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Harris Nuclear Plant

2003 Environmental Monitoring Report

Environmental Services Section

HARRIS NUCLEAR PLANT
2003 ENVIRONMENTAL MONITORING REPORT

December 2004

Environmental Services Section

PROGRESS ENERGY CAROLINAS
New Hill, North Carolina

Preface

This copy of the report is not a controlled document as detailed in Environmental Services Section Biology Program Procedures and Quality Assurance Manual. Any changes made to the original of this report subsequent to the date of issuance can be obtained from:

Director
Environmental Services Section
Progress Energy Carolinas
410 South Wilmington Street
Raleigh, North Carolina 27601

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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

Volume
1 milliliter (ml) = 0.034 fluid ounce
1 liter = 1000 ml = 0.26 gallon
1 cubic meter = 35.3 cubic feet

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

Temperature
Degrees Celsius (°C) = 5/9 (°F-32)

Specific conductance
μS/cm = Microsiemens/centimeter

Turbidity
NTU = Nephelometric Turbidity Unit

Water Chemistry Abbreviations

Cl^-	Chloride	NH_3-N	Ammonia-nitrogen
SO_4^{2-}	Sulfate	NO_3^- + NO_2^- - N	Nitrate + nitrite-nitrogen
Ca^{2+}	Total calcium	TP	Total phosphorus
Mg^{2+}	Total magnesium	TOC	Total organic carbon
Na^+	Total sodium	Cu	Total copper
TN	Total nitrogen	TDS	Total dissolved solids

EXECUTIVE SUMMARY

Harris Reservoir supplies makeup water to the closed-cycle cooling system for 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.

Harris Reservoir continued to show qualities of a typical, biologically productive, southeastern reservoir in 2003. Reservoir waters were well-mixed during late Autumn and Winter months with similar temperature and dissolved oxygen levels throughout the water column. Dissolved oxygen levels declined near the bottom with stratification during the late Spring and Summer. Nutrient concentrations, including total phosphorus and total nitrogen concentrations, remained similar to recent years and were in an acceptable range for a productive reservoir in this area.

Hydrilla stands reached the water surface in the intake canal in Harris Reservoir during 2003. However, no fouling of the plant intake screens occurred. No stands of hydrilla were observed in the littoral zone of the auxiliary reservoir during 2003. The attempt to control hydrilla in the auxiliary reservoir by releasing grass carp appears to have been effective in reducing the quantity and area covered by this vegetation.

HARRIS NUCLEAR PLANT
2003 ENVIRONMENTAL MONITORING REPORT

Reservoir Description

Harris Reservoir, located in Chatham and Wake Counties, North Carolina, was created by impounding Buckhorn Creek, a tributary of the Cape Fear River (Figure 1). The main body of Harris Reservoir has a surface area of 1680 ha; the auxiliary reservoir has a surface area of 130 ha. 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 National Geodetic Vertical Datum (NGVD), and an average residence time of 28 months. The reservoir began filling in December 1980 and reached full-pool elevation 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. The conversion of land from forestry or agricultural purposes to residential uses continues in many areas of the drainage.

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 Pollutant Discharge Elimination System (NPDES)-permitted wastewater discharges from the power plant cooling tower. Tributaries also receive NPDES-permitted discharges from the Harris Energy and Environmental Center and from wastewater treatment plants at Apex and Holly Springs. The reservoir is a source of drinking water for Progress Energy employees at the Harris Nuclear Plant and the Harris Energy and Environmental Center.

Objectives

The primary objectives of the 2003 Harris Nuclear Plant non-radiological environmental monitoring program were to: (1) assess the reservoir's overall water quality, (2) identify any natural or power plant-induced effects on the water quality in the reservoir, and (3) document the introduction and expansion of nonnative plant and animal populations in the reservoir. These objectives have also been addressed in previous annual monitoring reports with the most recent detailed in CP&L 1999, 2000, 2001, 2002, and PEC 2003.

Methods

The Harris Nuclear Plant environmental program for 2003 included monitoring the reservoir's (1) limnological characteristics (water quality, water chemistry, and phytoplankton); (2) possible introductions of zebra mussels (*Dreissena bugensis*) and quagga mussels (*D. polymorpha*); and (3) distribution of aquatic vegetation. Fish community assessments occur biannually and are scheduled for 2004. Sampling methods and statistical analyses for data collected during 2003 (Tables 2 and 3) were similar to those used for data collected during 2003 (PEC 2003). Supporting data summaries and appropriate statistical analyses were used to describe and interpret the environmental quality of the reservoir (Table 3).

All analytical testing completed in support of the Harris Reservoir environmental program was performed by appropriate laboratories which were qualified to perform water and wastewater testing. The accuracy and precision of laboratory analyses of water chemistry data were determined with analytical standards, spikes, and replicates. Quality assurance information including the accuracy and percent recovery of water chemistry standards are available upon request. 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. Where statistically significant results were reported, a Type I error rate of 5% ($\alpha = 0.05$) was used and Fisher's protected least significant difference test was applied to determine where significant differences in mean values occurred.

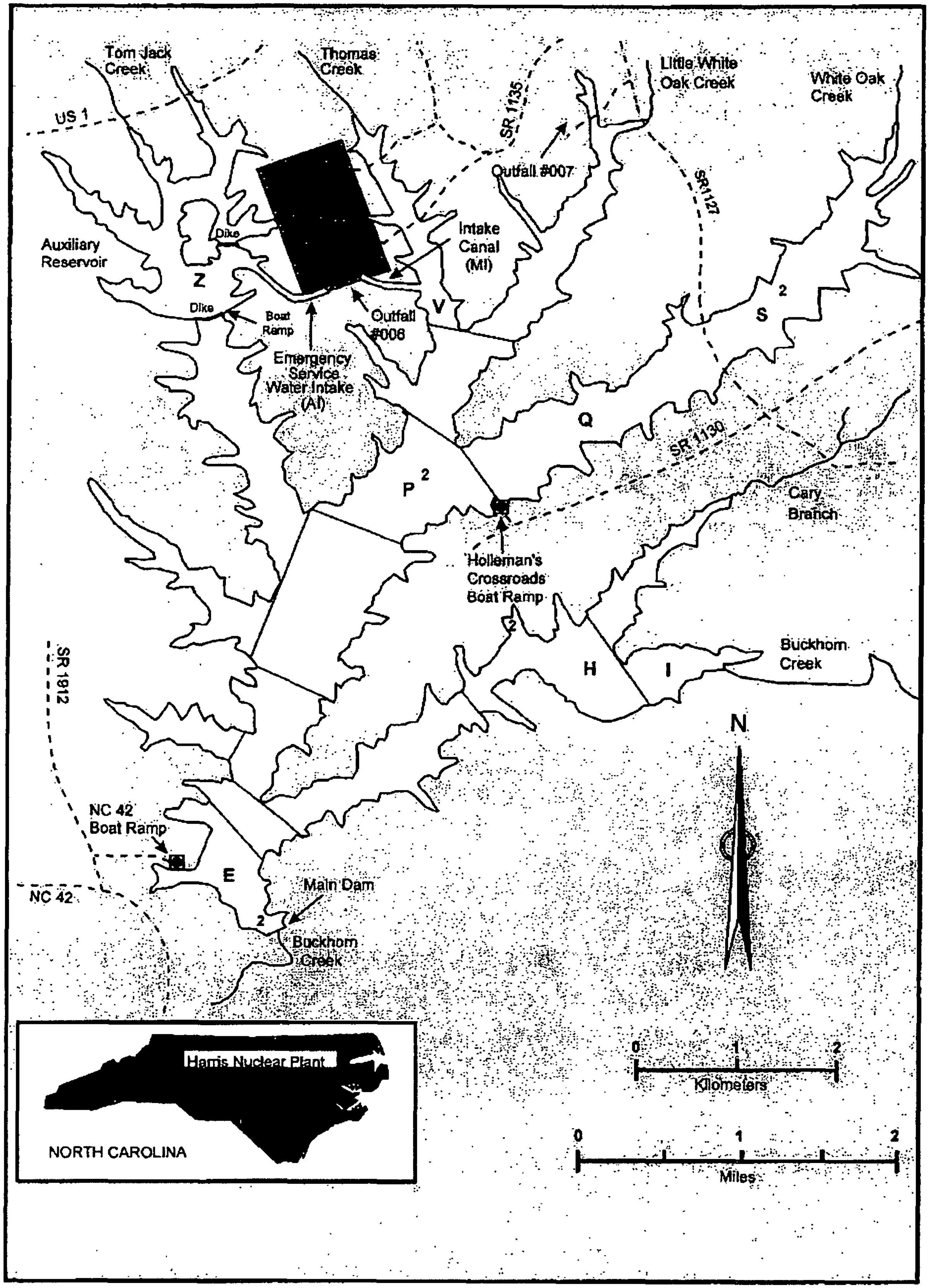

Figure 1. Sampling areas and stations at Harris Reservoir during 2003.

Table 1. Environmental monitoring program at Harris Reservoir for 2003.

Program	Frequency	Location
Water quality	January, May, July, November	Stations E2, H2, P2, and S2 (surface to bottom at 1-m intervals)
Water chemistry	January, May, July, November	Stations E2, H2, P2, and S2 (surface samples at all stations)
Plankton[+]	January, May, July, November	Stations E2, H2, P2, and S2
Biofouling monitoring		
Zebra and quagga mussel surveys	January, May, July, November	Areas E, P or Q, and V
Aquatic vegetation survey	November	Areas MI and Z

[+]Plankton included phytoplankton (algae) and chlorophyll *a* samples. Phytoplankton samples were collected and preserved but were not identified because all sampled chlorophyll *a* concentrations were < 40 μg/L during 2003.

Table 2. Field sampling and laboratory methods followed in the 2003 environmental monitoring program at Harris Reservoir.

Program	Method
Water quality	Temperature, dissolved oxygen, pH, turbidity, and specific conductance were measured with calibrated YSI® multiparameter instruments and YSI® dissolved oxygen meters. Measurements were taken from surface to bottom at 1-m intervals. Water clarity was measured with a Secchi disk.
Water chemistry	Surface water samples were collected in appropriate containers, transported to the laboratory on ice, and analyzed according to accepted laboratory methods.
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. A 250-ml sub sample was taken and preserved with 5 ml of "M3" fixative.
Chlorophyll *a*	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. A 1000-ml sub sample was collected in a dark bottle, placed on ice, and returned to the laboratory. In the laboratory a 250-ml sub sample was analyzed according to APHA (1995).
Biofouling monitoring	The Holleman's boat ramp dock or water quality station marker buoys were visually inspected for zebra and quagga mussels during water quality monitoring.
Aquatic vegetation survey	Portions of the shoreline and/or littoral zone of the Harris Plant main reservoir intake canal and auxiliary reservoir were systematically surveyed by boat to document the presence of aquatic vegetation, specifically hydrilla and water primrose.

Table 3. Statistical analyses performed on data collected for the 2003 environmental monitoring program at Harris Reservoir.

Program	Variable	Transformation	Statistical Test/model[+]	Main effect(s)
Water quality	Specific conductance and Secchi disk transparency	None	One-way, block on month	Station
Water chemistry	Select monitoring variables	None	One-way, block on month	Station
Phytoplankton	Chlorophyll *a*	None	One-way, block on month	Station

[+]Statistical tests used were one-way and two-way analysis of variance models. 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 (LSD) test was applied to determine where differences in means occurred.

RESULTS OF ENVIRONMENTAL MONITORING AT HARRIS RESERVOIR DURING 2003

Limnology

Temperature and Dissolved Oxygen

- Reservoir waters were well mixed at all four stations during January and November 2003 (Appendix 1). As the reservoir began to stratify with warming temperatures, portions of the water column near the reservoir bottom became anoxic (i.e., conditions where dissolved oxygen concentrations are less than 1 mg/liter). During July water below three to four meters deep was anoxic at all four stations (Appendix 1). A bottom-water oxygen decline is typical at the deeper stations during the warm summer months in Harris Reservoir and in other productive southeastern water bodies.

Water Clarity (Secchi Disk Transparency, Total Dissolved Solids, and Turbidity)

- The annual average secchi disk transparency depth for each station was 1.4 or 1.5 meters (Appendix 2). There were no significant differences in the annual mean Secchi disk transparency depths among stations during 2003. The largest difference among secchi disk transparency depths was 0.8 meters in November (Appendix 1).

- There were no significant spatial trends for total dissolved solids or turbidity during 2003 (Appendix 2). Turbidity was generally low at all stations with all recorded values less than 10 NTU. Values for all water clarity parameters were within the ranges of values for previous years at Harris Reservoir (CP&L 1999, 2000, 2001, 2002 and PEC 2003).

Chlorophyll *a*

- During 2003, mean chlorophyll *a* concentrations (an indicator of algal biomass) in Harris Reservoir continued to be indicative of moderate biological productivity. Chlorophyll *a* concentrations were greatest at all stations in the July samples and averaged 11 μg/liter reservoir-wide for 2003 (Appendix 2). The greatest recorded chlorophyll *a* concentration was 28 μg/liter at Station H2 in July. There were no significant differences in chlorophyll *a* concentrations among stations during 2003. Annual mean chlorophyll *a* concentrations for 2003 were within the range of concentrations for the past five years at Harris Reservoir

(CP&L 1999, 2000, 2001, 2002 and PEC 2003).

- Because chlorophyll *a* concentrations did not exceed the North Carolina water quality standard of 40 μg/liter (NCDEM 1992), the collected phytoplankton was not identified (Appendix 2).

Nutrients and Total Organic Carbon

- There were no significant spatial differences among stations for mean nutrient concentrations (i.e., nitrate + nitrite-N, total phosphorus, total nitrogen, and ammonia-N) or total organic carbon concentrations in Harris Reservoir during 2003 (Appendix 2). All nitrate + nitrite-N values for May and July were below the lower reporting limit. Values for all nutrients and for total organic carbon were within the ranges of values for previous years at Harris Reservoir (CP&L 1999, 2000, 2001, 2002 and PEC 2003). Most values for ammonia-N were below the lower reporting limit, and all values were equal to or less than 0.03 mg/liter.

- The ammonia-N sample at Station E2 during November was reported as 0.37 mg/liter by the testing laboratory. This value was considered erroneous because nitrate + nitrite-N and total nitrogen were not elevated at Station E2 during November and this value is an order of magnitude higher than other ammonia-N values for 2003. Therefore, this value was removed from analysis.

Specific Conductance, Ions, and Hardness

- There were no significant spatial differences in conductivity, ion concentration (calcium, chloride, magnesium, sodium, and sulfate) or hardness during 2003 (Appendix 2). Reservoir means during 2003 for calcium, magnesium, and sodium ions, and for hardness were lower than reservoir means from the previous five years (CP&L 1999, 2000, 2001, 2002 and PEC 2003). However, these changes in ion concentrations were not biologically significant.

pH and Total Alkalinity

- Surface water pH values in Harris Reservoir ranged from 6.4 to 8.2 during quarterly sampling in 2003 (Appendix 1). Surface pH values were highest at Stations E2, H2, and P2 in July when values exceeded 8.0. Chlorophyll *a* concentrations were also greatest at all stations in the July samples, suggesting that high pH values are a result of photosynthesis by phytoplankton. The highest pH for Station S2 was 7.8 during November. During May, pH values were 6.9 or less at all stations.

- Reservoir-wide total alkalinity concentrations ranged from 9 to 15 mg/liter as $CaCO_3$ during 2003 with a mean of 12 mg/liter for 2003. Total alkalinity concentrations were statistically different among stations with concentrations at Station S2 significantly less than concentrations at Stations E2 and H2 (Appendix 2).

Trace Metal - Copper

- All measured concentrations of copper were low (< 4.2 μg/liter) in 2003 with an annual reservoir mean of 1.9 μg/liter (Appendix 2). No spatial trends were observed. Copper concentrations for 2003 were within the range of concentrations for the past five years at Harris Reservoir (CP&L 1999, 2000, 2001, 2002 and PEC 2003).

Biofouling Monitoring Surveys

- No zebra mussels or quagga mussels, potentially serious biofouling organisms to power plant operations, were found in Harris Reservoir or the auxiliary reservoir during 2003. Zebra and quagga mussels are not expected to thrive in Harris Reservoir because alkalinity, calcium, total hardness, and pH levels are sub-optimal for mussel growth and reproduction (Claudi and Mackie 1993).

Aquatic Vegetation

- A visual survey for troublesome aquatic vegetation was conducted in the Harris auxiliary cooling reservoir, Harris Reservoir main intake canal, and in the Thomas Creek arm during November 2003. No hydrilla (*Hydrilla verticillata*) was observed in the auxiliary reservoir. These observations indicated that grass carp (*Ctenopharyngodon idella*) stocked during the last decade have effectively controlled the abundance of hydrilla in the auxiliary reservoir. The dominant species growing in the main intake canal were hydrilla and water primrose (*Ludwigia* spp.). Both shorelines of the main intake canal were covered with dense stands of water primrose and appeared to be similar in density and coverage area to stands observed in 2002. Similar levels of hydrilla growth in the past have had no effect on Harris Nuclear Plant operations.

- During November 2002 water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*), two species of invasive aquatic plants new to Harris Reservoir, were found across the reservoir from the Holleman's Crossroads boat ramp at Transect P. All individual plants were removed upon discovery and no additional specimens were observed during 2003.

- No impacts to Harris Nuclear Plant operations from aquatic vegetation occurred during 2003.

CONCLUSIONS

During 2003, Harris Reservoir continued to typify a biologically productive southeastern reservoir with seasonally occurring oxygen-deficient subsurface waters and abundant rooted, shallow-water aquatic plants.

The environmental monitoring program conducted during 2003 continued to provide an assessment of the effects of the Harris Nuclear Plant's operation on the various components of the aquatic environment. Most key indicators of the environmental quality in Harris Reservoir were unchanged from previous years. Nutrient concentrations have been a concern in Harris Reservoir since phosphorous and nitrogen concentrations increased rapidly in the late 1980s and early 1990s. Water quality assessments determined that nutrient concentrations have remained stable in recent years and at levels acceptable for productive, southeastern reservoirs. Assessments of other water quality parameters, including total dissolved solids, turbidity, total organic carbon, ions, hardness, and copper, indicated no consistent, statistically significant spatial trends. None of these variables were at concentrations that would be detrimental to the aquatic community.

No nuisance algal blooms, as indicated by chlorophyll *a* concentrations, or exotic mussels were detected in the main reservoir during 2003. Hydrilla abundance and coverage area in the intake canal during 2003 was similar to stands observed in 2002. Grass carp continued to control the amount and areal coverage of hydrilla in the auxiliary reservoir during 2003. No operational impacts have occurred at the Harris Nuclear Plant because of aquatic vegetation biofouling. No fish kills or disease outbreaks were noted in Harris Reservoir during 2003.

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Appendix 1. Water temperature, dissolved oxygen, conductivity, pH, and Secchi disk transparency data collected from Harris Reservoir during 2003.

January 29, 2003

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Conductivity (µS/cm)				pH				Secchi disk depth (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	5.1	4.1	4.5	3.4	11.9	12.4	12.1	11.6	75	62	69	54	6.9	7.0	7.0	7.1	1.4	1.3	1.5	1.2
1.0	5.1	4.0	4.5	3.4	11.8	12.0	12.1	11.6	75	62	69	54	6.9	6.9	6.9	7.0				
2.0	5.0	4.0	4.5	3.5	11.8	12.0	12.0	11.6	75	62	69	54	6.9	6.9	6.9	7.0				
3.0	5.0	4.0	4.5	3.7	11.8	11.9	12.0	11.6	75	62	69	54	6.9	6.9	6.9	7.0				
4.0	5.0	4.0	4.5	3.7	11.8	11.9	12.0	11.6	75	62	69	54	6.9	6.9	6.9	6.9				
5.0	5.0	4.0	4.4	3.8	11.8	11.9	12.0	11.5	75	62	69	56	6.9	6.9	6.9	6.9				
6.0	5.0	4.0	4.4		11.8	11.9	11.9		75	62	69		6.9	6.9	6.9					
7.0	4.9	4.0	4.4		11.7	11.9	11.9		75	62	69		6.9	6.9	6.9					
8.0	4.9	4.0	4.4		11.7	12.0	11.9		75	62	69		6.9	6.9	6.9					
9.0	4.9		4.4		11.7		11.9		75		69		6.9		6.9					
10.0	4.9				11.6				75				6.9							
11.0	4.9				11.6				75				6.9							
12.0	4.9				11.6				75				6.9							
13.0	4.9				11.6				75				6.9							
14.0	4.9				11.6				75				6.9							
15.0	4.8				11.6				75				6.9							
16.0	4.9				11.2				75				6.9							
17.0	5.0				11.0				75				6.9							

May 27, 2003

Depth (m)	Temperature (°C)				Dissolved oxygen (mg/liter)				Conductivity (µS/cm)				pH				Secchi disk depth (m)			
	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2	E2	H2	P2	S2
0.2	22.1	22.4	21.7	22.7	9.0	9.1	9.0	8.5	70	79	77	77	6.8	6.9	6.7	6.4	1.6	1.4	1.6	1.2
1.0	22.1	22.4	21.7	22.7	8.9	9.1	9.1	8.3	78	80	79	77	6.7	6.8	6.9	6.3				
2.0	22.0	22.4	21.4	21.4	8.6	9.0	8.7	4.7	76	80	78	78	6.5	6.7	6.9	6.0				
3.0	21.4	22.4	20.2	19.6	7.9	8.3	7.3	1.4	79	80	77	71	6.4	6.5	6.8	6.0				
4.0	20.4	19.8	19.4	18.2	6.3	4.3	5.8	0.1	80	82	81	68	6.2	6.3	6.6	5.9				
5.0	19.2	18.1	18.3	18.2	4.5	2.4	4.3	0.2	78	79	84	69	6.1	6.4	6.5	6.0				
6.0	17.3	17.2	15.8		2.9	1.2	1.7		84	85	86		6.1	6.3	6.3					
7.0	16.8	15.2	15.6		2.3	0.3	1.4		84	89	88		6.0	6.4	6.1					
8.0	15.6	15.2	15.0		1.7	0.4	0.8		87	86	88		6.1	6.6	6.1					
9.0	15.3		14.7		1.3		0.5		88		90		6.0		6.0					
10.0	14.5		14.6		0.7		0.3		85		91		6.1		6.0					
11.0	14.1				0.3				85				6.2							
12.0	13.7				0.1				91				6.2							
13.0	13.4				0.1				100				6.2							
14.0	12.8				0.1				99				6.3							
15.0	12.8				0.1				123				6.3							

Appendix 1 (continued)

July 16, 2003

Depth (m)	Temperature (°C) E2	H2	P2	S2	Dissolved oxygen (mg/liter) E2	H2	P2	S2	Conductivity (µS/cm) E2	H2	P2	S2	pH E2	H2	P2	S2	Secchi disk depth (m) E2	H2	P2	S2
0.2	28.7	29.5	28.9	29.4	8.6	8.3	8.4	7.6	88	90	88	97	8.0	8.2	8.2	7.2	1.5	1.5	1.6	1.3
1.0	28.4	29.5	28.9	29.4	8.6	8.3	8.3	7.6	87	90	88	90	8.0	8.2	8.2	7.2				
2.0	28.1	28.4	28.9	29.4	8.4	5.9	8.3	7.6	85	88	88	89	7.8	6.8	8.2	7.2				
3.0	27.3	27.6	28.8	29.4	4.4	2.4	8.2	7.6	86	85	87	89	6.5	6.3	8.1	7.2				
4.0	23.9	25.9	28.4	27.0	0.4	0.3	6.5	0.3	96	87	86	112	6.2	6.2	6.8	6.2				
5.0	21.6	22.5	21.8	27.0	0.3	0.2	0.2	0.5	104	94	97	112	6.3	6.3	6.3	6.2				
6.0	20.8	19.8	20.1		0.3	0.2	0.2		104	101	97		6.3	6.4	6.3					
7.0	19.3	18.4	19.1		0.2	0.2	0.2		103	105	96		6.4	6.5	6.3					
8.0	18.1	18.2	18.2		0.2	0.2	0.2		101	116	99		6.4	6.6	6.5					
9.0	17.3		17.5		0.2		0.2		95		143		6.4		6.6					
10.0	16.4				0.2				94				6.4							
11.0	15.6				0.2				93				6.5							
12.0	14.8				0.2				96				6.6							
13.0	14.3				0.2				103				6.8							
14.0	14.0				0.1				108				6.9							

November 12, 2003

Depth (m)	Temperature (°C) E2	H2	P2	S2	Dissolved oxygen (mg/liter) E2	H2	P2	S2	Conductivity (µS/cm) E2	H2	P2	S2	pH E2	H2	P2	S2	Secchi disk depth (m) E2	H2	P2	S2
0.2	17.6	17.4	17.1	15.9	7.7	7.8	7.5	8.9	77	76	77	82	7.2	7.2	7.1	7.8	1.4	1.4	1.1	1.9
1.0	17.6	17.3	17.1	15.8	7.4	7.7	7.5	8.7	77	76	77	82	7.1	7.1	7.0	7.8				
2.0	17.5	17.1	17.1	15.8	7.2	7.5	7.5	8.6	77	76	77	82	7.1	7.0	7.0	7.6				
3.0	17.4	16.8	17.0	15.4	7.2	7.3	7.4	8.5	77	76	77	84	7.0	7.0	7.0	7.5				
4.0	17.3	16.7	16.8	15.1	7.1	7.0	7.3	7.0	77	76	77	97	7.0	7.0	7.0	6.9				
5.0	17.3	16.6	16.7		7.0	6.9	7.2		77	76	77		7.0	7.0	7.0					
6.0	17.3	16.4	16.3		7.0	6.6	6.7		77	73	77		7.0	6.9	6.9					
7.0	17.3	16.3	16.1		6.9	6.4	6.3		77	73	77		7.0	6.9	6.9					
8.0	17.3	16.3	16.1		6.7	6.2	6.1		77	73	77		7.0	6.9	6.8					
9.0	17.3				6.6				77				7.0							
10.0	17.2				6.5				77				6.9							
11.0	17.2				6.5				77				6.9							
12.0	17.2				6.5				77				6.9							
13.0	17.2				6.5				77				6.9							
14.0	17.2				6.3				93				7.0							

Appendix 2. Means, ranges, and spatial trends of selected limnological variables from the surface waters of Harris Reservoir during 2003.[+]

Variable	Station E2	Station H2	Station P2	Station S2	Reservoir Mean
Total dissolved solids (mg/liter)	69 62-84	68 58-75	66 60-71	70 66-74	69 58-84
Turbidity (NTU)	4.0 2.7-6.9	4.4 2.0-6.2	4.7 3.0-6.0	5.6 3.1-9.8	4.7 2.0-9.8
Secchi disk transparency (m)	1.5 1.4-1.6	1.4 1.3-1.5	1.4 1.1-1.6	1.4 1.2-1.9	1.4 1.1-1.9
Chlorophyll *a* (µg/liter)	13 6.0-18	14 7.8-28	9.5 5.4-13	8.0 6.0-9.9	11 5.4-28
Nutrients (mg/liter) Ammonia-N[¶]	< 0.02 < 0.02-0.02	< 0.02 < 0.02	< 0.02 < 0.02-0.03	< 0.02 < 0.02	< 0.02 < 0.02-0.03
Nitrate + Nitrite-N	0.06 < 0.02-0.14	0.06 < 0.02-0.18	0.04 < 0.02-0.08	0.02 < 0.02-0.03	0.05 < 0.02-0.18
Total nitrogen	0.64 0.24-1.2	0.69 0.19-1.4	0.53 0.21-0.85	0.62 0.20-1.1	0.62 0.19-1.4
Total phosphorus	0.036 0.020-0.061	0.025 0.022-0.026	0.024 0.017-0.027	0.026 0.015-0.035	0.028 0.015-0.061
Total organic carbon	8.0 6.9-8.6	7.3 6.7-8.2	7.7 7.1-8.0	8.0 7.6-8.5	7.8 6.7-8.6
Hardness[§]	9.3 2.3-16	9.3 2.5-15	8.7 2.8-14.3	8.4 1.2-14	8.9 1.2-16
Conductivity (µS/cm)	78 70-88	77 62-90	78 69-88	78 54-97	77 54-97
Ions (mg/liter) Calcium	2.3 1.4-3.4	2.4 1.5-3.4	2.2 1.2-3.1	2.2 1.4-3.4	2.3 1.2-3.4
Chloride	15 12-22	12 11-13	12 11-14	11 10-12	12 10-22
Magnesium	1.2 < 1.0-1.8	1.2 < 1.0-1.6	1.2 < 1.0-1.6	1.1 < 1.0-1.4	1.2 < 1.0-1.8
Sodium	8.2 6.4-12	7.4 6.5-9.2	7.6 6.2-10	6.7 6.2-7.1	7.5 6.2-12
Sulfate	12 6.6-19	10 6.1-17	12 5.5-18	9.3 7.7-13	11 5.5-19
Total alkalinity[§]	12[a] 10-15	12[a] 10-14	12[a] 9-14	10[a] 9-12	12 9-15
Copper (µg/liter)	1.7 1.3-2.1	2.3 1.0-3.7	1.4 < 1.0-2.3	2.3 1.4-4.1	1.9 < 1.0-4.1

[+]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 ($P > 0.05$)—see shaded row. Sample size equaled 4 for all stations and equaled 16 for reservoir mean.

[¶]Ammonia-N value for Station E2 during November was excluded from analysis.

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