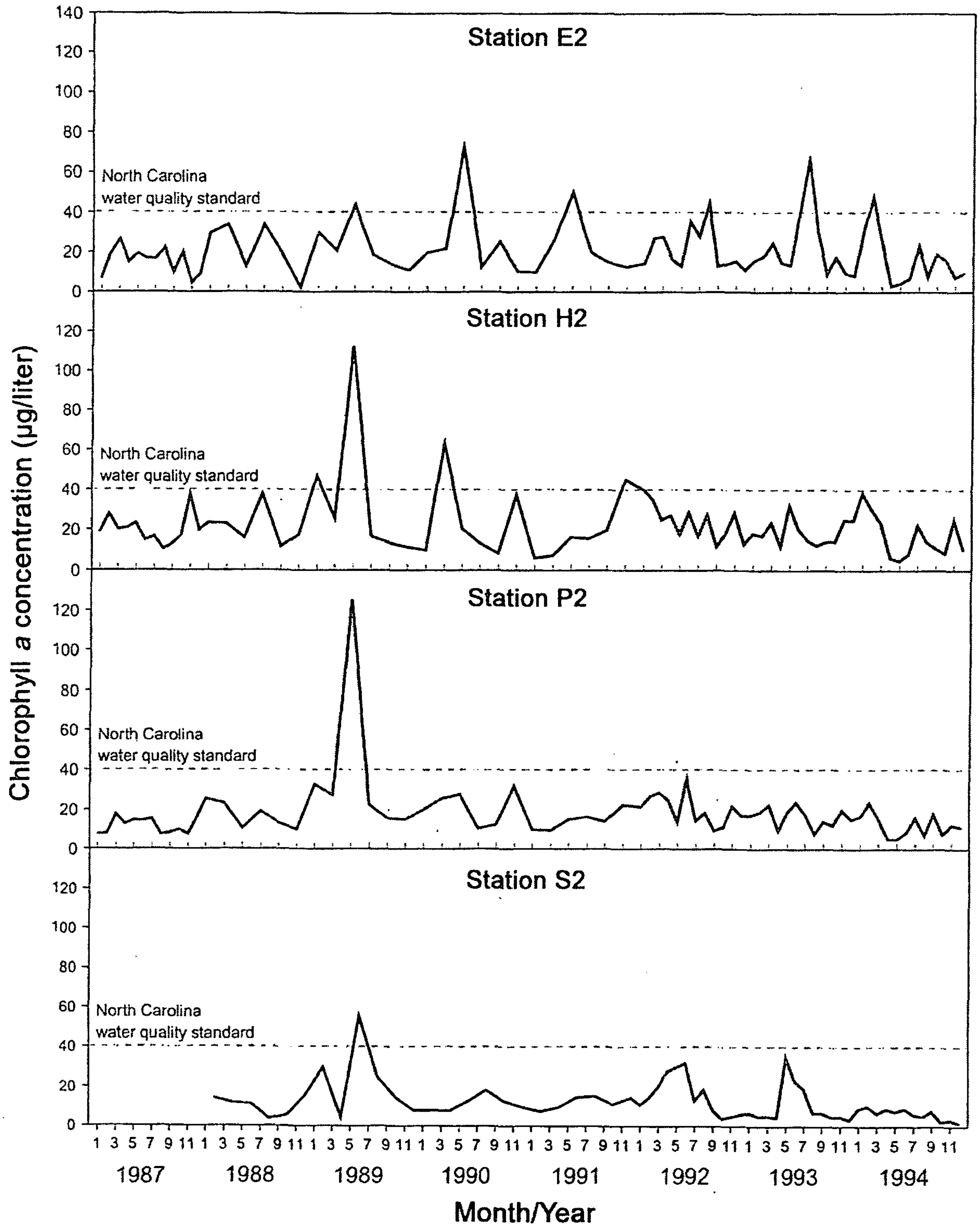
⁺Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Means followed by the same superscript were not significantly different ($P > 0.05$). Data were rounded to conform to significant digit requirements. The mean separation technique may yield separations which are obscured by data rounding.

¶Sample size (n) equaled 144 unless otherwise noted in parentheses.

§Total alkalinity units are mg/liter as $CaCO_3$ and hardness units are calculated as mg equivalents $CaCO_3$/liter.

£Variable was not subjected to statistical analyses.

NS = Not sampled.



Appendix 15. Chlorophyll *a* concentrations by station in Harris Reservoir, 1987-1994.

Appendix 16. Means, ranges, and spatial trends of trace metals and metalloids in the surface and bottom waters of Harris Reservoir during 1994[+].

Variable (μg/liter)	Station: E2 (surface)	E2 (bottom)	H2 (surface)	P2 (surface)	S2 (surface)	N. C. water quality standard	CP&L reporting limit [¶]
Aluminum	66 (< 50-120)	73 (< 50-160)	109 (< 50-330)	68 (< 50-140)	236 (< 50-1000)	None	20 (50)[¥]
Arsenic	< 1	1 (< 1-1)	< 1	< 1	< 1	50	1
Cadmium	0.08 (< 0.1-0.2)	< 0.1	< 0.1	0.06 (< 0.1-0.1)	0.06 (< 0.1-0.1)	2	0.1
Copper	1.3 (< 1.0-3.0)	2.4[§] (1.0-3.1)	1.4 (< 1.0-2.0)	1.5 (1.0-2.0)	1.2 (< 1.0-2.0)	7[£]	1
Mercury	< 0.05-< 0.20	0.15 (< 0.05-0.45)	< 0.05-< 0.20	< 0.05-< 0.20	< 0.05-< 0.20	0.012	0.05 (0.20)[¥]
Selenium	< 1	< 1	< 1	< 1	< 1	5	1
Zinc	12 (< 20-20)	13 (< 20-20)	< 20	< 20	< 20	50	20

[+]Statistical analyses were applied only to the aluminum and copper surface water data; neither variable showed significant spatial differences (P > 0.05).

[¶]A statistically determined lower reporting limit (LRL) beyond which a chemical concentration cannot be reliably reported. LRL = 3 sx + | x |, where x = the concentration of the blank, | x | = the absolute concentration of the blank, and s = sample standard deviation.

[§]A significant spatial difference in the mean concentrations was measured between the surface and bottom waters at Station E2.

[¥]The lower reporting limit for aluminum was changed from 20 to 50 μg/liter when the September 1994 samples were being analyzed. The lower reporting limit for mercury was changed from 0.05 to 0.20 μg/liter when the November 1994 samples were being analyzed.

[£]This value is an action level not a water quality standard. An action level is for toxic substances which are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics, or associated waste characteristics (NCDEM 1994b).

Appendix 17. **Temporal trends of selected limnological variables from the bottom waters of Harris Reservoir at Station E2, 1987-1994.[+]**

	Year							
Variable	1987	1988	1989	1990	1991	1992	1993	1994
Solids (mg/liter)								
Total (42)	75	NS	77	66	68	94	83	84
Total dissolved (24)	67	NS	NS	NS	NS	82	71	77
Total suspended (36)	NS	NS	3.8	11.3	6.8	7.2	7.0	5.3
Turbidity (NTU)	14	10	5.2	4.2	7.1	8.2	7.9	5.9
Nutrients (mg/liter)								
Total nitrogen	1.3	2.7	1.0	1.0	1.1	2.0	1.1	1.1
Nitrate + nitrite-N (36)	0.80	0.07	NS	NS	0.14	0.09	0.07	0.06
Ammonia-N (36)	0.59	2.0	NS	NS	0.58	1.2	0.78	0.36
Total phosphorus	0.28	0.31	0.21	0.15	0.20	0.21	0.29	0.11
TN:TP[§]	5	9	5	7	6	10	4	10
Total organic carbon (mg/liter)	6.6	6.8	7.9	7.4	6.9	8.2	8.0	6.8
Ions (mg/liter)								
Cations								
Calcium	4.5[b]	5.5[a]	4.2[b]	3.2[c]	3.2[c]	4.1[b]	4.2[b]	4.2[b]
Magnesium	1.7[d]	2.1[ab]	1.9[bcd]	1.8[cd]	2.0[bc]	2.3[a]	2.1[b]	2.0[bc]
Sodium	4.6[e]	7.8[d]	8.2[d]	7.5[d]	9.1[c]	12[a]	10[b]	12[a]
Anions								
Chloride	4.2[e]	5.6[d]	5.8[d]	6.2[d]	7.8[c]	9.7[a]	8.7[b]	10[a]
Sulfate	5.1[d]	5.3[d]	8.2[c]	8.3[b]	11[b]	12[a]	11[b]	14[a]
Total alkalinity[¶]	26	42	22	19	19	30	24	22
Hardness[¶]	18[bc]	22[a]	18[bc]	15[d]	16[cd]	20[ab]	19[bc]	19[bc]
Specific conductance (µS/cm)	148	139	125	102	94	111	93	114
Metals (µg/liter)								
Aluminum	37	55	113	69	76	82	72	73
Copper	4.4	3.7	4.5	4.0	2.3	3.7	3.5	2.4

[+]Fisher's protected least significant difference test was applied only if the overall F test for the treatment was significant. Annual means followed by the same superscript were not significantly different ($P > 0.05$). Sample size (n) equaled 48 unless otherwise noted in parentheses.

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

[§]Variable was not subjected to statistical analyses.

NS = Not sampled.

Appendix 18. **Approximate growth performance of zebra mussels in relation to total alkalinity, calcium, total hardness, specific conductance, pH, and water temperature with the range of these values reported from Harris Reservoir in 1994. The appendix was adopted from Claudi and Mackie (1993).**

Criterion	No survival		Poor growth		Moderate growth		Good growth		Best growth	Harris Reservoir (surface)
	From	To	From	To	From	To	From	To		
Total alkalinity (mg $CaCO_3$/l)	0	17	18	35	36	87	88	122	> 122	4.8-17
Calcium (mg/l)	5	6	10	11	25	26	35	> 35	≥ 35	2.6-4.5
Total hardness (mg $CaCO_3$/l)	0	22	23	41	43	90	91	125	> 125	12-20
Specific conductance (μS/cm)	0	21	22	36	37	82	83	110	> 110	54-117
pH	0	6.8	6.9	7.4	7.5	7.8	7.9	8.0	> 8.0	6.4-8.9
Temperature (°C)[+]	< -2	> 40	0-8	28-30	9-12	25-27	13-17	21-24	18-20	4.8-31.6

[+]According to Claudi and Mackie (1993): "Temperature should be interpreted with caution here because it affects mussels at both high and low values. For example, there is no survival at temperatures below -2 or above 40°C but there is survival between these temperatures; there is poor growth both between 0-8°C and 28-30°C but moderate to best growth between these extremes; etc." Thus, these values should be used only as approximate values and not as accurate endpoints.

Appendix 19. **Mean catch rate (number of fish/hour) of fish collected during electrofishing sampling at Harris Reservoir, May and November 1994.**

Taxon	Area					Area mean
	E	H	P	S	V	
Bowfin	0	0	0	0	1	< 1
Gizzard shad	< 1	3	6	6	4	4
Golden shiner	5	3	2	3	4	3
Unidentified shiner	0	0	1	0	12	3
Brown bullhead	3	3	4	1	0	2
Snail bullhead	0	1	0	0	1	< 1
Yellow bullhead	0	1	0	0	0	< 1
Channel catfish	< 1	0	0	0	2	< 1
Chain pickerel	2	1	1	1	6	2
Eastern mosquitofish	0	0	0	1	0	< 1
Hybrid sunfish	1	1	1	1	0	< 1
Bluespotted sunfish	2	0	1	1	9	3
Redbreast sunfish	12	8	2	3	4	6
Pumpkinseed	17	15	4	9	10	11
Warmouth	3	1	0	1	4	2
Bluegill	54	115	118	66	239	118
Redear sunfish	61	63	21	14	33	38
Largemouth bass	18	10	18	25	50	24
White crappie	0	0	0	1	1	< 1
Black crappie	7	0	6	2	8	5
Total[+]	**185**	**224**	**185**	**133**	**388**	**223**

[+]Totals may vary from column sums due to rounding.

Appendix 20. Mean catch rate (number of fish/hour) of the numerically dominant fish species collected during electrofishing sampling at Harris Reservoir, 1983-1994.[+]

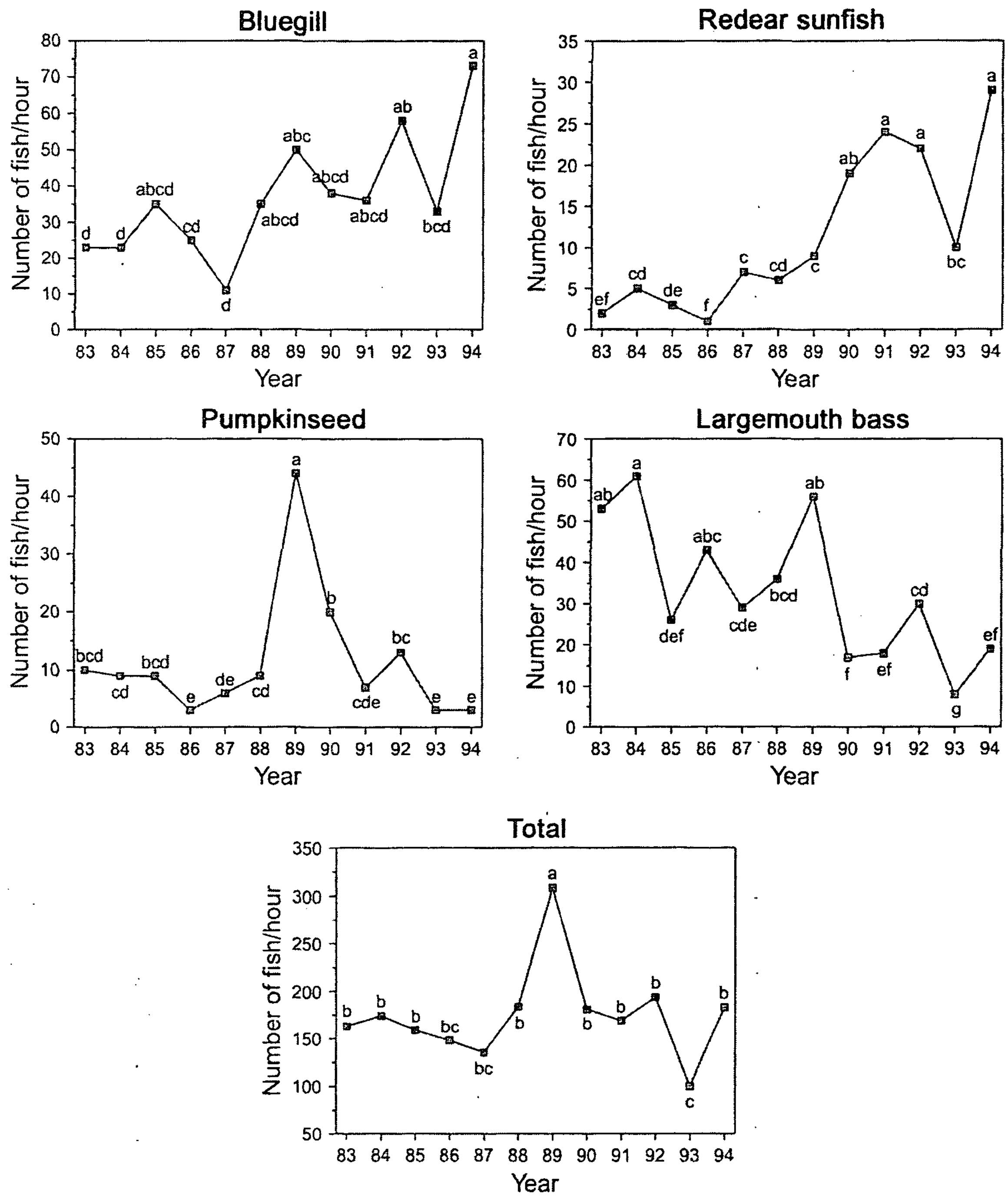
Taxon	Year											
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Gizzard shad	15	14	8	6	11	14	35	10	25	24	17	---[¶]
Threadfin shad[§]	---	---	---	---	---	---	24	---	---	6	---	---
Golden shiner	---	7	---	---	---	10	16	8	---	7	---	---
Brown bullhead	17	9	24	19	32	29	12	10	10	8	---	---
Flat bullhead	---	---	---	---	---	---	---	---	13	---	---	---
Redbreast sunfish	---	---	---	---	---	---	6	---	6	6	5	6
Pumpkinseed	16	15	13	7	10	14	68	33	19	23	10	11
Warmouth	11	13	14	17	16	9	13	9	---	---	---	---
Bluegill	40	32	48	43	18	91	131	134	96	80	71	118
Redear sunfish	5	8	5	6	10	10	15	28	29	29	21	38
Largemouth bass	63	65	40	58	36	46	63	20	27	39	10	24
Black crappie	---	---	---	---	---	12	18	19	8	---	---	5
Total[£]	**188**	**180**	**171**	**167**	**145**	**244**	**414**	**280**	**230**	**229**	**149**	**223**

[+] Areas E, H, P, S, and V and months May and November combined. A numerically dominant fish was defined subjectively as having a mean catch rate ≥ 5 fish/hour.

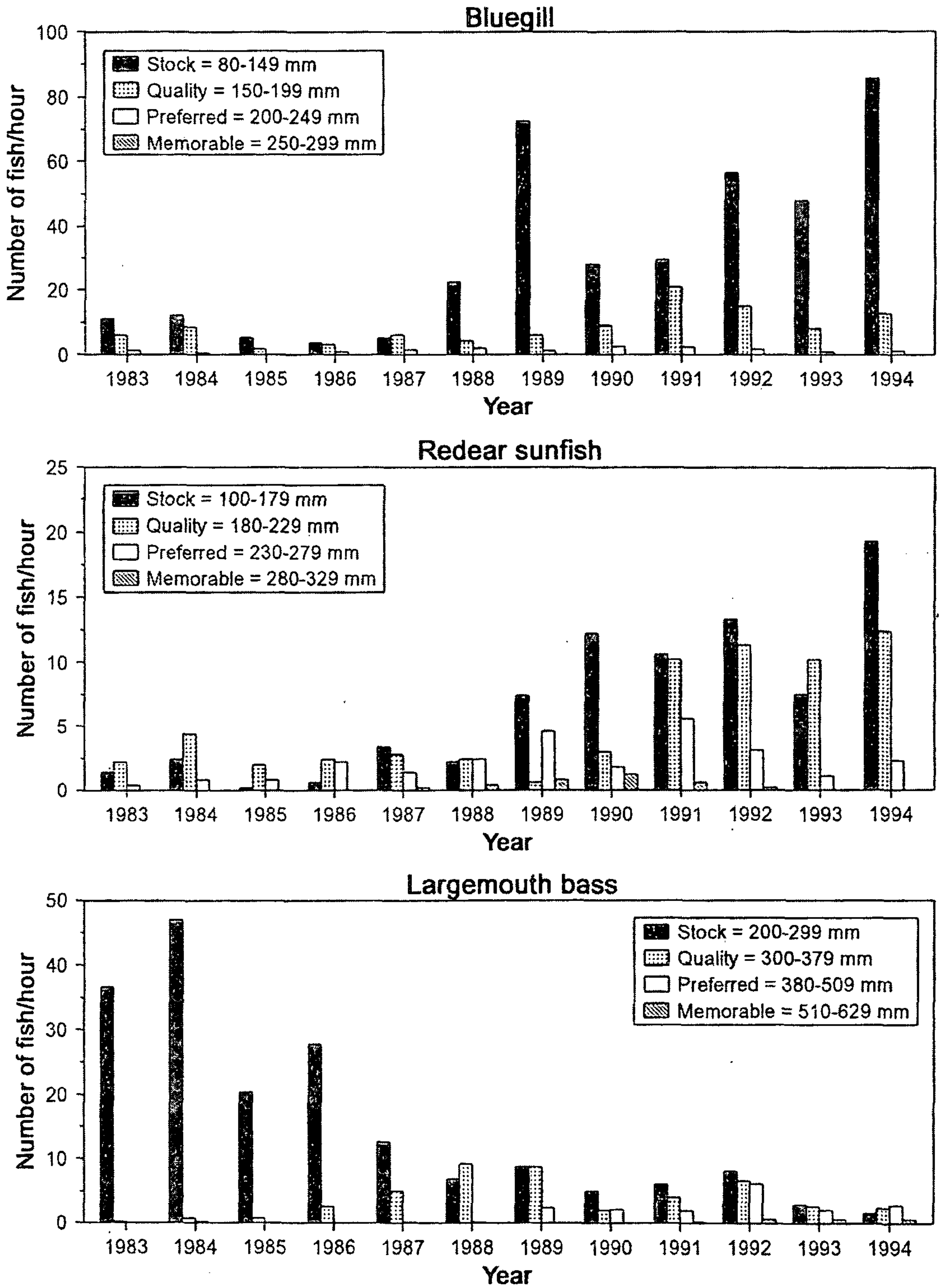
[¶] Annual mean catch rate was < 5 fish/hour.

[§] Threadfin shad were introduced into Harris Reservoir in 1987.

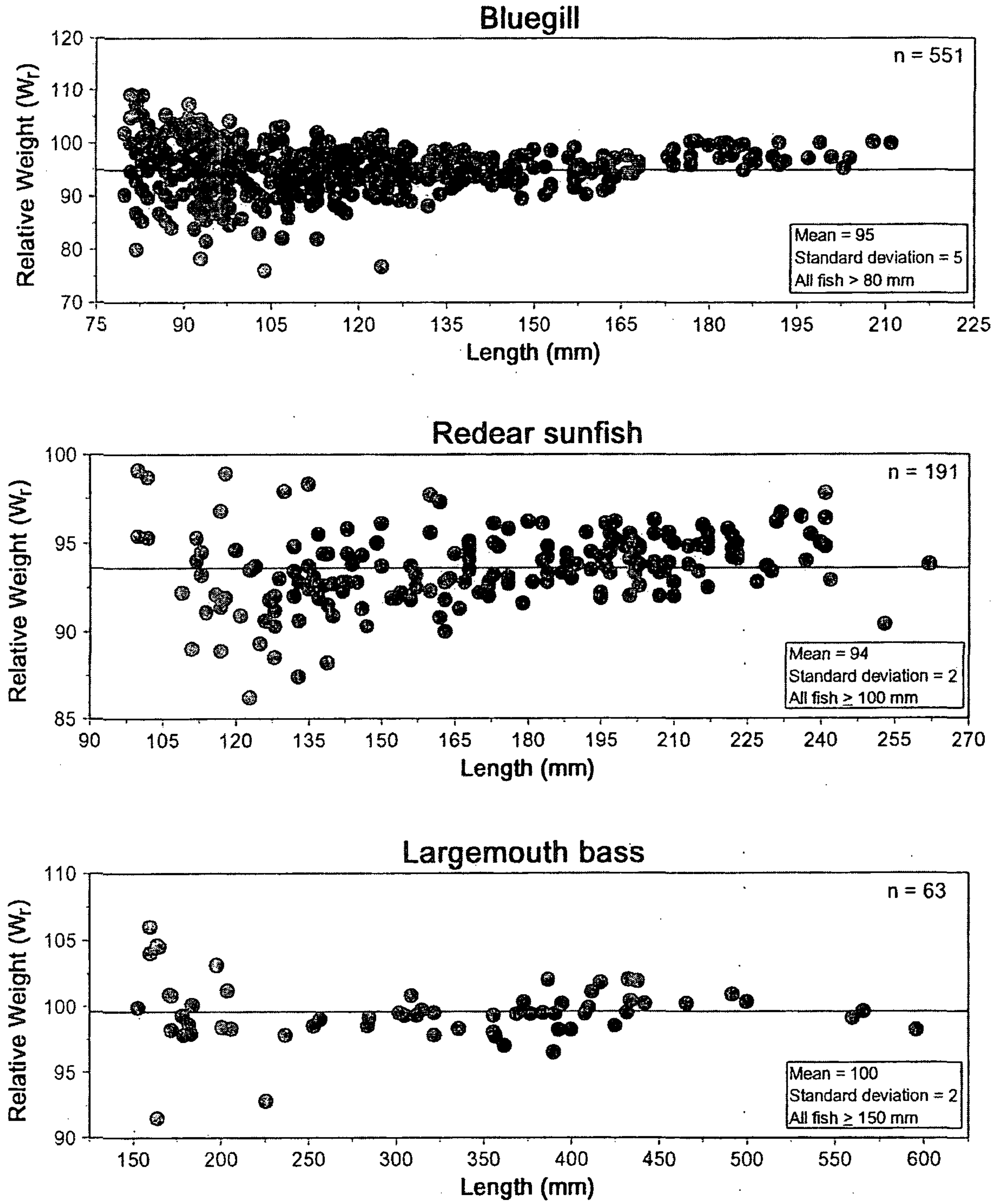
[£] Total catch rate of all species combined (i.e., numerically dominant and subordinate species).



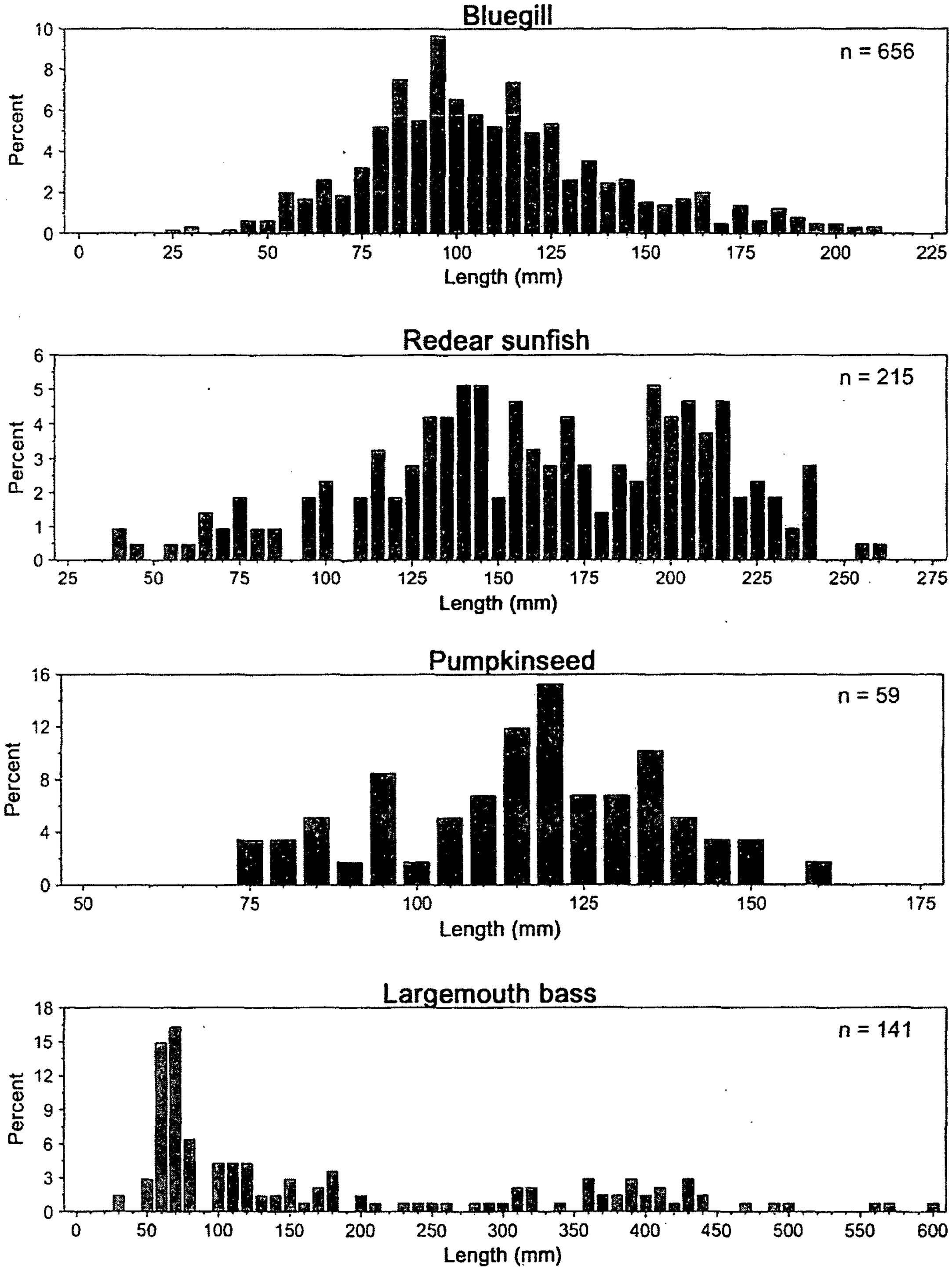
Appendix 21. Temporal trends of the mean catch rate (number of fish/hour) of selected sport fish species and total fish collected during electrofishing sampling at Harris Reservoir, May and November, 1983-1994. Geometric means (represented by the points on the lines) with the same letter were not significantly different ($P > 0.05$). Sample size (n) equaled 240. Note different scales on the y-axis for each taxon.



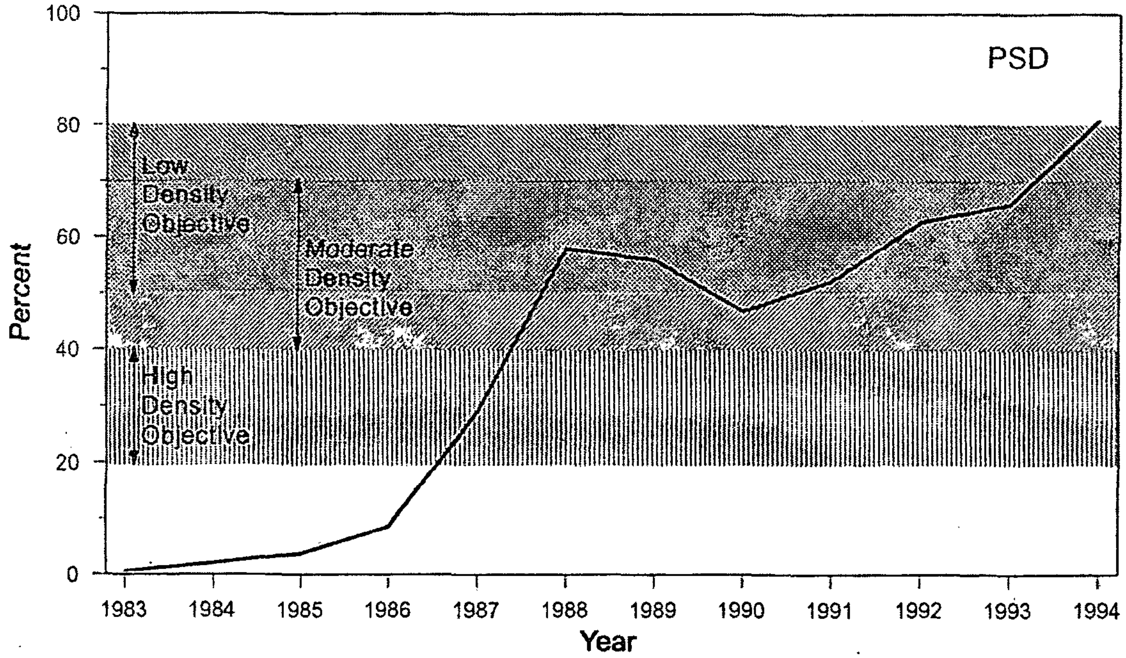
Appendix 22. **Catch rates of bluegill, redear sunfish, and largemouth bass by length group at Harris Reservoir, 1983-1994. Length groups were adopted from Gabelhouse (1984).**

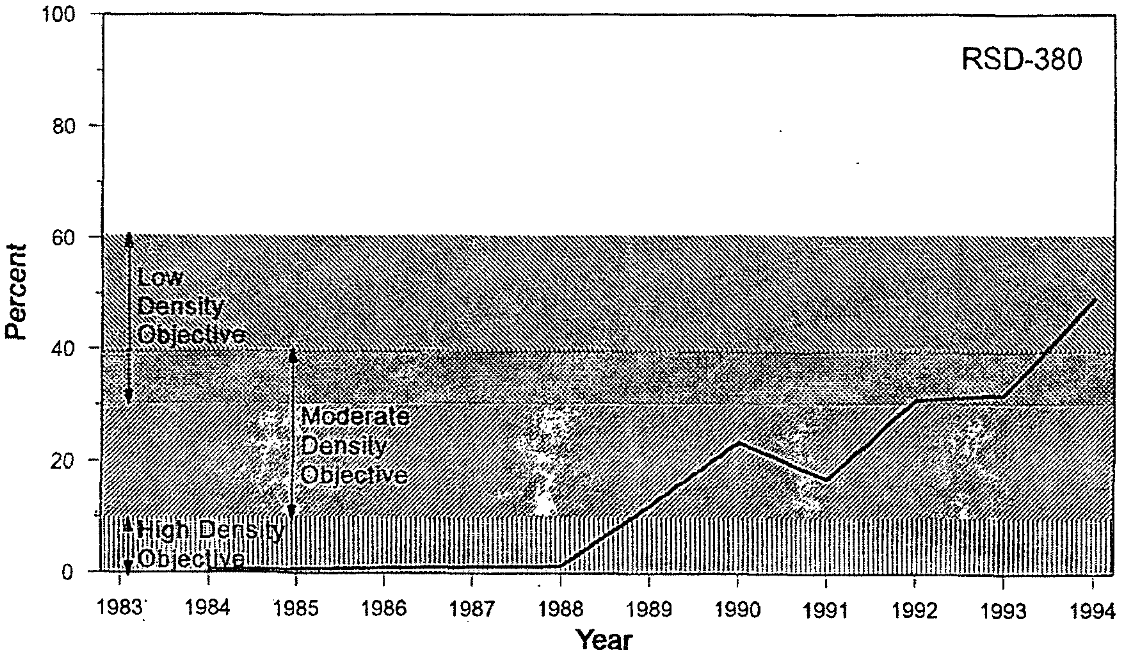


Appendix 23. **Predicted relative weight values for bluegill, redear sunfish, and largemouth bass collected during electrofishing sampling at Harris Reservoir, May and November 1994.**



Appendix 24. **Length-frequency distributions of bluegill, redear sunfish, pumpkinseed, and largemouth bass collected during electrofishing sampling at Harris Reservoir, May and November 1994.**





Appendix 25. Proportional Stock Density (PSD) and Relative Stock Density-380 mm (RSD-380) for largemouth bass collected during electrofishing sampling at Harris Reservoir, 1983-1994. The density objectives were adopted from Gabelhouse (1984).