Attachment 2

Ameren/CIPS Newton and Coffeen Lakes Research and Monitoring Project

Annual Report

Principal Investigator
Ronald Brooks

Researcher
Patrick Beck

Fisheries & Illinois Aquaculture Center
Southern Illinois University at Carbondale

March 2005
DRAFT

Table of Contents

List of Tables

List of Tables, continued

List of Tables, continued

List of Figures

List of Figures, continued

ABSTRACT

Water temperatures in power-cooling reservoirs are often elevated to the point where summer habitat is limited for most fishes. Occasionally, increases in water temperatures may be responsible for stress-related fish kills. Since 1997, three types of critical conditions that resulted in fish kills have been recognized in Newton and Coffeen Lakes. The first type was associated with severe summer ambient conditions, and lead to the most severe fish kills. The largest fish kill of mature largemouth bass in both Newton Lake and Coffeen Lake occurred in 1999 when elevated water temperatures associated with an experimental mixing zone surface water temperature variance combined with summer weather conditions that caused particularly low levels of dissolved oxygen. Weather conditions that promoted a dissolved oxygen reduction in the power-cooling reservoirs also caused fish kills in local ambient lakes.

Another type of fish kill that likely occurred was habitat erosion, and we believe it accounted for three smaller fish kills since 1997. In 2001 there was a temperature related fish kill on July 10 in Coffeen Lake and August 24 in Newton Lake. A small fish kill (124 fish) was observed by SIU personnel and estimated by IDNR between 24 June and 4 July, 2002 in Coffeen Lake. In these cases, the small fish were probably trapped in a thermal refuge near or in the discharge mixing zones. Prolonged periods of heated discharge eventually eroded away the refuge. The third type of fish kill is anglér related. During 2003 and 2004, few dead fish were observed either lake, and the deaths appeared to be angler related, it accounted for the most frequent occurrences, but the least number of deaths. In each year of the study, a few largemouth bass and channel catfish are found dead or dying in both lakes. The dead or moribund fish are often in proximity of boat ramps or popular fishing areas. The bass probably succumbed to angling

related stress. Such events were occasionally witnessed by SIU personnel during the warmest periods. The deaths are usually delayed, and most anglers are not aware of the problem. The preponderance of the data collected during 2000 through 2004 suggests that there were no long-term negative effects of the fish kills in either of these lakes. Largemouth bass populations remain healthy, and their numbers have not measurably decreased since 1997.

INTRODUCTION

The information contained in this year's report represents 2004 data as a continuation of data collected since fall 1997. Long-term data sets are necessary to fully understand interactions within and among biotic communities and abiotic forces in freshwater reservoirs. When water temperatures are manipulated, as is the case in power-cooling reservoirs, the interactions among the various biotic entities are changed. The scope of the current study is the same that was implemented in 2000 (reduced from 1997-1999). To ensure that comparable data was collected for all eight years, we used the same methods to monitor condition of three sportfish populations and abiotic variables affecting fish habitat availability. Habitat is determined combining water temperature, dissolved oxygen, and depth; the limiting factors being water temperature tolerances in conjunction with dissolved oxygen available to the fish. The three fish species include largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*). Trends of growth, relative weight, mortality, and abundance are analyzed through all years of data collection to provide indices of each population's condition and possibly explain effects of elevated temperature ranges in which the sportfish survive, and for largemouth bass, thrive in Newton Lake and Coffeen Lake in Illinois.

The original project, which encompassed fall 1997 through fall 1999, monitored biotic communities ranging from phytoplankton through major sportfish. The goal was to evaluate conditions of the biotic communities prior to a water temperature "Variance" initiated in 1999 and compare those evaluations to the same parameters during and after the "Variance". A fish kill occurred during July, 1999 in Newton Lake while the power plant was operating under a new "Variance." A kill occurred essentially at the same time in Coffeen Lake while the plant was operating within the parameters of its old variance (Heidinger et al. 2000). As a result of the fish kills and other economic considerations, the corporate decision was made to add additional cooling capacity to the Newton Lake and Coffeen Lake electrical generating stations. After summer 1999, the impetus of the study was to determine if the 1999 fish kill and subsequent smaller fish kills in either Newton Lake or Coffeen Lake adversely affected the three sportfish populations. Although we continue to examine the data for anomalies that may have been caused by the fish kills, data presented in this 2004 report will be used in conjunction with the previous years' data primarily to examine trends of the biotic indices in conjunction with abiotic parameters during potentially stressful summer periods.

For sampling purposes, Newton Lake was divided into four segments (Figure 1). From 1997 to 1999, Coffeen Lake was divided into two sampling segments. Beginning in 2000, temperature/oxygen/depth profiles were taken in two additional Segments (3 and 4) in Coffeen Lake (Figure 2). The basic sampling regime for data collected concurrently from 1997-2004 is outlined in Table 1. A description of the methods can be found in the four appendices (A-D). The 2004 study was approved, and therefore initiated at Newton Lake and Coffeen Lake during May. An additional component was added to this year's data collection which include obtaining information on fish species and bathymetry of the two ash ponds at the Newton Lake facility. That data is presented in Appendix F.

PLANT OPERATION IN RELATION TO DISCHARGE STANDARDS

The four months including June-September potentially encompass the most critical period when extremely warm water temperatures may be lethal to fish species. In Newton Lake during 2004, the average mixing zone temperature was 93.2 for May and higher than in any previous study year. However, the average May water temperature was not indicative of critically high temperatures and was lower than the remaining summer months (Table 2). During summer 2004, water temperatures in the mixing zone were similar (93.3-96.8°F) to the remaining seven years' mean temperatures. The maximum hourly temperature recorded was 106° which occurred on five occasions during 14 June, 2004. Since 1999, neither mean monthly nor hourly temperatures have approached the old "Variance" levels of 102°F and 111°F, respectively. In July 1999, the highest monthly average temperature (104.1°F) during this study was recorded, and the hourly temperatures were also the highest recorded during this study exceeding 111°F on 100 occasions (Table 3). Water temperatures during summer 2004 tended to cool from the discharge mixing zone to our Segment 1 station (Figure 1) located near the ash pond discharge (Appendix D; Figures D25 and D26); but more pronounced differences occurred from the Segment 1 station (Appendix D; Figure D26) to our Segment 2 station (Appendix D; Figure D27). At Segment 1, the temperatures were usually considerably cooler at 3.0 m than near the surface or at 1.5 m. Differences between surface water temperatures and temperatures at the various depth were largest in Segment 1 and least in Segment 4.

Coffeen Lake mixing zone water temperatures were recorded hourly at the edge of the mixing zone in Segment 1(Figure 2) either by AmerenCIPS or SIU-C for the past eight years. SIU-C's temperature logger placement was located in direct proximity to the station used by AmerenCIPS for measuring surface water temperatures in the mixing zone, thus the data should is comparable among years. Mean monthly mixing zone water temperatures for June-September in 2003 (97.8-104.3°F) and 2004 (105.0-106.5°F) were the highest among the eight years studied in Coffeen Lake (Table 2). However, there were no indications of fish stress during either year.

Maximum water temperatures can be more lethal to fish than average water temperatures. In Newton Lake during 1999, July temperatures exceeded 112°F on 83 occasions (Table 4). Interestingly, 2003 mixing zone hourly water temperatures were recorded at 111°F on only one occasion and 110°F on 32 others. In 2004, the highest temperature recorded was 110°, and it was recorded on four occasions on 4 September. Mixing zone surface water temperatures exceeded 106°F on 129 occasions from 19 August through 5 September. Thus, despite the higher monthly averages in 2003 and 2004, maximum water discharge mixing zone temperatures were lower throughout the critical summer periods than they were in 1999.

Surface water temperatures at the discharge mixing zone are assumed to be indicators of potential water quality problems in power-cooling lakes. In Coffeen Lake during 2004, they were not indicative of temperature profiles below 1.5 m in the mixing zone. Water temperatures at the surface and at 1.5 m fluctuated much more than at the deeper depths (Appendix D; Figure D31). Water temperature differences between 1.5-m and 3.0-m records were striking in the mixing zone and usually 10°F cooler at 3.0 m than 1.5 m. Anglers have reported catching largemouth bass in Coffeen Lake near the mixing zone when surface water temperatures exceeded 104°F. Temperature profiles explain the reason that this may occur if ample dissolved oxygen is present to 3.0 m. Water temperatures near the surface at the biostation located near the dam were only slightly cooler than at the mixing zone, but temperatures at 3.0 m and below were very similar (generally 90°F to 95°F) to those at the mixing zone. In fact, maximum water temperatures at the remaining three stations all were quite similar to the deeper temperatures recorded at the dam and intake stations. If air temperatures and humidity are not excessively high, the cooling capacity of water within a meter or so of the surface seems to be such that, at least in Coffeen Lake, surface water temperatures are mitigated quickly and do not drive temperatures up at lower depths. This likely is more true in Coffeen Lake than Newton Lake because Coffeen Lake's warm arm is much deeper than Newton Lake's. The differences between 2004 and 1999 were not only in the number of times maximum hourly surface water temperatures were very high in 1999, but more importantly, the cooling capacity of the upper portion of the water column was lower in 1999 because of a prolonged periods of very high air temperatures and calm weather conditions. As a result 1999 water temperatures were elevated at all depths and in all segments of the lake (Appendix E). In 2004, average surface water mixing zone temperatures were actually higher than in 1999, but air temperatures were not as hot, and the surface water was sufficiently cooled to prevent the entire water column from becoming critically high.

FACTORS ASSOCIATED WITH FISH KILLS

In every reservoir or body of water where fish exist, one can find dead fish over the course of a summer or year. The deaths may have been natural or induced by extraordinary events. Excessive water temperatures alone rarely cause massive fish kills. In most instances, there are other factors acting in concert with water temperatures to cause fish kills. In reservoirs, prolonged calm, cloudy weather patterns during warm periods can cause oxygen depletions that result in fish kills of a larger magnitude. Characteristically, few fish species are spared, but mortality among the species is dependent upon their tolerance to low levels of dissolved oxygen. Such a weather pattern occurred during July, 1999 when fish kills occurred in Newton and Coffeen lakes - as well as in ambient lakes such as East Fork Lake near Olney, Illinois. Personnel from SIU-C observed 121 largemouth bass and 8 dead or morbid channel catfish in Coffeen Lake (Table 5). In Newton Lake, 227 largemouth bass and 70 channel catfish were observed dead or dying (Table 6).

Under the high thermal loading parameters in Newton Lake, no differences in net primary productivity or chlorophyll were observed in July and August (1999) as compared to July and August (1998). Some of the fauna such as zooplankton, benthos number, benthos weight, and phytomacrobenthos actually increased (Heidinger et al. 2000). Thus, the data did not suggest long-term perturbation of the primary biota in the lakes. Examination of the fish indices resulted in similar conclusions.

The number of largemouth bass that died in Coffeen Lake and Newton Lake in 1999, relative to their abundance in the two lakes, indicated no significant long-term negative effects on the two bass populations were likely. In Coffeen Lake, assuming that only 50% of the largemouth bass that died were counted, then 242 bass died (0.22 per acre). If there were 20 bass per acre in Coffeen Lake (1100 acres), then the death of 242 bass represented only 1% of the population. Although we have no recent creel data for Coffeen Lake, 242 bass is probably well below what is removed by anglers each year. Also, to place the 1% mortality due to the fish kill in perspective, the average total annual mortality rate for largemouth bass in Coffeen Lake from 1997-2004 is approximately 42% (Table 7). In Newton Lake, assuming 20 largemouth bass per acre (1,750 acres), there were 35,000 bass in the lake before the kill. If anything, this was an underestimate, considering that from 02/16/98 through 12/31/98 the creel indicated that 60,187 bass were caught (Heidinger et al. 2002). In other words, if there were 35,000 bass in the lake, each bass on average was caught 1.7 times. Based on an estimate of 454 bass killed during the 1999 event and a population of 35,000 bass, the death of 454 (0.26 per acre) bass in Newton Lake would equal only 1% of the population. Again, to place the 1% of dead bass in perspective, average total annual mortality for bass in Newton Lake from 1997-2004 is approximately 57% (Table 7).

The 1999 fish kills were likely induced by a combination of elevated, discharge water temperatures, prolonged periods of relatively hot air temperatures (which reduced the cooling capacity of the lakes and increased water temperatures at most depths throughout the lakes), and low levels of dissolved oxygen due to atmospheric conditions (which also induced fish kills in local ambient lakes). Habitat availability was extremely low for extended periods during late July 1999 in both lakes (Appendix E). The combination of factors caused the 1999 fish kills; but the kills were relatively insignificant to the largemouth bass populations.

Fish kills of smaller magnitudes also occurred in the two reservoirs during the study. Those kills were likely more directly associated with water mixing zone temperatures. Water currents associated with power-cooling discharge cause the biota behavior to be more characteristic of slow-moving rivers than of reservoirs. As a result, fish movement increases over that of ambient reservoirs. The movement is, in large part, dictated by forage abundance and locality. In power-cooling reservoirs, forage species often inhabits water temperatures near their thermal maximums because it happens that their food supply is more abundant there. If a sudden pulse of lethally hot water is pushed through, and some fish happen to be located in a cove away from the main water flow, the fish can be forced to stay in the cove until the slug of hot water passes. If the lethally hot water temperatures persist in the main channel long enough, water temperatures in the coves will increase until they are similar to those in the main channel. This phenomenon, described as eroded fish habitats, results in smaller but more frequent fish kills and likely occurred in 2001 and 2002.

On July 10, 2001, in Coffeen Lake, 546 channel catfish (2-7 in TL), 513 Lepomis spp. (2-6 in TL) and 65 largemouth bass (2-7 in TL) were estimated to have died (Table 8). Mixing zone surface water temperatures began a prolonged increase where mean temperatures were at least 100°F on July 7 in 2001 (Figures 3 and 4). Prior to that date, although maximum water temperatures had increased to over 100°F, minimum temperatures were low enough to provide the fish with relief within a several-hour period. Minimum water temperatures increased to nearly 100°F after July 7 and did not decrease until mid-August. The prolonged nature of the high water temperatures after July 7 likely caused an eroding of cove habitat in the discharge mixing zone which resulted in the

July 10 fish kill. Mean water temperatures were also high to a depth of 3 m which was the depth at which dissolved oxygen was limiting at that time (Figures 5 and 6).

In Newton Lake on August 28, 2001, we estimated that 10,765 three-inch gizzard shad were killed (Table 8). Again, maximum temperatures in the mixing zone prior to that time had been at least as high as on the day of the fish kill (Figures 7 and 8); but as in Coffeen Lake, Newton Lake mid-August water temperatures were increasing from summer lows, and by August 28, the temperatures stabilized at mean at over 100°F for several days. The prolonged high temperatures most likely caused the kill in a relatively small cove where the fish's thermal refuge was broken down..

The last fish kill reported during this study, which was likely a result of eroding habitat, occurred in Coffeen Lake during late June and early July 2002. Forty two largemouth bass, 64 striped bass, and small amounts of five other species were found dead by SIU-C Personnel during the period (Table 9). The abiotic circumstances were very similar to the previous two fish kills in that water temperatures were increasing from summer lows, and the temperatures increased until late June (Figure 9). Higher minimum temperatures also persisted in Coffeen Lake after late June 2002 as they had in each of the previous instances.

It is likely these three fish kills were associated with eroding of thermal refuge areas. In Newton Lake, one particular area near the discharge mixing zone that draws many fish is the cove that receives spillage from the small ash pond. Water pouring in from the ash pond is generally cooler than the surrounding lake, and this cove typically is "stacked" with fish. This could be an area of concern if the water coming into the cove from the ash pond is warm and has relatively little oxygen at the same time when the surrounding lake water suddenly becomes very hot with low dissolved oxygen. Alternatively, if water discharge temperatures are not excessive, there are many small coves in the upper portion of Segment 1 that fish could use and eventually get trapped if the discharge water became suddenly hot and remained hot for extended periods. Coffeen Lake also has cove habitats in the discharge area where fish could be trapped. In particular, there is a cove located immediately adjacent to the discharge area where fish could easily congregate during less severe discharge temperatures and get trapped during a sudden increase of temperatures.

The magnitude of kills associated with habitat erosion should be relatively small. Identification of particularly suspect areas may be possible, but we are not certain at this time of whether the problem can be eradicated. We would need more information concerning fish use of the habitat at various water temperatures to further address this issue.

Beyond the previously described kills, very small numbers of dead fish have been observed by SIU-C personnel each year. The causes of death for these fish may be natural or associated with angling. In waters where fishing is popular, fish can be lethally hooked and released or stressed from capture and subsequent handling beyond their ability to recover. Stress-induced fish mortality from angling is primarily dependent upon water temperatures that, when relatively high, will increase the likelihood of stress-induced death. The extent of these fish kills are further dependent upon fish species, the number of fish hooked, where the fish were hooked, depth the fish were residing when hooked, and handling time. Fishing tournaments can cause higher numbers of stress related deaths not only because of the sheer numbers of fish caught, but also because of the additional stress the fish must endure from time spent in anglers' live wells and the extra handling during the weigh-in process. Fish killed by angling do not usually die at the time of capture or release; the mortality is delayed. The amount of delay is dependent upon the intensity of trauma inflicted on the fish during capture, time in captivity, or conditions of release.

In 2000, only four largemouth bass and two channel catfish were observed dead or dying in Coffeen Lake. In Newton Lake only two dead largemouth bass and two dead gizzard shad were observed in 2000. During 2001 in Coffeen Lake, except for the kill on July 7, 2001, only one dead striped bass, two white crappie, one largemouth bass and two channel catfish were observed by SIU personnel. In Newton Lake during 2001, only 10 dead fish were observed except for the kill of shad on August 28, 2001. Anglers reported several dead largemouth bass on August 21, 2002, but an exploratory visit to Newton Lake on the following day did not confirm this. We observed only two other dead channel catfish and three largemouth bass during 2002. However, due to the timing of the funding, we did not begin regular monitoring of the lakes until August. In 2003, we only observed ten dead or dying fish in Newton Lake; and only two were observed in 2004. In both cases in 2004, the dead largemouth bass were observed at the west boat ramp. Only seven fish were observed dead or dying in Coffeen Lake during 2003, and three channel catfish were found dead in 2004. Since None of the deaths in 2004 were suspected to have resulted from water temperatures or dissolved oxygen.

CHARACTERISTICS OF THE FISH COMMUNITIES

Size Frequency and Electrofishing Catch Per Hour

From both Newton Lake and Coffeen Lake where fall electrofishing data are available, we compared, among years, the size frequency distributions and catch-per-unit efforts for bluegill, channel catfish and largemouth bass. Since the IDNR and SIU electrofishing data were not taken with exactly the same equipment and the sampling procedures were different, trend comparisons should be made only within the respective data sets and not between data sets.

Newton Lake

The fish community in Newton Lake has undergone many changes since 1976. Fishing started in 1980. Initially crappie were abundant and grew well in Newton Lake. Although they continue to grow well, recruitment was greatly reduced after 1987. Crappie from a recently built nursery area near the lake probably accounted for the slight increase in their electrofishing catch rates after 1998 (Table 10). Only one crappie was collected in fall 2004 by SIU-C personnel.

Historically, except for the first few years after filling, very few bluegill reached 7 inches in total length (Table 11). Since 1978, except for the 1998 spring sample, less than 5% of the bluegill have been larger than 7 inches. The size trend has continually decreased, and less than 1% of the bluegill collected since 1998 were at least 7 inches. Only five bluegill older than age-3 have been collected since fall 1999 (Appendix A). The decreasing trend for bluegills is most likely due to inadequate invertebrate forage; possibly a result of fluctuating water levels and associated loss of macrophytic habitat. Macrophytes serve two purposes for bluegill: refuge from predators and habitat for invertebrate forage.

During 1979 through spring 1981, a significant number of channel catfish exceeded 20 inches in total length in Newton Lake. After the mid 1980's, fewer than 7 % of the sampled channel catfish exceeded 20 inches (Table 12). Similarly, only 8% of channel catfish collected by IDNR in 2004 were larger than 20 inches. That number was higher than any number in that size range since fall 1982, but given the type and amount of effort for collection, the number would not represent a significant increase. Surface electrofishing does not collect channel catfish in relation to their true population size structure (i.e.: larger channel catfish are not as susceptible to electrofishing as smaller ones); but electrofishing effort can still identify trends within certain size limitations afforded by gear type. The food habits study completed in 1999 (Heidinger et al. 2000) indicated that many of the channel catfish susceptible to electrofishing are stunted due to an inadequate diet that consisted mainly of small invertebrates gleaned from bottom algae. Based on the fact that we know anglers often catch larger channel catfish than we are collecting electrofishing, we suspect that a portion of channel catfish are able to shift to a fish diet and grow accordingly. However, most of those channel catfish are not susceptible to shallow-water electrofishing. In order to get a better understanding of the entire channel catfish population in Newton Lake, an alternative method of capture (such as netting) would be required.

Largemouth bass are the most sought after sportfish in Newton Lake. There has been an 18-inch minimum length limit and a 3 fish-per-day creel limit on the lake since it opened for fishing in 1980. The highest percentage of bass larger than 18 inches in total length tended to occur in the spring samples rather than in the fall samples (Table 13). From 1979 through 1992, an average of 19.1% (range = 12%-27%) of the largemouth bass collected were larger than 18.1 inches. After 1992, the percentage of large bass collected by IDNR averaged 9.1% (range = 0% to 16%). Disregarding 1994 and 1995 when no large bass were collected by IDNR, the range of percentages for large fish has remained consistent since 1993.

In 2004, the IDNR reduced their sampling effort in Newton Lake to fall sampling only. Despite lower numbers, the fall sample length frequency trend has been similar to spring's. Since 1978, an average of 7.0% (range = 2% - 15%) of the largemouth bass collected during fall by IDNR have been larger than 18 inches total length. An average of 10.2% (range = 6% to 15%) were larger than 18 inches between 1978 and 1991; and during 1992 through 2004, only 3.9% (range = 2% - 7%) of the bass collected during fall were over 18 inches. Since 1999, the larger bass have never represented more than 4% of the total number of bass collected. Although the percentages of larger bass has seemingly declined, the percentages may be negatively influenced by recruitment in each year. For instance, in 2004, only 3% of the largemouth bass collected were larger fish. However, IDNR CPUE was 78 fish per hr (Table 14) and the length frequency histogram for fish collected by SIU-C (Appendix C) indicated that 56% of the largemouth bass were age-0. Thus, a larger recruitment class in 2004 accounted for some of the low contribution of larger bass to the total number collected.

In fall 1999, largemouth bass size frequency distributions were not indicative of a significant fish kill. The fall numbers in each length class were similar to in 1999 to nearly every fall since 1995 and through 2004. Evaluation of the 2000 data indicated that electrofishing CPUE was low, and the size structure also favored smaller fish. After a significant fish kill, an increase in reproduction during the following spring and thus, smaller, age-0 largemouth bass would have been expected. Largemouth bass collected by IDNR in fall 2000 were smaller, and their CPUE (35 per hr) was also relatively low (Table 14); both could be results of a significant fish kill. However, age-0 and age-1 abundance trends from fall 1999, to spring 2000, and to fall 2000 do not come together (See CPUE section; Table 19). It is likely that the IDNR fall 2000 collection results were influenced by some other parameter (such as weather patterns) that would drive the larger fish deeper on the day the collections were made. SIU-C's fall 2000 catch rate was 76 per hr; the highest it has ever been. Also, SIU-C's length frequency data (Appendix C) indicated that 56% of the fish were greater than 12.2 inches TL; a length frequency comparable to IDNR's historical data. Newton Lake is still a premier bass fishing lake, and many fish exceeding five pounds are caught by anglers each year. From a bass fishery stand point this is still an excellent population.

Coffeen Lake

Data from IDNR for Coffeen lake was limited to fall electrofishing samples from 1997 through 2004. The mean percentage for largemouth bass over 18 inches was 7.9% and they ranged from 4% to 12% (Table 15). The percentages for larger fish were lowest (4%) in 2000 and 2001, but not significantly different than 1998. Percentages across all four size classes increased in the last two years of study (2003 and 2004). The increasing percentages of larger bass are also illustrated in SIU-C electrofishing length frequency charts (Appendix C). IDNR catch rates have been variable among all years ranging from 20 per hr in 2000 to 100 per hr in 2004 (Table 16). The variability does not appear to have a trend. SIU-C catch rates have fluctuated less and ranged from 14 to 39 fish per hr. As with the IDNR data, no specific trends in size structure or catch rates are apparent.

There was no difference in size frequencies of bluegill from 1997 to 2004 in Coffeen Lake (Table 15). Essentially, no bluegill longer than 6.3 inches in total length were collected in the IDNR fall electrofishing samples. SIU catch rates were higher in every year since 1997 than in 1998. IDNR catch rates of bluegill were lower in 2000 (89) and 2001 (86) than in 1998 but increased to its second highest level in 2002 (179). It is interesting that few large bluegill have been collected in Coffeen Lake. There is an abundance of aquatic macrophytes; just the opposite of conditions in Newton Lake. However, there is also an abundance of several other *Lepomis sp.* ; most notably the redear sunfish (*Lepomis microlophus*). It is possible that the dense macrophytes are inhabited by an overabundance of sunfish that, because of the density of macrophytes, are also not particularly susceptible to predators. Also, shad (*Dorosoma spp.*) are very abundant and the primary forage of most piscivores in Coffeen Lake.

There has been no apparent trend in size structure of channel catfish (Table 15). Catch rates by IDNR have been variable throughout the study and ranged from 3 to 16 fish per hr. SIU-C catch rate ranged from 1 to 13 fish per hour, and the rates were higher in 2002 and 2004 than in all other years. However, the ranges of catch rates and sizes do not suggest particular trends. The same limitations of sampling method described for Newton Lake apply to Coffeen Lake.

Relative Weight

Many biologists assume that the desirable range for relative weights of largemouth bass, bluegill, and channel catfish is between 90 and 110. Largemouth bass collected in the fall of each year since 1997 from both Newton Lake and Coffeen Lake tend to be near the middle of the range (Table 17). Although a few statistically significant differences were found among years, no discernible trend occurred in either lake between 1997 and 2004. Mean relative weights average approximately 102 in Newton Lake and 103 in Coffeen Lake. Largemouth bass in both lakes appear to be very robust.

In both lakes, bluegill tended to be below or at the low end of the 90-110 range both before and after the 1999 fish kill. Over the past eight years, fall relative weight of bluegill collected by IDNR and SIU averaged approximately 88 in Newton Lake and 87 in Coffeen Lake (Table 17). The high relative weight (104) determined by SIU in 1998 was due to 32 very plump bluegill that were picked up at the intake structure. No bluegill have been collected from that area since 1998.

Smaller channel catfish susceptible to electrofishing tended to have lower mean relative weights in Newton Lake (88) than in Coffeen Lake (90) (Table 17). Fall relative weight values for channel catfish were similar from 1997 to 2004 in Newton Lake. In Coffeen Lake, 2004 mean relative weights (82) were lower than all other years.

Mortality Rates

The eight-year mean total annual mortality rate for largemouth bass in Newton Lake is 55% and has ranged from 51% in 2003 to 68% in 1997 (Table 7). The mortality rate is higher than would be expected for ambient reservoirs (Lake of Egypt averaged 32% during 1997 and 1998); but since growth rates are increased in power-cooling reservoirs, the fish are expected to have shorter life spans. The highest mortality observed was 68% in 1997; the lowest was 45% in 1998. A similar disparity occurred from 2003 (51%) to 2004 (59%). As with size structure percentages, one of the assumptions of mortality rates is that recruitment is constant from year to year. Since we know that the assumption is violated, mortality is still useful as a trend index, but only when significant changes in recruitment are acknowledged. There has been no significant trends in mortality since 1997. Interestingly, despite higher water temperatures in Coffeen Lake, largemouth bass mortality is lower than in Newton Lake. Annual mortality in Coffeen lake has averaged only 42% since 1997 and ranged from 39% to 47%. There have been no years where extremely high mortality has occurred. In fact, the mortality rates have been remarkable consistent (42% - 44%) since 2001.

The mean annual mortality rate for Newton Lake bluegill was 74% and ranged from 64% to 83% (Table 7). The highest mortality rate was 83% and it occurred in 1998. The mortality rates are inflated because the maximum age of the bluegills tend to be age-3 to age-4, and there is a high abundance of the fish. The mortality rate was only 64% in 2004, and that was the lowest rate observed during the past eight years. In Coffeen Lake, the bluegill annual mortality rate has averaged 68% and ranged from a low of 59% (1999) to 77% (2004). The mortality rates are high, and the reasons are similar to those in Newton Lake. Unlike Newton Lake, the highest bluegill mortality occurred in 2004.

Total mean annual mortality rate of channel catfish in Newton Lake was 37% since 1997 (Table 7). Annual mortality has ranged from 26% (2002) to 48% (1997). Mortality of channel catfish has not deviated significantly since 1997, and no trends are apparent. In Coffeen Lake, the mean mortality rate of channel catfish was 38% and ranged from 23% (1997) to 47% (2002). Mortality in 2004 was only 34%; the lowest since 1998. No mortality trends are apparent for Coffeen Lake and none of the annual mortality rates for channel catfish appear unusually excessive.

Recruitment

Recruitment of age-0 and age-1 bass was determined from IDNR and SIU-C fall electrofishing samples since 1997. Largemouth bass collected each fall by SIU-C were measured and aged using their otoliths. The bass collected by IDNR were measured but not aged. Thus, the catch per hour of age-0 and age-1 bass could be determined directly from the SIU-C fall samples but not from the IDNR fall collected fish. By looking at the length of the age-0 and age-1 bass each year in the SIU-C sample, it was possible to estimate the number of age-0 bass in the IDNR sample. The lengths of the largest age-0 bass aged in the SIU-C fall electrofishing samples were used as the cut off length between age-0 and age-1 bass collected by IDNR in their fall samples (Table 18).

SIU-C did not spend as many hours quantitatively electrofishing for largemouth bass as did IDNR; thus, the IDNR database is larger. For example, from 1997 to 2004, the number of bass collected by IDNR each fall from Coffeen Lake ranged from 139 to 652 (Table 15) while the number that SIU-C collected each year from 1997 to 2004 ranged from 73 to 156 (Table 17). From 1997 to 2004, IDNR collected 316 to 705 (Table 13) largemouth bass each fall from Newton Lake while SIU-C collected only 99 to 208 fish (Table 17).

In Newton Lake, fall electrofishing catch per hour of age-0 largemouth bass averaged 15.6 (range = 10.1 to 20.8) for IDNR and 21.1(range = 8.5 to 38.2) for SIU-C. Catch rates were higher in 1999 after the fish kill than in 1998 in both the IDNR sample and the SIU-C samples (Table 19).

Variability in catch rates is common in freshwater systems since there are numerous fluctuating biotic and abiotic factors to influence recruitment of fish into their first fall. Thus, the variability observed in largemouth bass recruitment since 1997 is not unusual.

In Coffeen Lake, catch-per-unit effort of age-0 bass in the IDNR samples averaged 20.4 (range= 5.1 to 32.0), and in samples collected by SIU-C, the mean age-0 catch rate was 7.0 (range = 5.0 to 10.2). Although the magnitude of catch rates was higher for IDNR, the trends from year to year were similar (Table 20).

Many fishery biologists do not consider a fish to be recruited to the fishery prior to their first winter; in other words until age-1. In Newton Lake, fewer age-1 largemouth bass were collected by both IDNR and SIU in 1999 than in any other study year (Table 19). The lower catch rate in 1999 is probably not due to the added thermal stress that occurred in 1999. The high number of age-1 bass collected in 1998 reflects the very strong 1997 year-class. The low number of age-1 bass collected in 1999 when the fish kill occurred resulted from the relatively weak 1998-year class. Likewise, a strong 1999-year class is reflected in the very high catch per hour obtained for age-1 bass in 2000. Thus, the high catch rates in 2000 are a result of the high survival of age-0 bass that were produced in 1999, the year of the fish kill.

In Coffeen Lake, we do not have IDNR spring electrofishing data sets to estimate catch per hour of age-1 largemouth bass. Based on the fall electrofishing samples by SIU-C where the bass were aged, age-1 CPUEs for largemouth bass ranged from 3.2 (2000 and 2004) to 13.4 (2002) (Table 20). There were no obvious trends suggesting that fish kills have caused any perturbations of largemouth bass recruitment since 1997 in either Coffeen Lake or Newton Lake.

Growth of Largemouth Bass

The total lengths of age-0 to age-4 largemouth bass at the time of capture in fall electrofishing samples by SIU-C were compared from 1997 to 2004 in both Newton Lake and Coffeen Lake (Table 21). Too few age-5 and older largemouth bass were collected to statistically analyze growth rates among years. Bass were aged from their sagittae otoliths.

In Newton Lake, mean growth to late October for age-0 largemouth bass was 164 mm (6.5 in). Growth rates since year 1997 were significantly lower prior to year 2000 than in all remaining years. Age-1 largemouth bass average 304 mm (12.0 ins), and as with the age-0 fish, growth from year 2000 was statistically higher than in previous years. Growth of age-2 and older largemouth bass averaged 391 mm (15.3 in), 433 mm (17.0 in), and 456 mm (18.0 in) for the respective ages. The growth was very similar with ages and among years. Though there were a few statistically significant differences among years and ages, there were no biologically significant differences in terms of notable reductions in growth (Table 21; Figure 10).

The growth rates of age-0 to age-4 largemouth bass in Coffeen Lake were interesting in that age-1 was the only year-class that indicated possible effects of the higher 1999 water temperatures (Table 21; Figure 11). Slightly more interesting is the fact that all largemouth bass age groups exhibited increases in growth rates the year following the 1999 fish kill. In 2003 and 2004, mean water mixing zone temperatures were fairly high relative to the other years of study. However, growth rates exhibited by largemouth bass in all age groups for the two years were comparable to previous years' rates. This is additional evidence that mean water temperatures in the ranges of this study have not been deleterious to largemouth bass.

HABITAT

Temperature/Oxygen/Depth Profiles

Seasonal temperature/oxygen /depth profiles were taken in Newton Lake and Coffeen Lake from 1997 through 2004. Exact periods of data collection varied somewhat by grant time lines, but the historically, most stressful periods for the fish were usually encompassed. We estimated how much of the lake or lake segments were available to the fish as a percentage of the depth of the water that was below various temperatures (87-97° F) and above various dissolved oxygen levels (1-4ppm) (Heidinger et al. 2000). Based on comparisons of habitat limits between morning and afternoon samples, it appears that afternoon temperature/oxygen/depth profiles give a reasonable estimate of when the amounts of habitat available to the fish at various temperature and oxygen levels are at a minimum (Heidinger et al. 2001). Therefore, the afternoon samples would likely best indicate times when fish would likely be exposed to maximum stress periods, and habitat profiles used in this report were taken from the latest possible times recorded with a date for each year. During 2000-2004, we added two additional lake segments (segment 3 and 4) to our original two segments (segment 1 and 2) in Coffeen Lake. Segment 3 is the large arm on the west side of Coffeen Lake known as cemetery bay, and segment 4 is the area between the intake canal and the railroad bridge. Both segment 3 and segment 4 are outside of the normal cooling loop. The mean percentage difference in habitat was calculated at 1.0° F intervals from 87-97° F at dissolved oxygen levels from 1-4ppm at 1ppm intervals.

Habitat availability was recorded year around during the initial three years of study. The results indicated that potentially critical periods for fish only existed in the power-cooling lakes between June and mid-September. Therefore, since 2000, water temperature, dissolved oxygen, and depth profiles were monitored only during the summer periods when the grant time lines permitted.

Data from 2004 are presented in Appendix D.

In Newton Lake, mean monthly water temperatures at the outer edge of the discharge mixing zone tended to be the same or lower in 2000 through 2004 than in 1998 or 1999 (Table 2). Conversely, June through September mean monthly mixing zone temperatures in Coffeen Lake during 2003 and 2004 were higher than in all previous years. However, as earlier reported, maximum hourly temperatures in 2003 and 2004 were lower than in 1999 and never reached "Variance" levels. In fact, maximum hourly temperatures at the outer edge of the mixing zone in each year have been lower those recorded in 1999 (See the section on Plant Operation in Relation to Discharge Standards).

Surface water temperatures at the mixing zone are only indicators of effluent and do not necessarily predict water temperatures throughout the lake. They are also not necessarily indicative of depth-related water temperatures. Therefore, a more informative indicator of abiotic lake conditions for fish is our habitat analysis. We determined the three days per year that had the smallest amount of habitat from our samples in 1998 through 2004 for Coffeen Lake (Table 22) and Newton Lake (Table 23). In 2002, because of the contract time line, habitat monitoring formally started August 1. However, since there was a particularly warm period in July, we took temperature, oxygen, and depth profiles in Coffeen Lake on July 6 and July 8. For all years (1998-2004), in order to compare the amount of habitat among years, percent habitat was calculated using 3-ppm dissolved oxygen as a minimum criterion combined with four temperatures from 87°F to 96°F. Habitat percentages reported represent means across all four segments in Newton Lake (Figure 1) and only segments one and two in Coffeen Lake (Figure 2).

In Coffeen Lake, five days appeared to be more critical than the remaining days with the "worst habitat conditions." Those were days when habitat availability was less than 10% at even 93°F. At that temperature, fish in Coffeen Lake would be pressed to locate some type of thermal refugia to avoid short-term thermal stress. The most critical days did not necessarily only occur in 1999; further evidence that conditions beyond high water temperatures occurred in July to cause the 1999 fish kill. Habitat conditions were nearly as critical on 8 August, 2001, 6 July and 8 July, 2001, and 20 August, 2003 as they were on 23 July, 1999 - just four days before the major portion of the fish kill occurred (Table 22). Unless dissolved oxygen becomes limited lake wide, Segments 3 and 4 (which are outside the cooling loop) should offer some refugia from the warmest temperatures with the cooling loop, and typical differences in habitat availability throughout the years can be seen in the 2004 data (Table 24) and in previous years (Heidinger et al. 2003; Brooks 2004). Since the two segments were not added until 2000, their habitats are not averaged into the data in Table 22.

Average, whole-lake habitat values do not necessarily give a complete indication of how stressful the habitat really is to fish in specific sections of the lake. For example, the 8 July 2002 habitat values in Coffeen Lake indicate a more severe situation in Segment 1 (Table 24) than when both segments are averaged (Table 22). Extremely limited habitat was available to fish in Coffeen Lake on 8 August 2001, 6 and 8 July 2002, and 8 July 2002 (Table 22). Interestingly, and perhaps indicating more serious conditions, these low levels usually occurred in both the cooling loop (Segments 1 and 2) and outside of the cooling loop (Segments 3 and 4; Heidinger et al. 2003). Despite higher mean mixing zone water temperatures, such conditions were not detected during 2003 or 2004.

The auxiliary cooling pond at Newton has been in operation since summer in 2000. Among the three least desirable temperature/oxygen events with 3-ppm oxygen at 87° F, the most critical periods were recorded on 24 July, 1999, 25 July and 7 August 2001, and 2 August 2002. At 90° F, 0% habitat with 3-ppm oxygen occurred on 24 July 1999; but on 25 July 2001, only 2% habitat was available to fish (Table 23). To put this in perspective, if the lake depth averaged 5 m, 2% of that depth would mean only 0.1 m of water was available to the fish on that date. Fish kills occurred within three days of each of the two latter dates. All four segments are in the cooling loop at Newton Lake. Segments 1 and 2 (discharge arm) tend to have less desirable habitat during the summer months than Segments 3 and 4 (intake arm) (Table 25). It is likely that most of the fish killed during the periods of stressed habitat were located well inside the discharge arm when the potentially fatal conditions began. If this were not true, then the fish kills would have involved much higher numbers of fish within and among species.

Water Levels

Water levels in power-cooling reservoirs are typically lower than pool. Effects of lower water levels on fish species are dependent on loss of aquatic macrophyte habitats, or depending upon time of year, spawning areas. Effects of lower water levels on water temperature and dissolved oxygen profiles are not known. In Newton Lake, three of the four worst habitat conditions occurred when water levels were at least 1.5 feet below pool level (Figures 12 and 13). The fourth occurred in 1999, just prior to the water levels dropping to 2.0 feet below pool. However, since there have been several summer periods when water levels were similar to the aforementioned dates, effects of low water levels on fish habitat are unclear at this time. Water levels occasionally are greater than pool over extended periods. No attempt has been made to determine the extent of spillway mortality in Newton or Coffeen lakes. Given the amount of movement of largemouth bass exhibit throughout all seasons, it is likely that some do escape over the spillway.

In Coffeen Lake, water levels fluctuate more than in Newton Lake. The levels have dipped to over 3 feet below pool during four extended periods over the last eight years (Figures 14 and 15). Examination of the most severe habitat conditions does not show any indication that low water levels promote the poor habitat conditions. As one would expect, those periods when water levels were over pool level often occurred during late spring or early summer. Since the higher water levels were infrequent, spillway mortality was not considered to be a threat to sport species in the lake.

SUMMARY

The data collected since 2000 represents a small, but specific portion of the data collected during 1997 through 1999. The high cost of field data collection, laboratory work, and data analyses is often prohibitive to researchers attempting to answer field-related questions concerning fish populations and the interaction between abiotic and biotic entities. In order to circumvent the problem of costs, biologists attempt to examine trends in conjunction with traditional indices. Data collected since 2000 was used as a continuation of the data previously collected to examine such biotic indices as abundance, mortality, relative weights, length frequencies, and growth as well as abiotic information to determine habitat quality.

We also attempted to use data available from Illinois' Department of Natural Resources in conjunction with SIU-C's for further analyses. Differences between parameters such as catch per unit effort obtained by SIU and IDNR is probably due to sampling on different days. The same portion of the fish community is not vulnerable to electrofishing gear every day. Electrofishing methods were not consistent enough to average the IDNR and SIU CPUEs for each year. IDNR data was collected annually at specific stations and with preset amounts of effort at each station, whereas SIU employed a more random method of data collection. However, all of the data was useful as evidence to develop conclusions about the various population parameters.

Mean monthly water temperatures in Newton Lake during the annual study periods were cooler following 1999. In Coffeen Lake, the temperatures were actually warmer in 2003 and 2004 than in 1999. However, in both Newton Lake and Coffeen Lake, maximum hourly water temperatures at the outer edge of the mixing zone in June, July and August were cooler in every year since 1999. In part, these lower discharge temperatures resulted from the use of cooling ponds added adjacent to Newton Lake and, in Coffeen Lake, cooling towers. Another factor was the weather patterns in 2000 - 2004 versus 1999. In 1999, temperatures remained very hot for a number of weeks. In 2000 - 2004, very hot weather was followed for a few days by cooler weather, and in some cases, heavy rain events. These rain events are reflected in the summer water levels of Newton Lake. Weather patterns were mild through most of summer 2003 and 2004, and at least in Newton Lake, water temperatures were somewhat indicative of the weather. The higher 2003 and 2004 mean mixing zone, surface water temperatures in Coffeen Lake reflected the stable increase in power production in that power plant. However, the mixing zone surface water temperatures were not indicative of cooler temperatures that persisted at depths of 3 m and lower in the mixing zone and throughout the lake in 2004.

Water temperature, dissolved oxygen, and water depth profiles (habitat availability) has been monitored in both lakes since 1997. In Coffeen Lake, these profiles demonstrated that cemetery cove and the area between the railroad bridge and the intake canal could serve as refuges for at least part of the fish community during heavy thermal loading and/or low oxygen events.

On average, lower water temperatures resulted in more available habitat in both Newton Lake and Coffeen Lake after 1999; however, averages can be somewhat misleading. Some of the most severe habitat conditions that we have observed occurred in Coffeen Lake on August 8, 2001, July 6, 2002, and July 8, 2002. Coffeen Lake's Segments 3 and 4 can provide added refuge during some extremely stressful habitat periods, but habitat conditions on the same three dates indicated that these thermal refuge areas can be subjected to extremely low oxygen levels.

Shorter-term conditions or weather patterns that promote fish kills in ambient lakes (as witnessed in 1999) can also be deleterious to habitat quality in the power-cooling lakes. These conditions include very warm, cloudy periods when, in fact for power-cooling ponds, added power is required which may further deteriorate critical habitat. These types of weather patterns cause the largest fish kills in all lakes, and it is difficult to ascertain whether an additional heat load induced fish kills in the power-cooling reservoirs, or if the severe weather patterns (or a combination of both) induced the kills.

In power-cooling ponds, a second condition that can contribute to fish kills is an eroding refuge. A sudden increase of power output and concurring increase in water discharge temperatures can cause some fish to move to an immediate, nearby cove for refuge. If that refuge becomes secluded from inhabitable water by a significant distance (such as is likely if it would occur nearer the discharge mixing zone in either lake), then the refuge can be depleted over time from continuously high discharge temperatures. Fish inhabiting the cove will eventually succumb to heat if they must travel too far in find cooler water. In such instances, the fish kill would likely be relatively small since not all fish would react to the sudden increase in temperatures in the same manner (i.e. some would move to the cooler end of the lakes at the time increased temperatures were initially perceived). Based on information collected since 1997, this entrapment likely occurred on three occasions in the two lakes; the second highest frequency in terms of fish kills since 1997.

Low-level angler mortality is likely the most frequently cited kill factor. When epilimnion temperatures are very hot, detrimental effects of stress induced from increased activity and consequential increase in lactic acid from hooking and handling by anglers is compounded and likely causes incidental mortality that is witnessed every year in both lakes. The number of dead or moribund fish observed at specific areas frequented or recently vacated by anglers is usually small, but witnessed or not, this type of mortality most certainly occurs throughout summer. During the once-per-week sampling effort completed during summer 2000, 2003, and 2004, very few dead or dying fish were observed in either Newton Lake or Coffeen Lake. The few largemouth bass observed were found near boat docks and popular angler fishing areas. Since, in 2000, a number of boats were present at the dock when bass were observed, the bass may have been caught in a club tournament and released at the dock.

Some of the variables were statistically tested to determine if they changed among years; however, many of the variables measured before and after the fish kill in 1999 did not lend themselves well to statistical comparisons. For example, it is possible to determine if the length frequency distributions of the sampled fish are different among years. Such a tool as the Kolmogorov-Smirnov test will indicate if there is a significant difference in the length frequency distributions of fish sampled between years. The problem is that fish kills are not the only reason why the length frequency distributions can differ among years. Hypothetically, if there is a statistical difference between the length frequency distributions of largemouth bass in Newton Lake in 1998 versus 1999, one possible reason could be the fish kill in 1999. Another possible reason could be due to unequal year-class strength. The largemouth bass population in Newton Lake, as in most lakes, exhibits unequal year-class strength. Thus as strong and weak year classes move through the population the shape of the length frequency distributions changes. A statistical test can indicate a difference in shape but it cannot assign a specific cause to the difference.

In many cases a more appropriate approach, especially if data are available for a number of years, is to determine if the variables associated with the health of a fish community fall within the range of historical data. Variables such as size frequency, electrofishing catch-per-unit effort, recruitment at age-0 and age-1, total annual mortality, growth rates , and relative weight were compared before and after the fish kill. All of the variables were essentially within historical levels. These results strongly suggests that no substantial long-term detrimental effects occurred from the fish kills in either lake. They also indicate that warmer water temperatures in Coffeen Lake during the past two years have not been detrimental the largemouth bass population. Bluegill in both lakes are generally stunted and short lived. This has been the case throughout the study period. The channel catfish susceptible to surface electrofishing have also exhibited low condition characteristics throughout the study.

In both lakes, largemouth bass represent the major sportfish. The largemouth bass have exhibited characteristics of populations that are healthy and should continue to offer very good angling opportunities. Channel catfish also offer anglers with an alternative fishing source, but our sampling method did not lend itself fully characterizing this species in either lake. White crappie and striped bass are also fished for in Coffeen lake, but neither species was targeted for trend comparisons. In Newton Lake, white bass have recently increased in abundance, and based on conversations with local anglers and a SIU-C technician, anglers are catching larger numbers of quality-sized fish. White bass were not a target species for this study, and we collected insufficient numbers to characterize the species further. If the species is reproducing, it will provide another quality sportfish for anglers in Newton Lake.

LITERATURE CITED

Brooks, R. C. 2004. AmerenCIPS Newton and Coffeen Lakes Project. Report to AmerenCIPS covering research from 5/02/2003-11/30/2003 by Fisheries and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Heidinger, R. C., R. Sheehan, and R. Brooks. 2000. AmerenCIPS Newton Lake Project. Report to AmerenCIPS covering research from 8/15/97-8/30/99 by Fisheries Research Laboratory and Illinois Aquaculture Center, Southern Illinois University at Carbondale. Vol. I and II.

Heidinger, R. C., R. Sheehan, and R. Brooks. 2001. AmerenCIPS Newton and Coffeen Lakes Research and Monitoring Project. Report to AmerenCIPS covering research from 1/04/2000-12/30/2000 by Fisheries and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Heidinger, R. C. and R. Brooks. 2002. AmerenCIPS Newton and Coffeen Lakes Project. Report to AmerenCIPS covering research from 4/06/2001-10/31/2001 by Fisheries and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Heidinger, R. C. and R. Brooks. 2003. AmerenCIPS Newton and Coffeen Lakes Project. Report to AmerenCIPS covering research from 4/06/2002-10/31/2002 by Fisheries and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Table 1. AmerenCips Newton Lake Project's basic sampling schedule for data collected concurrently from 1997 through 2004.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Newton Lake													
Age and growth, mortality	0	0	0	0	0	0	0	0	0	1	1	1	October and November for mortality. Extra sampling in following months as necessary for age and growth rquirements.
Temp/DO	0	0	0	0	4	4	4	4	3	0	0	0	**4 samples per date:** midway between segment borders; 1/2 meter intervals to bottom.
Coffeen Lake													
Age and growth, mortality	0	0	0	0	0	0	0	0	0	1	1	1	October and November for mortality. Extra sampling in following months as necessary for age and growth rquirements.
Temp/DO	0	0	0	0	4	3	4	4	3	0	0	0	**4 samples per date:** midway between segment borders; 1/2 meter intervals to bottom

[1]/ Starting dates for sampling were contingent upon grant approval.

Table 2. Comparison of summer and fall mean monthly temperatures (°F) at the outer edge of the discharge mixing zones.[a]

Month	Year							
	1997	1998	1999	2000	2001[a]	2002	2003[a]	2004[a]
				Newton Lake				
May	---	89.8	88.4	82.5	91.7	84.8	84.6	93.2
June	95.9	96.3	97.0	94.2	94.5	97.4	90.8	96.7
July	101.7	101.7	104.1	98.0	100.1	99.1	96.9	96.8
August	96.2	102.3	99.7	97.5	99.4	96.6	98.3	95.3
September	94.9	94.6	93.1	92.8	92.9	94.0	92.7	93.3
October	86.3	87.5	85.4	84.9	84.8	86.3	84.8	84.2
				Coffeen Lake				
May	77.7	90.8	86.4	88.0	84.7	83.5	--	--
June	87.9	94.9	90.5	93.9	86.6	82.2	101.3	106.5
July	100.8	102.4	103.9	99.2	101.3	96.9	104.3	105.0
August	98.7	100.1	101.5	99.2	102.4	100.4	104.2	105.6
September	88.7	96.1	94.8	93.5	93.2	100.4	97.8	105.5
October	81.6	79.9	83.6	83.4	64.2	99.1	--	--

[a]/ Hourly temperature data was provided by AmerenCIPS except for Coffeen Lake in 2001, 2003, and 2004 which were obtained from SIU temperature recorders.

Table 3. Hourly surface temperatures in 1999 that exceeded 111°F at the outer edge of Newton Lake discharge mixing zone. Within a year total hours above 111°F were not to exceed 110°F (3% of total number of hours during the period June-October, 3,672 hours).

Date	Time	Surface temp.	Date	Time	Surface temp.	Date	Time	Surface temp.
7/22/1999	13:34:28	111.22	7/24/1999	20:34:28	111.47	7/28/1999	0:34:28	111.36
7/22/1999	14:34:28	111.39	7/24/1999	21:34:28	111.18	7/29/1999	12:34:28	111.33
7/22/1999	15:34:28	111.48	7/24/1999	22:34:28	111.01	7/29/1999	13:34:28	111.79
7/22/1999	16:34:28	111.65	7/25/1999	13:34:28	111.53	7/29/1999	14:34:28	111.99
7/22/1999	17:34:28	111.84	7/25/1999	14:34:28	111.5	7/29/1999	15:34:28	111.87
7/22/1999	18:34:28	112.03	7/25/1999	15:34:28	111.71	7/29/1999	16:34:28	111.99
7/22/1999	19:34:28	112.09	7/25/1999	16:34:29	111.77	7/29/1999	17:34:28	112.31
7/22/1999	20:34:29	112.06	7/25/1999	17:34:28	112.03	7/29/1999	18:34:28	111.43
7/22/1999	21:34:28	111.93	7/25/1999	18:34:28	112.13	7/29/1999	19:34:28	112.61
7/22/1999	22:34:28	111.85	7/25/1999	19:34:28	112.06	7/29/1999	20:34:28	112.85
7/22/1999	23:34:28	111.74	7/25/1999	20:34:28	112.11	7/29/1999	21:34:28	113
7/23/1999	0:34:28	111.48	7/25/1999	21:34:28	112.44	7/29/1999	22:34:28	112.39
7/23/1999	10:34:28	111.59	7/25/1999	22:34:28	112.53	7/29/1999	23:34:28	112.85
7/23/1999	11:34:29	112.01	7/25/1999	23:34:28	112.32	7/30/1999	0:34:28	112.79
7/23/1999	12:34:28	112.32	7/26/1999	11:34:28	111.15	7/30/1999	11:34:28	111.81
7/23/1999	13:34:28	112.53	7/26/1999	12:18:32	111.28	7/30/1999	12:34:28	111.85
7/23/1999	14:34:28	111.93	7/26/1999	16:34:28	111.35	7/30/1999	14:34:28	112.99
7/23/1999	15:34:28	112.06	7/26/1999	17:34:28	112.57	7/30/1999	15:34:28	113.31
7/23/1999	16:34:28	112.05	7/26/1999	18:34:28	112.46	7/30/1999	16:34:28	113.27
7/23/1999	17:34:28	111.98	7/26/1999	19:34:28	112.47	7/30/1999	17:34:28	113.35
7/23/1999	18:34:28	111.84	7/26/1999	20:34:29	112.34	7/30/1999	18:34:28	113.37
7/23/1999	19:34:28	111.77	7/26/1999	21:34:28	112.31	7/30/1999	19:34:28	113.51
7/23/1999	20:34:28	111.73	7/26/1999	22:34:28	112.33	7/30/1999	20:34:28	113.56
7/23/1999	21:34:28	111.79	7/26/1999	23:34:29	112.29	7/30/1999	21:34:28	113.63
7/23/1999	22:34:28	111.75	7/27/1999	0:34:28	112.23	7/30/1999	22:34:28	113.66
7/23/1999	23:34:28	111.49	7/27/1999	14:34:28	111.37	7/30/1999	23:34:28	113.64
7/24/1999	11:34:28	111.54	7/27/1999	15:34:28	111.54	7/31/1999	0:34:28	113.48
7/24/1999	12:34:28	111.96	7/27/1999	16:34:28	111.71	7/31/1999	1:34:28	111.98
7/24/1999	13:34:28	112.18	7/27/1999	17:34:28	111.82	7/31/1999	2:34:28	112.8
7/24/1999	14:34:28	112.27	7/27/1999	18:34:28	111.78	7/31/1999	3:34:28	112.67
7/24/1999	15:34:28	112.09	7/27/1999	19:34:28	111.57			
7/24/1999	16:34:28	112.05	7/27/1999	20:34:29	111.59			
7/24/1999	17:34:28	111.77	7/27/1999	21:34:28	111.7			
7/24/1999	18:34:28	111.7	7/27/1999	22:34:28	111.71			
7/24/1999	19:34:28	111.75	7/27/1999	23:34:28	111.6			
						TOTAL HOURS		100

Table 4. Hourly surface temperatures in 1999 that exceeded 112°F at the outer edge of Coffeen Lake discharge mixing zone. Within a year total hours above 112°F were not to exceed 132 (3% of total number of hours during the period May – October, 4,416 hours).

Date	Time	Surface temp.	Date	Time	Surface temp.	Date	Time	Surface temp.
7/23/1999	16:00:00	112	7/28/1999	16:00:00	112.95	7/31/1999	14:00:00	113.02
7/23/1999	17:00:00	112.5	7/28/1999	17:00:00	113.17	7/31/1999	15:00:00	112.88
7/23/1999	18:00:00	112.21	7/28/1999	18:00:00	113.86	7/31/1999	18:00:00	113.29
7/23/1999	19:00:00	112.59	7/28/1999	19:00:00	113.91	7/31/1999	19:00:00	113.83
7/23/1999	20:00:00	112.16	7/28/1999	20:00:00	113.58	7/31/1999	20:00:00	114.09
7/25/1999	14:00:00	112.09	7/28/2002	21:00:00	113.37	7/31/1999	21:00:00	114.2
7/25/1999	15:00:00	112.72	7/28/2002	22:00:00	112.17	7/31/1999	22:00:00	113.68
7/25/1999	16:00:00	112.72	7/29/1999	13:00:00	112.89	7/31/1999	23:00:00	112.83
7/25/1999	17:00:00	112.43	7/29/1999	14:00:00	114.24	9/7/1999	14:00:00	120.27
7/25/1999	18:00:00	113.34	7/29/1999	15:00:00	114.04	9/7/1999	15:00:00	120.08
7/25/1999	19:00:00	112.95	7/29/1999	16:00:00	114.14	9/7/1999	16:00:00	122.49
7/25/1999	20:00:00	112.2	7/29/1999	17:00:00	114.56			
7/25/1999	23:00:00	112.8	7/29/1999	18:00:00	114.67			
7/26/1999	12:00:00	113.01	7/29/1999	19:00:00	114.19			
7/26/1999	13:00:00	113.48	7/29/1999	20:00:00	114.21			
7/26/1999	14:00:00	113.75	7/29/1999	21:00:00	113.6			
7/26/1999	15:00:00	113.87	7/29/1999	22:00:00	114			
7/26/1999	16:00:00	112.19	7/29/1999	23:00:00	113.89			
7/26/1999	18:00:00	112.36	7/30/1999	1:00:00	113.24			
7/26/1999	19:00:00	113.4	7/30/1999	2:00:00	113.9			
7/26/1999	20:00:00	114.35	7/30/1999	3:00:00	113.11			
7/26/1999	21:00:00	112.96	7/30/1999	4:00:00	112.34			
7/26/1999	22:00:00	114.17	7/30/1999	12:00:00	112.74			
7/26/1999	23:00:00	113.93	7/30/1999	13:00:00	114.2			
7/27/1999	0:00:00	112.9	7/30/1999	14:00:00	114.3			
7/27/1999	14:00:00	113.62	7/30/1999	15:00:00	114.65			
7/27/1999	15:00:00	113.22	7/30/1999	16:00:00	114.88			
7/27/1999	16:00:00	113.81	7/30/1999	17:00:00	115.05			
7/27/1999	17:00:00	113.31	7/30/1999	18:00:00	115.39			
7/27/1999	18:00:00	113.68	7/30/1999	19:00:00	114.06			
7/27/1999	19:00:00	113.43	7/30/1999	20:00:00	113.44			
7/27/1999	20:00:00	113.81	7/30/1999	21:00:00	113.52			
7/27/1999	21:00:00	114	7/30/1999	22:00:00	112.95			
7/27/1999	22:00:00	113.29	7/30/1999	23:00:00	113.64			
7/27/1999	23:00:00	112.91	7/31/1999	1:00:00	112.54			
7/28/1999	15:00:00	112.41	7/31/1999	2:00:00	112.31			

Total Hours 83

Table 5. Numbers of dead and morbid fishes observed by SIU personnel in Coffeen Lake in 1999.

Date	Largemouth bass	*Lepomis*	Channel catfish	*Morone*	White crappie	Carp	Shad
04/09/99	0	0	2	0	0	1	0
06/02/99	0	0	0	0	0	0	0
06/03/99	0	0	0	0	0	0	0
06/08/99	0	0	0	0	0	0	0
06/15/99	0	0	0	0	0	0	0
06/16/99	0	0	0	0	0	0	0
06/29/99	0	0	0	0	0	0	0
06/29/99	0	0	0	0	0	0	0
06/30/99	0	0	0	0	0	0	0
07/08/99	1	0	0	0	0	0	0
07/09/99	0	0	0	0	0	0	0
07/13/99	0	0	0	0	0	0	0
07/16/99	0	0	0	0	0	0	0
07/21/99	0	0	0	1	1	0	0
07/23/99	0	0	0	0	0	0	0
07/27/99	15	31	0	0	0	0	5
07/28/99	105	0	5	11	0	0	7
08/01/99	0	0	0	0	0	0	0
08/02/99	0	0	0	0	0	0	0
08/06/99	0	0	0	0	0	0	0
08/10/99	0	0	1	0	1	0	0
08/11/99	0	0	0	0	0	0	0
08/19/99	0	0	0	0	0	0	0
08/20/99	0	0	0	0	0	0	0
08/24/99	0	0	0	0	0	0	0
08/25/99	0	0	0	0	0	0	0
08/26/99	0	0	0	0	0	0	0
08/27/99	0	0	0	0	0	0	0
Total	121	31	8	12	2	1	12

Table 6. Number of dead and morbid fishes observed by SIU personnel in Newton Lake in 1999.

Date	Largemouth bass	*Lepomis*	Channel catfish	*Morone*	Carp	Shad
03/23/99	1	0	0	0	0	0
05/20/99	1	0	0	0	0	1
06/01/99	0	0	0	0	0	0
06/02/99	0	0	0	0	0	0
06/03/99	0	0	0	0	0	0
06/04/99	0	0	0	0	0	0
06/08/99	0	0	0	0	0	0
06/09/99	27	0	0	0	0	0
06/14/99	0	0	0	0	0	0
06/15/99	0	0	0	0	0	0
06/19/99	0	0	0	0	0	0
06/22/99	4	0	0	0	0	0
06/23/99	0	0	0	0	0	0
06/24/99	0	0	0	0	0	0
06/29/99	0	0	0	0	0	0
07/06/99	0	0	0	0	0	0
07/07/99	1	0	0	0	0	0
07/08/99	0	0	0	0	0	0
07/14/99	0	0	0	0	0	0
07/15/99	0	0	0	0	0	0
07/16/99	0	0	0	0	0	0
07/20/99	1	0	0	1	0	0
07/21/99	0	0	0	0	0	0
07/23/99	0	0	0	0	0	0
07/24/99	0	0	0	0	0	0
07/27/99	18	1	22	1	1	8
07/29/99	60	4	36	1	0	15
07/30/99	5	0	0	0	0	0
07/31/99	0	0	0	0	0	0
08/05/99	3	0	9	0	0	2
08/09/99	3	0	2	0	0	0
08/10/99	0	0	0	0	0	0
08/11/99	20	0	0	0	0	35
08/18/99	24	0	1	2	0	0
08/19/99	18	0	0	0	0	0
08/24/99	6	0	0	0	0	0
08/25/99	9	0	0	0	0	0
08/26/99	14	0	0	0	0	0
08/27/99	11	0	0	0	0	0
08/31/99	1	0	0	0	0	0
Total	227	5	70	5	1	59

Table 7. Summary of Chapman-Robson (1960) (C-R) and catch curve estimates (C-C) of actual annual mortality rate (percent) for largemouth bass, bluegill, and channel catfish calculated from catch data of fish captured in each lake during fall 1997-2004 (-- indicates an undeterminable value or no sampling scheduled).

	Newton Lake			Lake of Egypt			Coffeen Lake		
Year	C-R	C-C	Mean	C-R	C-C	Mean	C-R	C-C	Mean
				Largemouth Bass					
1997	73	63	68	30	28	29	40	37	39
1998	56	34	45	39	28	34	50	35	43
1999	61	55	58	--	--	--	40	38	39
2000	66	62	64	--	--	--	48	45	47
2001	57	47	52	--	--	--	47	37	42
2002	63	56	59	--	--	--	49	39	44
2003	52	49	51	--	--	--	59	27	43
2004	62	55	59	--	--	--	42	43	43
Weighted mean	61	53	57	35	28	32	47	38	42
				Bluegill					
1997	73	72	73	59	38	49	71	60	66
1998	88	78	83	36	52	44	70	69	70
1999	88	67	78	--	--	--	56	61	59
2000	81	83	82	--	--	--	70	74	72
2001	79	68	74	--	--	--	67	65	66
2002	65	71	68	--	--	--	66	64	65
2003	66	68	67	--	--	--	66	74	70
2004	68	59	64	--	--	--	78	76	77
Weighted mean	76	71	74	48	45	47	68	68	68
				Channel Catfish					
1997	54	41	48	67	50	59	32	13	23
1998	44	38	41	11	--	11	33	18	26
1999	40	32	36	--	--	--	36	38	37
2000	30	27	29	--	--	--	50	42	46
2001	43	46	45	--	--	--	47	43	45
2002	27	25	26	--	--	--	47	46	47
2003	36	22	29	--	--	--	46	41	44
2004	47	42	45	--	--	--	35	33	34
Weighted mean	40	34	37	39	50	35	41	34	38

Table 8. Number and total length of dead and morbid fish observed by SIU personnel in Coffeen Lake and Newton Lake in 2000 and 2001.

Date	Species[a]	Number	Length (in.)	Status	Location/ Segment
		Coffeen Lake			
7/18/2000	LMB	1	18	Dying	Boat Ramp
	LMB	1	16	Dying	Boat Ramp
	LMB	1	21	Dying	Boat Ramp
	CCF	1	16	Dead	Boat Ramp
7/25/2000	CCF	1	14	Dead	Boat Ramp
7/10/2001	CCF	2 (11)[b]	2	Dead	1
	CCF	15 (85)	3	Dead	1
	CCF	37 (210)	4	Dead	1
	CCF	20 (114)	5	Dead	1
	CCF	14 (80)	6	Dead	1
	CCF	8 (46)	7	Dead	1
	Lepomis spp.	20 (113)	2	Dead	1
	Lepomis spp.	47 (265)	3	Dead	1
	Lepomis spp.	22 (124)	4	Dead	1
	Lepomis spp.	1 (7)	5	Dead	1
	Lepomis spp.	1 (7)	6	Dead	1
	LMB	5 (36)	2	Dead	1
	LMB	4 (29)	3	Dead	1
	LMB	1 (7)	7	Dead	1
7/12/2001	STPB	1	26.5	Dead	3
	WC	1	7	Dead	1
8/2/2001	CCF	1	15	Dead	4
	CCF	1	14.5	Dead	4
	LMB	1	16	Dead	3
	WC	1	9	Dead	1

Table 8. Continued.

Date	Species[a]	Number	Length (in.)	Status	Location/ Segment
		Newton Lake			
7/21/2000	LMB	1	19	Dead	3
	LMB	1	16	Dead	3
8/17/2000	GS	1	8	Dead	
	GS	1	8	Dead	
7/20/2001	BC	1	12	Dead	4
	WHB	1	17	Dying	3
7/25/2001	GZ	1	12.5	Dying	4
	Lepomis spp.	1	7	Dead	2
	WHB	1	13	Dead	4
8/1/2001	WHB	1	15	Dead	4
8/7/2001	LMB	1	20.5	Dead	4
8/14/2001	CCF	1		Dead	3
	GZ	1	12.5	Dead	2
8/22/2001	LMB	1	12	Dead	1
	LMB	1	16.5	Dead	4
	WC	1	11.5	Dead	4
8/28/2001	GZ	175 (10,765)[b]	3	Dead	1

[a]/ LMB = Largemouth bass; CCF = channel catfish; GZ = gizzard shad; WC = white crappie; BC = black crappie; HSB = hybrid striped bass; STPB = striped bass; WHB = white bass

[b]/ The number in parenthesis represents the prorated number of fish killed in each size group based on the extrapolated estimate. See appendix G and H for the extrapolation procedure.

Table 9. Number and total length of dead and moribund fish estimated by IDNR personnel in Coffeen Lake from 24 June through 4 July, 2002.

Species	Number	Length (in.)
Largemouth bass	1	8
	2	12
	6	14
	10	15
	8	16
	6	17
	9	18
	42	
Bluegill	2	7
	2	8
	4	
White crappie	2	7
	1	8
	3	
Channel catfish	2	14
	1	16
	3	
Gizzard shad	1	4
	3	6
	3	9
	7	
Threadfin shad	1	2
Striped bass	5	17
	6	18
	8	19
	11	24
	19	25
	15	26
	64	
Total	124	

Table 10. Size frequency distributions (%) for white crappie in Newton Lake based on IDNR spring and fall electrofishing samples from fall 1976 to fall 2004. The electrofishing effort was not constant over all sampling periods.

Year	Sample size	Total length (inches)[a]		
		6.3	7.1	10.2
1976 Fall	6	33	33	33
1977 Spring	6	17	17	17
1977 Fall	6	100	83	83
1978 Spring	37	70	30	19
1978 Fall	11	100	64	18
1979 Spring	65	100	23	8
1979 Fall	0	33	33	33
1980 Spring	24	100	100	62
1980 Fall	57	100	96	17
1981 Spring	185	100	85	5
1981 Fall	78	100	100	44
1982 Spring	89	100	98	31
1982 Fall	140	100	96	36
1983 Spring	793	100	95	14
1983 Fall	No data	No data	No data	No data
1984 Spring	63	100	63	13
1984 Fall	178	100	97	26
1985 Spring	279	100	85	6
1985 Fall	188	100	95	28
1986 Spring	103	100	80	24
1986 Fall	104	100	100	62
1987 Spring	24	100	100	54
1987 Fall	38	100	100	76
1988 Spring	6	100	100	83
1988 Fall	7	100	100	100
1989 Spring	0	0	0	0
1989 Fall	9	100	100	56
1990 Spring	2	100	100	0
1990 Fall	3	100	100	33
1991 Spring	18	33	22	17
1991 Fall	0	0	0	0
1992 Spring	0	0	0	0
1992 Fall	0	0	0	0
1993 Spring	5	60	40	0
1993 Fall	3	100	0	0
1994 Spring	3	43	0	0
1994 Fall	3	100	100	100
1995 Spring	1	100	100	0
1995 Fall	2	100	100	50

Table 10. Continued.

Year	Sample size	Total length (inches)[a]		
		6.3	7.1	10.3
1996 Spring	0	0	0	0
1996 Fall	1	0	0	0
1997 Spring	0	0	0	0
1997 Fall	2	100	100	0
1998 Spring	2	100	100	100
1998 Fall	1	100	100	100
1999 Spring	1	100	0	0
1999 Fall	22	100	100	5
2000 Spring	82	0	0	0
2000 Fall	12	100	100	100
2001 Spring	25	100	100	56
2001 Fall	1	100	100	0
2002 Spring	14	100	100	93
2002 Fall	2	50	50	0
2003 Spring	0	0	0	0
2003 Fall	4	100	100	100
2004 Fall	1	0	0	0

[a]/ Since IDNR measures fish in 10 mm size groups, it is not possible to calculate the percentages of white crappie in even inch groups.

Table 11. Size frequency distributions (%) for bluegill in Newton Lake based on IDNR spring and fall electrofishing samples from fall 1976 to fall 2004. Electrofishing effort was not constant for all years.

Year	Sample size	Total length (inches)[a]		
		6.3	7.1	8.3
1976 Fall	103	38	6	0
1977 Spring	200	45	5	0
1977 Fall	73	29	3	0
1978 Spring	548	43	9	0
1978 Fall	259	31	4	0
1979 Spring	466	24	3	0
1979 Fall	361	7	<1	0
1980 Spring	113	15	0	0
1980 Fall	262	13	<1	0
1981 Spring	379	15	2	0
1981 Fall	264	20	0	0
1982 Spring	1,026	13	<1	0
1982 Fall	363	3	<1	0
1983 Spring	534	25	3	0
1983 Fall	No data	No data	No data	No data
1984 Spring	399	29	1	0
1984 Fall	181	18	2	0
1985 Spring	367	13	<1	0
1985 Fall	550	6	0	0
1986 Spring	312	10	0	0
1986 Fall	125	16	0	0
1987 Spring	472	6	0	0
1987 Fall	372	5	0	0
1988 Spring	150	5	<1	0
1988 Fall	376	3	0	0
1989 Spring	120	9	<1	0
1989 Fall	628	5	0	0
1990 Spring	95	17	4	2
1990 Fall	107	5	2	2
1991 Spring	512	5	<1	0
1991 Fall	108	4	0	0
1992 Spring	108	14	1	0
1992 Fall	78	15	0	0
1993 Spring	112	21	3	<1
1993 Fall	620	14	3	0
1994 Spring	106	0	0	0
1994 Fall	289	0	0	0
1995 Spring	133	0	0	0

Table 11. Continued.

Year	Sample size	Total length (inches)[a]		
		6.3	7.1	8.3
1995 Fall	1,236	<1	0	0
1996 Spring	434	5	2	<1
1996 Fall	618	0	0	0
1997 Spring	368	4	2	0
1997 Fall	542	2	1	0
1998 Spring	348	28	8	0
1998 Fall	522	2	1	0
1999 Spring	478	10	1	0
1999 Fall	832	1	0	0
2000 Spring	386	3	0	0
2000 Fall	508	1	<1	0
2001 Spring	282	5	0	0
2001 Fall	852	1	0	0
2002 Spring	348	5	1	0
2002 Fall	876	4	1	<1
2003 Spring	264	<1	<1	0
2003 Fall	242	<1	<1	0
2004 Fall	342	2	<1	0

[a]/ Since IDNR measures fish in 10 mm size groups, it is not possible to calculate the percentages of bluegill in even inch groups.

Table 12. Size frequency distributions (%) for channel catfish in Newton Lake based on IDNR spring and fall electrofishing samples from fall 1976 to fall 2004. Electrofishing effort was not constant over all years.

Year	Sample size	Total length (inches)[a] 12.2	16.1	20.1
1976 Fall	0	0	0	0
1977 Spring	0	0	0	0
1977 Fall	0	0	0	0
1978 Spring	4	100	0	0
1978 Fall	0	0	0	0
1979 Spring	19	100	53	26
1979 Fall	22	82	77	27
1980 Spring	6	50	33	17
1980 Fall	51	12	6	2
1981 Spring	52	40	31	27
1981 Fall	87	90	23	7
1982 Spring	148	64	18	9
1982 Fall	80	72	28	8
1983 Spring	87	49	9	2
1983 Fall	No data	No data	No data	No data
1984 Spring	327	45	13	0.3
1984 Fall	115	62	23	6
1985 Spring	267	93	8	1
1985 Fall	381	50	17	4
1986 Spring	336	49	11	1
1986 Fall	105	48	15	5
1987 Spring	148	31	8	3
1987 Fall	85	27	12	5
1988 Spring	238	31	7	2
1988 Fall	227	44	12	4
1989 Spring	191	35	7	1
1989 Fall	221	24	10	1
1990 Spring	82	46	7	1
1990 Fall	114	60	19	4
1991 Spring	396	48	13	3
1991 Fall	186	58	13	3
1992 Spring	44	43	5	2
1992 Fall	139	40	18	7
1993 Spring	73	36	15	1
1993 Fall	193	4	0	0
1994 Spring	72	42	19	0
1994 Fall	137	28	8	1

Table 12. Continued.

Year	Sample size	Total length (inches)[a]		
		12.2	16.1	20.1
1995 Spring	186	0.5	0	0
1995 Fall	528	9	2	1
1996 Spring	177	14	0	0
1996 Fall	149	13	2	0
1997 Spring	54	32	2	0
1997 Fall	49	35	10	2
1998 Spring	111	8	1	1
1998 Fall	161	33	4	0
1999 Spring	76	30	0	0
1999 Fall	142	38	1	0
2000 Spring	54	48	4	0
2000 Fall	107	44	14	0
2001 Spring	111	46	4	0
2001 Fall	167	64	17	2
2002 Spring	127	68	7	2
2002 Fall	131	62	10	2
2003 Spring	28	61	4	0
2003 Fall	24	58	21	0
2004 Fall	53	57	17	8

[a]/ Since IDNR measures fish in 10 mm size groups, it is not possible to calculate percentages of channel catfish in even inch groups.

Table 13. Size frequency distributions (%) for largemouth bass in Newton Lake based on IDNR spring and fall electrofishing samples from fall 1976 to fall 2004. Electrofishing effort was not constant over all years.

Year	Sample size	Total length (inches)[a] 12.2	14.2	16.1	18.1
1976 Fall	79	51	51	1	0
1977 Spring	137	59	51	2	0.5
1977 Fall	211	84	61	22	3
1978 Spring	342	92	73	46	4
1978 Fall	427	82	74	49	10
1979 Spring	364	95	86	71	21
1979 Fall	1,622	79	65	29	10
1980 Spring	273	90	79	57	21
1980 Fall	462	74	65	31	11
1981 Spring	471	84	73	47	18
1981 Fall	522	71	66	31	12
1982 Spring	592	86	71	42	19
1982 Fall	445	72	61	21	8
1983 Spring	1,006	82	64	27	13
1983 Fall	No data	No data	No data	No data	No data
1984 Spring	344	88	74	47	14
1984 Fall	356	70	66	30	13
1985 Spring	266	82	75	51	23
1985 Fall	310	59	56	12	6
1986 Spring	343	85	72	43	27
1986 Fall	363	71	62	25	10
1987 Spring	245	78	70	40	22
1987 Fall	469	70	60	20	8
1988 Spring	586	80	72	43	21
1988 Fall	377	82	69	38	15
1989 Spring	663	89	74	48	21
1989 Fall	623	66	62	24	9
1990 Spring	520	85	74	49	18
1990 Fall	518	69	60	20	7
1991 Spring	721	86	64	28	12
1991 Fall	534	70	66	31	13
1992 Spring	383	80	71	43	18
1992 Fall	642	62	57	14	5
1993 Spring	509	69	60	21	8
1993 Fall	637	69	56	11	6
1994 Spring	809	52	50	0	0
1994 Fall	1,126	79	53	6	2
1995 Spring	548	53	50	0	0
1995 Fall	840	44	32	14	2
1996 Spring	592	86	70	43	9

Table 13. Continued.

Year	Sample size	Total length (inches)[a] 12.2	14.2	16.1	18.1
1996 Fall	1,000	58	47	27	7
1997 Spring	718	84	70	46	12
1997 Fall	357	24	19	12	5
1998 Spring	691	63	53	41	15
1998 Fall	705	53	27	15	6
1999 Spring	606	90	69	36	16
1999 Fall	514	48	38	12	4
2000 Spring	512	72	57	37	8
2000 Fall	424	26	14	6	2
2001 Spring	394	67	42	24	10
2001 Fall	634	51	31	12	3
2002 Spring	638	71	52	30	11
2002 Fall	654	67	35	16	4
2003 Spring	477	88	67	35	11
2003 Fall	316	35	24	13	2
2004 Fall	621	35	23	12	3

[a]/ Since IDNR measures fish in 10 mm size groups, it is not possible to calculate the percentages of largemouth bass in even inch groups.

Table 14. Three phase electrofishing catch-per-unit effort of largemouth bass, bluegill, and channel catfish from Newton Lake during the fall of 1997-2004 by IDNR and SIU.

	Hours[a]		Catch per hour	
Year	IDNR	SIU	IDNR	SIU
		Largemouth bass		
1993	12	--	53	--
1994	12	--	94	--
1995	12	--	78	--
1996	12	--	83	--
1997	12	9.4	30	28
1998	12	6.3	59	44
1999	12	9.1	43	32
2000	12	5.0	35	76
2001	12	4.5	53	33
2002	12	2.8	55	39
2003	6	3.1	53	32
2004	8	2.4	78	42
		Bluegill		
1997	12	11.4	45	28
1998	12	8.1	44	51
1999	12	5.1	69	59
2000	12	1.0	42	115
2001	12	1.8	71	54
2002	12	0.8	73	149
2003	6	2.8	40	39
2004	8	0.7	43	198
		Channel catfish		
1993	12	--	6	--
1994	12	--	11	--
1995	12	--	44	--
1996	12	--	12	--
1997	12	16.6	4	2
1998	12	10.0	13	7
1999	12	17.8	12	7
2000	12	7.0	9	12
2001	12	12.0	14	8
2002	12	7.5	11	13
2003	6	12.9	4	4
2004	8	9.5	7	10

[a]/ IDNR collected fish from their standard sampling sites and SIU collected fish from each of their four sampling segments.

Table 15. Size frequency distribution (%) for largemouth bass, bluegill, and channel catfish in Coffeen Lake from IDNR fall electrofishing samples.

Largemouth Bass

Year	Hours Sampled	Number Sampled	Total length (inches)[a] 12.2	14.2	16.1	18.1
1997	7.5	595	57	45	26	10
1998	7.5	325	46	37	18	9
1999	7	467	64	48	28	12
2000	7	139	68	50	24	4
2001	7	573	50	39	21	4
2002	7	648	64	41	24	7
2003	6.5	431	74	55	25	8
2004	6.5	652	63	55	34	9

Bluegill

Year	Hours Sampled	Number Sampled	Total length (inches)[a] 6.3	7.1	8.3
1997	7.5	1468	0	0	0
1998	7.5	740	0	0	0
1999	7	888	0	0	0
2000	7	623	<1	0	0
2001	7	605	0	0	0
2002	7	1250	0	0	0
2003	6.5	461	0	0	0
2004	6.5	423	0	0	0

Channel Catfish

Year	Hours Sampled	Number Sampled	Total length (inches)[a] 12.2	16.1	20.1
1997	7.5	65	94	51	2
1998	7.5	87	90	48	2
1999	7	102	90	24	1
2000	7	18	67	5	5
2001	7	50	94	16	0
2002	7	75	97	44	1
2003	6.5	27	89	26	11
2004	6.5	81	78	28	1

[a]/ Since IDNR measures fish in 10 mm size groups, it is not possible to calculate the percentages in even inch groups.

Table 16. Three phase electrofishing catch-per-unit effort of largemouth bass, bluegill, and channel catfish from Coffeen lake during the fall of 1997-2004 by IDNR and SIU.

	Hours[a]		Catch per hour	
Year	IDNR	SIU	IDNR	SIU
		Largemouth bass		
1997	7.5	4.8	79	23
1998	7.5	7.3	43	14
1999	7	5.2	67	25
2000	7	12.1	20	16
2001	7	7.1	99	23
2002	7	2.8	93	39
2003	6.5	4.0	66	26
2004	6.5	4.8	100	22
		Bluegill		
1997	7.5	4.0	196	54
1998	7.5	2.6	99	49
1999	7	1.0	127	163
2000	7	1.1	89	97
2001	7	1.6	86	66
2002	7	0.6	179	166
2003	6.5	1.5	71	67
2004	6.5	1.7	65	67
		Channel catfish		
1997	7.5	6.0	9	5
1998	7.5	7.9	12	1
1999	7	10.2	16	5
2000	7	12.2	3	7
2001	7	7.1	6	3
2002	7	6.6	11	13
2003	6.5	15.7	4	6
2004	6.5	9.0	13	13

[a]/ IDNR collected fish from their standard sampling sites and SIU collected fish from each of their two sampling segments.

Table 17. Relative weights of three species of fish collected by IDNR and SIU in fall electrofishing samples of Newton Lake and Coffeen Lake from 1997-2004.[a] ANOVA followed by Tukey post doc text were used to test for significance. Means with the same superscript are not significantly different (alpha = 0.01).

	Newton Lake				Coffeen Lake			
	Sample size		Relative weight		Sample size		Relative weight	
Year	IDNR	SIUC	IDNR	SIUC	IDNR	SIUC	IDNR	SIUC
Largemouth bass								
1997	275	99	103^{a}	100^{b}	428	73	102^{b}	100^{b}
1998	481	104	102^{b}	$105^{a,b}$	251	104	96^{e}	$106^{a,b}$
1999	409	121	100^{e}	$103^{a,b}$	353	114	99^{d}	$104^{a,b}$
2000	338	100	$101^{b,c}$	$101^{a,b}$	118	99	102^{b}	108^{a}
2001	488	208	$101^{c,d}$	107^{a}	366	156	100^{c}	107^{a}
2002	442	108	$100^{d,e}$	$102^{a,b}$	474	104	106^{a}	$104^{a,b}$
2003	236	100	99^{e}	$102^{a,b}$	326	100	96^{e}	$102^{a,b}$
2004	371	100	100^{e}	99^{b}	448	106	101^{b}	$104^{a,b}$
Weighted mean			101	103			101	104
Bluegill								
1997	119	98	91^{a}	84^{d}	86	119	89^{a}	$81^{b,c}$
1998	92	101	91^{a}	104^{a}	89	85	80^{d}	94^{a}
1999	109	48	92^{a}	96^{b}	71	166	84^{c}	96^{a}
2000	103	109	88^{b}	$93^{b,c}$	80	103	86^{b}	94^{a}
2001	102	97	83^{c}	$88^{c,d}$	110	101	86^{b}	$83^{b,c}$
2002	79	118	88^{b}	$89^{b,c}$	79	101	87^{a}	$89^{a,b}$
2003	50	107	77^{d}	74^{c}	66	101	86^{b}	79^{c}
2004	54	142	$85^{b,c}$	78^{e}	78	111	88^{a}	76^{c}
Weighted mean			88	88			86	87

Table 17. Continued

Year	Newton Lake Sample size IDNR	Newton Lake Sample size SIUC	Newton Lake Relative weight IDNR	Newton Lake Relative weight SIUC	Coffeen Lake Sample size IDNR	Coffeen Lake Sample size SIUC	Coffeen Lake Relative weight IDNR	Coffeen Lake Relative weight SIUC
				Channel catfish				
1997	49	21	82[b,c]	73[c]	64	11	89[b]	87[b,c]
1998	90	19	84[b]	90[a,b,c]	77	17	89[a,b]	88[b,c]
1999	70	92	83[b,c]	82[c]	102	66	92[a]	91[b]
2000	56	93	83[b,c]	86[b,c]	18	66	91[a,b]	89[b]
2001	97	91	84[b]	89[a,b]	48	21	93[a]	97[a]
2002	67	95	80[c]	94[a]	72	100	91[a,b]	98[a]
2003	24	53	87[a]	85[b,c]	27	98	91[a,b]	92[b]
2004	52	92	84[b]	85[b,c]	78	114	84[c]	80[c]
Weighted mean			83	88			90	90

Table 18. Errors associated with using IDNR fall electrofishing length frequency data to estimate catch-per-unit effort of age-0 largemouth bass based on the size-age distribution of SIU fall electrofishing samples.

Year	Longest Age-0 bass (in)	Smallest Age-1 bass (in)	Sample Size[b]	Net Overlap
		Coffeen Lake		
1997	10.9	9.0	69	2
1998	8.5	9.4	67	0
1999	9.1	9.3	82	0
2000	10.6	10.8	72	0
2001	9.9	8.6	115	22
2002	9.9	9.8	59	3
2003	10.1	12.0	33	0
2004	11.2	9.6	61	10
Total			558	37 (7)[a]
		Newton Lake		
1997	9.6	7.7	92	1
1998	9.2	8.8	84	1
1999	8.5	7.7	142	6
2000	8.8	8.2	109	2
2001	10.7	6.4	134	20
2002	9.9	8.2	81	14
2003	10.7	9.8	70	2
2004	11.6	9.6	92	17
Total			631	66 (10)[a]

[a]/ Percent error associated with choosing the longest age-0 largemouth bass as the cut off point.
[b]/ Number of age-0 and age-1 bass.

Table 19. Trends in recruitment of largemouth bass in Newton Lake based on electrofishing catch per unit effort (catch per hour) age-0 and age-1+ bass.

Year of Sample	CPU of Age-0		CPU of Age-1	
	Fall Sample		Spring Sample	Fall Sample
	IDNR[a]	SIU[b]	IDNR[c, d]	SIU[b, d]
1996	--	--	--	--
1997	16.7	30.4	1.5	5.6
1998	10.1	8.5	3.0	21.7
1999	12.9	25.0	0.3	4.9
2000	17.8	38.2	3.5	19.7
2001	15.2	8.6	4.7	11.7
2002	12.8	13.7	16.7	15.5
2003	20.8	17.2	6.8	5.5
2004	18.3	27.0	35.6[e]	11.4

[a]/ Largemouth bass in the IDNR fall electrofishing samples less than or equal to the length of the longest age-0 largemouth bass at capture that was aged in each of the SIU fall samples were considered to be age-0 bass.

[b]/ Largemouth bass were aged by examining their saggitae otoliths.

[c]/ Back-calculated length of bass at age-1 for each year was used as the upper cut off lengths for age-1 bass collected by IDNR in their spring samples.

[d]/ The age-1 fish collected in a given spring sample belong to the previous year's age-class.

[e]/ Fall sample. IDNR no longer samples in spring.

Table 20. Trends in recruitment of largemouth bass in Coffeen Lake based on fall electrofishing catch per unit effort (catch per hour) of age-0 and age-1+ bass.

Year of Sample	CPU of Age-0		CPU of age-1
	Fall Sample		Fall Sample
	IDNR[a]	SIU[b]	SIU[b.]
1997	32.0	10.2	4.1
1998	12.6	3.4	5.8
1999	9.9	8.9	6.2
2000	5.1	5.0	3.2
2001	30.0	8.2	8.2
2002	26.6	8.0	13.4
2003	15.3	2.8	5.5
2004	31.9	9.7	3.2

a/ Largemouth bass in the IDNR fall electrofishing samples less than or equal to the length of the longest age-0 largemouth bass at capture that was aged in each of the SIU fall electrofishing samples were considered to be age-0 bass.

b/ Fish were aged by examining their saggittae otoliths.

Table 21. Largemouth bass total lengths (mm) at age when collected during late October through mid-November. Different superscripts indicate total lengths that were statistically significantly different (p=0.05) among years and within ages.

	Age				
Year	0+	1+	2+	3+	4+
			Newton Lake		
1997	$150^{c,d}$	$284^{b,c}$	424^{a}	439^{a}	463^{a}
1998	$141^{c,d,e}$	$313^{a,b}$	$395^{a,b}$	437^{a}	449^{a}
1999	127^{e}	255^{e}	381^{b}	422^{a}	449^{a}
2000	$164^{b,c,d}$	$308^{a,b}$	$393^{a,b}$	429^{a}	431^{a}
2001	193^{a}	$306^{a,b}$	$386^{a,b}$	415^{a}	461^{a}
2002	$189^{a,b}$	329^{a}	372^{b}	448^{a}	481^{a}
2003	$167^{b,c}$	335^{a}	$394^{a,b}$	448^{a}	458^{a}
2004	$185^{a,b}$	$306^{a,b}$	$387^{a,b}$	424^{a}	459^{a}
			Coffeen Lake		
1997	141^{d}	$305^{b,c,d}$	$377^{a,b}$	429^{a}	473^{a}
1998	$140^{c,d}$	$321^{b,c,d}$	377^{b}	395^{a}	451^{a}
1999	$170^{b,c,d}$	310^{c}	$381^{a,b}$	403^{a}	436^{a}
2000	206^{a}	355^{a}	407^{a}	436^{a}	445^{a}
2001	$162^{b,c,d}$	$317^{c,d}$	$392^{a,b}$	439^{a}	458^{a}
2002	$189^{a,b}$	$348^{a,b}$	$397^{a,b}$	428^{a}	--
2003	$189^{a,b,c}$	$348^{a,b,c}$	$391^{a,b,c}$	414^{a}	426^{a}
2004	$181^{a,b}$	$315^{b,c}$	$389^{a,b}$	413^{a}	415^{a}

Table 22. Comparison of the three days in Coffeen Lake during 1998 through 2004 that had the worst habitat conditions. Comparisons are made at 3 ppm dissolved for 4 temperatures. Percent habitats were averaged between Segment 1 and 2.

Temperature (°F)	1998			1999			2000		
	3-Jul	24-Jul	28-Aug	23-Jul	6-Aug	19-Aug	18-Jul	15-Aug	4-Sep
87	0	0	0	0	0	0	0	3	0
90	2	0	5	0	0	33	5	39	3
93	14	16	24	10	21	42	30	44	24
96	34	41	36	27	25	47	42	50	43
	2001			2002[a]			2003		
	10-Jul	24-Jul	8-Aug	6-Jul	8-Jul	1-Aug	8-Jul	20-Aug	27-Aug
87	0	0	0	0	0	0	0	0	0
90	17	2	0	0	0	3	0	0	3
93	29	18	0	3	0	24	12	7	21
96	33	25	21	42	17	31	25	30	29

Table 22. Continued.

Temperature (°F)	2004		
	16-Jun	30-Jun	7-Jul
87	0	2	0
90	9	10	33
93	27	14	35
96	31	21	42

[a]/ In 2002, due to the timing of funding, temperature, oxygen and depth profiles were not formally started until August. However, profiles were taken on July 6 and July 8, 2002.

Table 23. Comparison of the three days in Newton Lake during 1998 through 2004 that had the worst habitat conditions. Comparisons are made at 3 ppm dissolved for 4 temperatures. Percent habitats were averaged in all four segments.

Temperature	1998			1999			2000		
(°F)	26-Jun	11-Jul	24-Aug	24-Jul	5-Aug	18-Aug	13-Jul	28-Jul	1-Sep
87	0	0	0	0	1	31	2	31	4
90	18	22	29	0	21	41	15	41	21
93	29	29	40	7	44	42	30	46	35
96	33	29	43	32	48	52	40	57	44
	2001			2002[a]			2003		
	18-Jun	25-Jul	7-Aug	2-Aug	21-Aug	29-Aug	2-Jul	9-Jul	28-Aug
87	3	0	0	0	34	47	15	0	2
90	37	2	9	9	53	57	26	31	28
93	44	24	26	27	72	69	39	41	40
96	56	32	39	34	79	85	50	53	45

Table 23. Continued.

Temperature (°F)	2004 15-Jun	13-Jul	3-Aug
87	11	0	9
90	34	7	22
93	34	26	32
96	42	30	39

[a]/ In 2002, due to the timing of funding, temperature, oxygen and depth profiles were not formally started until August.

Table 24. Percent habitat among segments at various temperatures and oxygen ranges in Coffeen Lake during May-September 2004. Profiles were taken from 2:00 p.m. to 7:00 p.m.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
05/05/04	87	80	98	100	100	70	90	100	100	60	73	100	100	50	65	100	100
05/05/04	90	93	98	100	100	83	90	100	100	73	73	100	100	63	65	100	100
05/05/04	93	93	98	100	100	83	90	100	100	73	73	100	100	63	65	100	100
05/05/04	96	93	98	100	100	83	90	100	100	73	73	100	100	63	65	100	100
05/12/04	87	68	69	100	100	63	57	100	97	58	43	100	97	53	43	100	90
05/12/04	90	68	69	100	100	63	57	100	97	58	43	100	97	53	43	100	90
05/12/04	93	68	69	100	100	63	57	100	97	58	43	100	97	53	43	100	90
05/12/04	96	68	69	100	100	63	57	100	97	58	43	100	97	53	43	100	90
05/19/04	87	83	63	100	100	68	60	100	100	63	52	100	100	58	52	97	96
05/19/04	90	83	63	100	100	68	60	100	100	63	52	100	100	58	52	97	96
05/19/04	93	83	63	100	100	68	60	100	100	63	52	100	100	58	52	97	96
05/19/04	96	83	63	100	100	68	60	100	100	63	52	100	100	58	52	97	96
05/26/04	87	48	67	91	94	33	63	91	94	33	54	84	94	29	46	78	94
05/26/04	90	62	67	91	94	48	63	91	94	48	54	84	94	43	46	78	94
05/26/04	93	74	67	91	94	60	63	91	94	60	54	84	94	55	46	78	94
05/26/04	96	74	67	91	94	60	63	91	94	60	54	84	94	55	46	78	94
06/02/04	87	29	67	96	91	24	63	96	91	19	59	96	85	14	50	96	74
06/02/04	90	43	67	96	91	38	63	96	91	33	59	96	85	29	50	96	74
06/02/04	93	64	67	96	91	60	63	96	91	55	59	96	85	50	50	96	74
06/02/04	96	64	67	96	91	60	63	96	91	55	59	96	85	50	50	96	74

Table 24. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
06/09/04	87	35	31	47	67	30	27	43	60	30	27	23	53	20	19	17	53
06/09/04	90	40	38	100	83	35	35	97	77	35	35	77	70	25	27	70	70
06/09/04	93	45	52	100	83	40	48	97	77	40	48	77	70	30	40	70	70
06/09/04	96	45	52	100	83	40	48	97	77	40	48	77	70	30	40	70	70
06/16/04	87	5	8	13	0	5	0	13	0	0	0	7	0	0	0	0	0
06/16/04	90	25	20	77	67	25	12	77	67	10	8	70	67	0	8	63	67
06/16/04	93	30	50	97	83	30	42	97	83	15	38	90	83	5	38	83	83
06/16/04	96	35	54	97	83	35	46	97	83	20	42	90	83	10	42	83	83
06/23/04	87	0	42	56	60	0	42	56	60	0	37	56	60	0	32	56	60
06/23/04	90	15	58	81	80	10	58	81	80	5	53	81	80	0	42	81	80
06/23/04	93	15	68	97	97	10	68	97	97	5	63	97	97	0	53	97	97
06/23/04	96	20	82	97	97	15	82	97	97	10	76	97	97	5	66	97	97
06/30/04	87	0	12	25	0	0	4	25	0	0	4	21	0	0	0	7	0
06/30/04	90	15	23	39	40	10	15	39	40	5	15	36	40	0	8	21	40
06/30/04	93	15	31	89	67	10	23	89	67	5	23	86	67	0	15	71	67
06/30/04	96	20	38	100	77	15	31	100	77	10	31	96	77	5	23	82	77
07/07/04	87	0	8	40	35	0	4	40	35	0	0	13	35	0	0	7	35
07/07/04	90	25	58	97	100	20	54	97	100	15	50	70	100	10	46	63	100
07/07/04	93	30	58	97	100	25	54	97	100	20	50	70	100	15	46	63	100
07/07/04	96	45	58	97	100	40	54	97	100	35	50	70	100	30	46	63	100

Table 24. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
07/14/04	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07/14/04	90	20	8	36	36	10	4	29	36	0	4	21	36	0	0	21	29
07/14/04	93	35	48	61	89	25	44	54	89	15	44	46	89	10	40	46	82
07/14/04	96	35	48	61	89	25	44	54	89	15	44	46	89	10	40	46	82
07/21/04	87	0	0	11	0	0	0	11	0	0	0	11	0	0	0	0	0
07/21/04	90	30	35	32	46	25	26	32	46	20	22	32	38	10	17	14	38
07/21/04	93	40	48	75	96	35	39	75	96	30	35	75	88	20	30	57	88
07/21/04	96	45	48	100	96	40	39	100	96	35	35	100	88	25	30	82	88
07/28/04	87	19	33			14	29			0	21			0	13		
07/28/04	90	24	50			19	46			5	38			0	29		
07/28/04	93	24	58			19	54			5	46			0	38		
07/28/04	96	24	67			19	63			5	54			0	46		
08/04/04	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/04/04	90	10	13	25	14	5	9	17	14	0	4	8	7	0	4	8	7
08/04/04	93	29	28	71	75	24	24	63	75	19	20	54	68	14	20	54	68
08/04/04	96	33	54	71	75	29	50	63	75	24	46	54	68	19	46	54	68
08/11/04	87	0	35	60	50	0	35	60	50	0	30	60	50	0	20	60	50
08/11/04	90	42	78	97	96	33	78	97	96	33	73	97	96	17	63	97	96
08/11/04	93	42	78	97	96	33	78	97	96	33	73	97	96	17	63	97	96
08/11/04	96	50	78	97	96	42	78	97	96	42	73	97	96	25	63	97	96

Table 24. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
08/18/04	87	24	45	43	47	24	27	43	47	19	23	36	40	14	14	29	40
08/18/04	90	29	55	96	83	29	36	96	83	24	32	89	77	19	23	82	77
08/18/04	93	33	75	96	83	33	57	96	83	29	52	89	77	24	43	82	77
08/18/04	96	33	75	96	83	33	57	96	83	29	52	89	77	24	43	82	77
08/25/04	87	9	21	16	43	4	21	16	43	0	13	16	43	0	8	16	43
08/25/04	90	22	33	91	96	17	33	91	96	13	25	91	96	9	21	91	96
08/25/04	93	26	60	91	96	22	60	91	96	17	52	91	96	13	48	91	96
08/25/04	96	26	60	91	96	22	60	91	96	17	52	91	96	13	48	91	96
09/01/04	87	10	28	33	29	0	20	33	21	0	12	33	14	0	8	27	0
09/01/04	90	30	40	40	64	20	32	40	57	15	24	40	50	10	20	33	36
09/01/04	93	30	44	60	79	20	36	60	71	15	28	60	64	10	24	53	50
09/01/04	96	30	44	97	96	20	36	97	89	15	28	97	82	10	24	90	68
09/10/04	87	53	44	27	50	37	44	27	50	5	40	27	50	0	32	27	50
09/10/04	90	58	52	70	84	42	52	70	84	11	48	70	84	0	40	70	84
09/10/04	93	58	52	90	91	42	52	90	91	11	48	90	91	0	40	90	91
09/10/04	96	63	66	90	91	47	66	90	91	16	62	90	91	5	54	90	91
09/15/04	87	10	23	11	41	5	23	11	41	5	18	11	41	0	14	11	29
09/15/04	90	20	39	81	91	15	39	81	91	15	34	81	91	10	30	81	79
09/15/04	93	20	61	81	91	15	61	81	91	15	57	81	91	10	52	81	79
09/15/04	96	25	61	81	91	20	61	81	91	20	57	81	91	15	52	81	79

Table 24. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
09/22/04	87	35	42	75	71	25	38	75	71	20	33	75	71	10	25	71	71
09/22/04	90	35	46	100	96	25	42	100	96	20	38	100	96	10	29	96	96
09/22/04	93	35	54	100	96	25	50	100	96	20	46	100	96	10	38	96	96
09/22/04	96	40	65	100	96	30	60	100	96	25	56	100	96	15	48	96	96

Table 25. Percent habitat among segments at various temperatures and oxygen ranges in Newton Lake during May-September 2004. Profiles were taken from 12:00 p.m. to 6:30 p.m.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
05/04/04	87	100	100	100	100	100	100	100	100	100	100	100	100	100	96	100	100
05/04/04	90	100	100	100	100	100	100	100	100	100	100	100	100	100	96	100	100
05/04/04	93	100	100	100	100	100	100	100	100	100	100	100	100	100	96	100	100
05/04/04	96	100	100	100	100	100	100	100	100	100	100	100	100	100	96	100	100
05/11/04	87	19	47	82	100	0	47	76	100	0	40	66	100	0	33	50	94
05/11/04	90	44	47	82	100	25	47	76	100	25	40	66	100	25	33	50	94
05/11/04	93	69	60	82	100	50	60	76	100	50	53	66	100	50	47	50	94
05/11/04	96	100	77	82	100	81	77	76	100	81	70	66	100	81	63	50	94
05/18/04	87	7	43	64	100	7	36	58	100	7	21	53	100	7	14	53	100
05/18/04	90	21	50	64	100	21	43	58	100	21	29	53	100	21	21	53	100
05/18/04	93	79	75	64	100	79	68	58	100	79	54	53	100	79	46	53	100
05/18/04	96	100	75	64	100	100	68	58	100	100	54	53	100	100	46	53	100
05/25/04	87	25	36			25	29			13	21			0	7		
05/25/04	90	25	36			25	29			13	21			0	7		
05/25/04	93	63	50			63	43			50	36			38	21		
05/25/04	96	94	68			94	61			81	54			69	39		
06/01/04	87	6	77	82	100	0	70	76	100	0	57	71	100	0	50	71	100
06/01/04	90	50	77	82	100	44	70	76	100	44	57	71	100	44	50	71	100
06/01/04	93	100	77	82	100	94	70	76	100	94	57	71	100	94	50	71	100
06/01/04	96	100	77	82	100	94	70	76	100	94	57	71	100	94	50	71	100

Table 25. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
06/08/04	87	0	25	55	100	0	19	55	100	0	0	45	95	0	0	45	95
06/08/04	90	11	25	63	100	11	19	63	100	11	0	53	95	11	0	53	95
06/08/04	93	11	38	63	100	11	31	63	100	11	13	53	95	11	13	53	95
06/08/04	96	44	59	63	100	44	53	63	100	44	34	53	95	44	34	53	95
06/15/04	87	0	13	16	40	0	7	11	30	0	7	5	30	0	0	5	30
06/15/04	90	0	20	50	95	0	13	45	85	0	13	39	85	0	0	39	85
06/15/04	93	0	20	50	95	0	13	45	85	0	13	39	85	0	0	39	85
06/15/04	96	25	27	50	95	25	20	45	85	25	20	39	85	13	0	39	85
06/22/04	87	0	13	64	100	0	7	64	100	0	0	64	100	0	0	53	100
06/22/04	90	13	33	64	100	13	27	64	100	13	20	64	100	0	13	53	100
06/22/04	93	81	63	64	100	81	57	64	100	81	50	64	100	69	43	53	100
06/22/04	96	81	63	64	100	81	57	64	100	81	50	64	100	69	43	53	100
06/29/04	87	0	19	47	73	0	6	42	64	0	6	37	55	0	0	32	55
06/29/04	90	13	25	53	86	13	13	47	77	0	13	42	68	0	6	37	68
06/29/04	93	25	44	61	86	25	31	55	77	13	31	50	68	13	25	45	68
06/29/04	96	69	53	61	86	69	41	55	77	56	41	50	68	56	34	45	68
07/06/04	87	0	0	56	100	0	0	50	100	0	0	44	100	0	0	39	95
07/06/04	90	6	31	64	100	6	31	58	100	6	31	53	100	6	31	47	95
07/06/04	93	100	53	64	100	100	53	58	100	100	53	53	100	100	53	47	95
07/06/04	96	100	53	64	100	100	53	58	100	100	53	53	100	100	53	47	95

Table 25. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
07/13/04	87	0	0	6	8	0	0	6	8	0	0	0	0	0	0	0	0
07/13/04	90	0	6	17	25	0	0	17	25	0	0	11	17	0	0	6	17
07/13/04	93	14	13	47	71	14	6	47	71	0	0	42	63	0	0	36	63
07/13/04	96	14	25	47	71	14	19	47	71	0	13	42	63	0	13	36	63
07/20/04	87	0	0	6	17	0	0	6	17	0	0	6	17	0	0	0	17
07/20/04	90	0	0	58	100	0	0	58	100	0	0	58	100	0	0	53	100
07/20/04	93	0	7	58	100	0	7	58	100	0	0	58	100	0	0	53	100
07/20/04	96	63	50	58	100	63	50	58	100	63	43	58	100	63	43	53	100
07/27/04	87	25	78	86	88	13	68	86	88	13	63	86	88	13	58	86	88
07/27/04	90	81	78	86	88	69	68	86	88	69	63	86	88	69	58	86	88
07/27/04	93	94	78	86	88	81	68	86	88	81	63	86	88	81	58	86	88
07/27/04	96	94	78	86	88	81	68	86	88	81	63	86	88	81	58	86	88
08/03/04	87	0	17	32	18	0	11	21	18	0	0	16	18	0	0	16	9
08/03/04	90	20	22	37	55	10	11	26	55	10	0	21	55	10	0	21	45
08/03/04	93	30	22	47	77	20	11	37	77	20	0	32	77	20	0	32	68
08/03/04	96	40	33	55	77	30	22	45	77	30	11	39	77	30	11	39	68
08/10/04	87	0	12	44	88	0	0	39	88	0	0	33	88	0	0	28	88
08/10/04	90	22	18	75	88	22	6	69	88	22	0	64	88	22	0	58	88
08/10/04	93	44	24	75	88	44	12	69	88	44	6	64	88	44	6	58	88
08/10/04	96	83	44	75	88	83	32	69	88	83	26	64	88	83	26	58	88

Table 25. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
08/17/04	87	0	13	92	95	0	13	86	95	0	6	81	95	0	6	81	95
08/17/04	90	0	53	92	95	0	53	86	95	0	47	81	95	0	47	81	95
08/17/04	93	67	53	92	95	67	53	86	95	67	47	81	95	67	47	81	95
08/17/04	96	83	53	92	95	83	53	86	95	83	47	81	95	83	47	81	95
08/25/04	87	0	17	75	86	0	0	75	86	0	0	75	86	0	0	69	86
08/25/04	90	6	42	75	86	0	17	75	86	0	17	75	86	0	17	69	86
08/25/04	93	100	79	75	86	94	54	75	86	94	54	75	86	94	54	69	86
08/25/04	96	100	79	75	86	94	54	75	86	94	54	75	86	94	54	69	86
08/31/04	87	22	38	74	82	11	31	68	82	0	25	68	82	0	25	53	73
08/31/04	90	44	50	82	95	33	44	76	95	22	38	76	95	22	38	61	86
08/31/04	93	67	56	82	95	56	50	76	95	44	44	76	95	44	44	61	86
08/31/04	96	94	66	82	95	83	59	76	95	72	53	76	95	72	53	61	86
09/07/04	87	0	0	81	95	0	0	81	95	0	0	81	85	0	0	81	85
09/07/04	90	0	57	81	95	0	57	81	95	0	57	81	85	0	57	81	85
09/07/04	93	33	57	81	95	33	57	81	95	33	57	81	85	22	57	81	85
09/07/04	96	61	57	81	95	61	57	81	95	61	57	81	85	50	57	81	85
09/14/04	87	0	0	79	100	0	0	79	100	0	0	74	100	0	0	74	100
09/14/04	90	0	20	79	100	0	20	79	100	0	20	74	100	0	20	74	100
09/14/04	93	100	43	79	100	100	43	79	100	100	43	74	100	94	43	74	100
09/14/04	96	100	43	79	100	100	43	79	100	100	43	74	100	94	43	74	100

Table 25. Continued.

		Dissolved Oxygen															
		1 ppm				2 ppm				3 ppm				4 ppm			
	Temperature	Segment				Segment				Segment				Segment			
Date	(°F)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
09/21/04	87	13	53	92	100	13	27	92	100	0	13	92	100	0	13	81	100
09/21/04	90	38	77	92	100	38	50	92	100	25	37	92	100	25	37	81	100
09/21/04	93	94	77	92	100	94	50	92	100	81	37	92	100	81	37	81	100
09/21/04	96	94	77	92	100	94	50	92	100	81	37	92	100	81	37	81	100

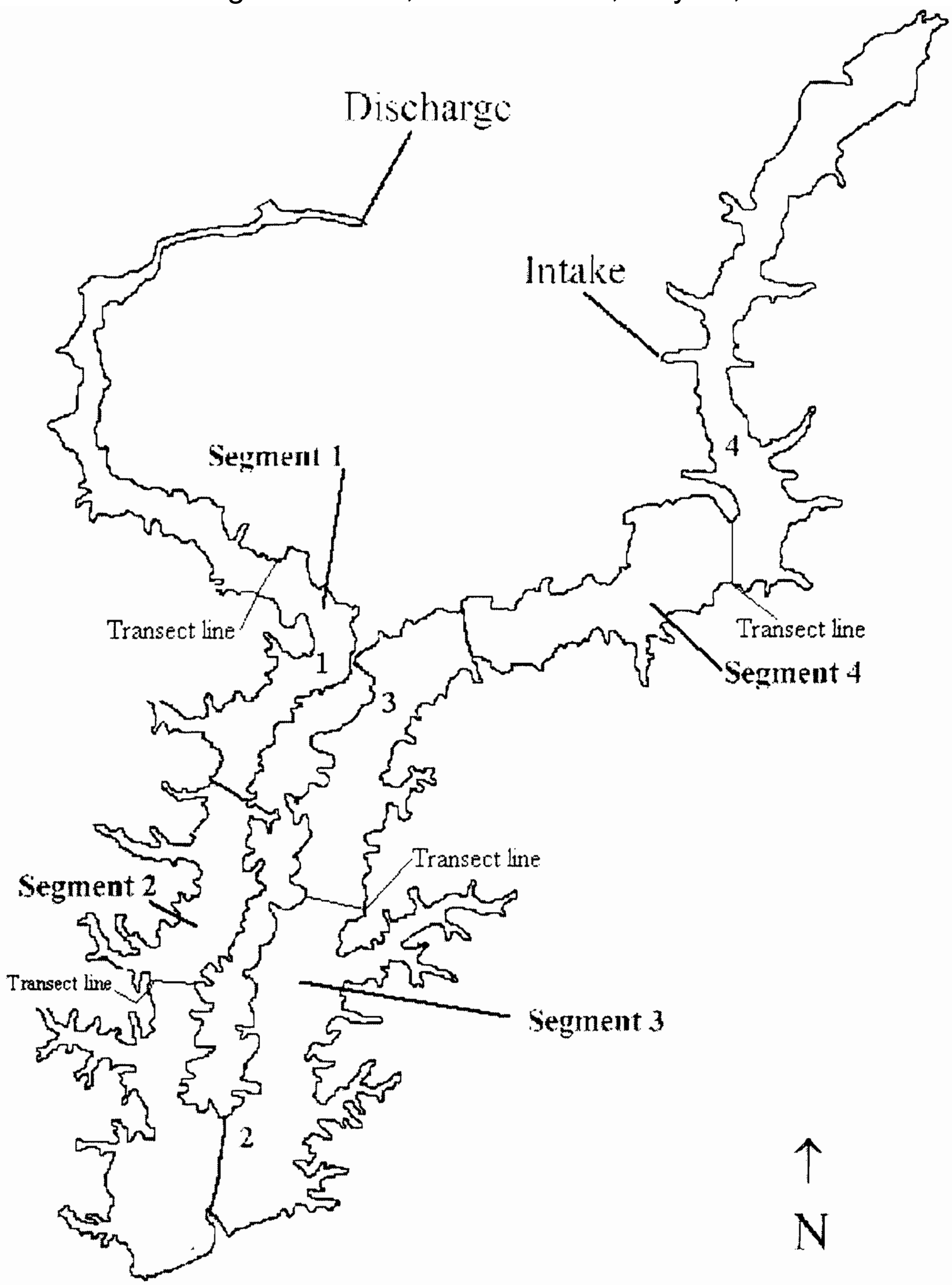


Figure 1. Newton Lake with four segments where sampling was conducted. Water temperature and dissolved oxygen were sampled at each transect line from August 1997 through 2004. Numbers represent locations of continuous temperature recorders.

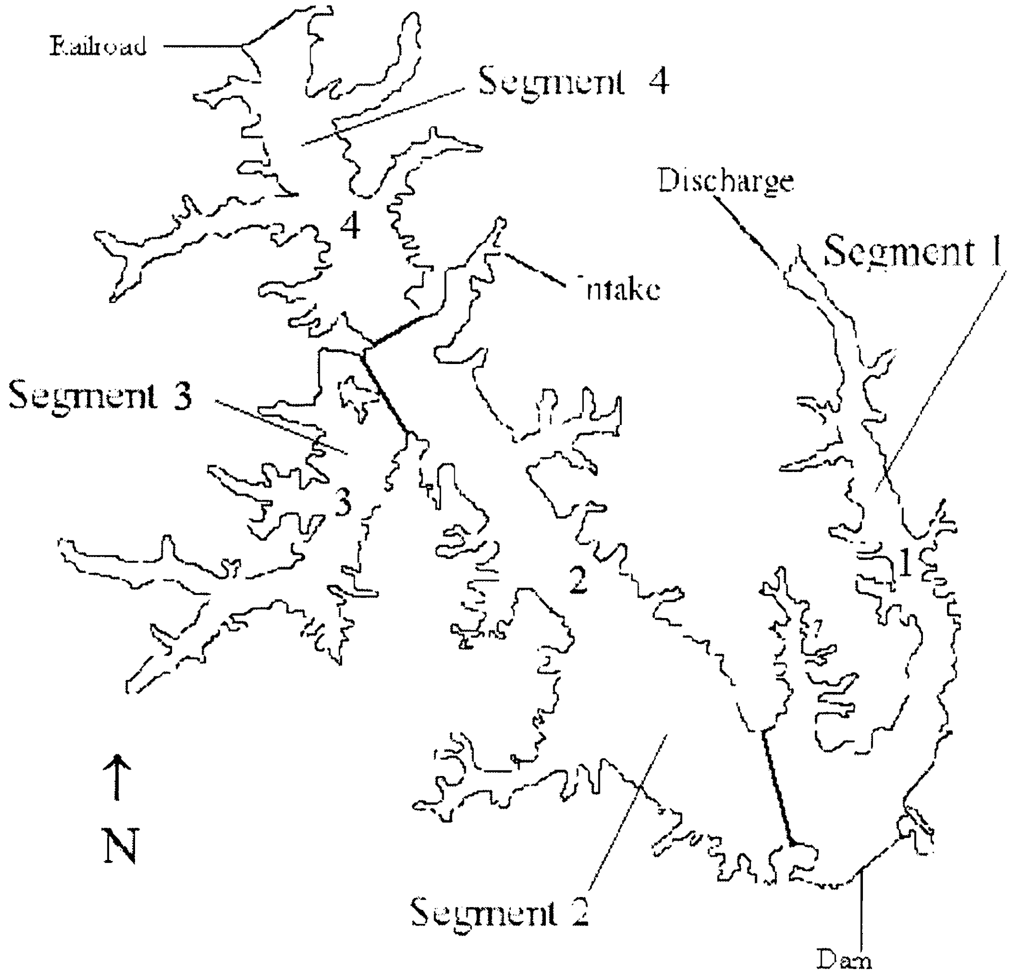


Figure 2. Coffeen Lake with two segments where sampling was conducted for water temperature and dissolved oxygen from August 1997 through 2004. Segments 3 and 4 were added in 2000. Sampling sites are represented by numbers inside lake borders.

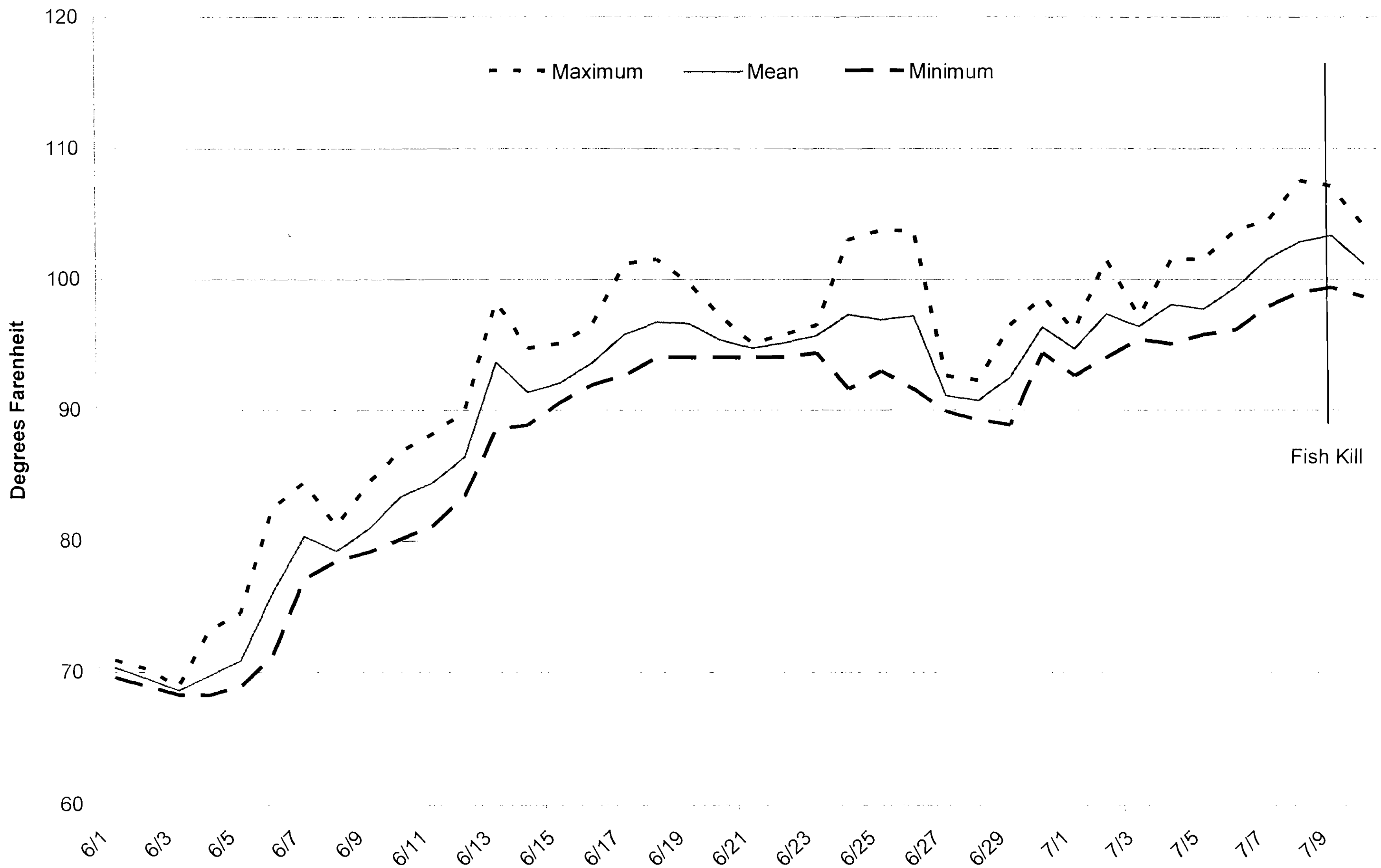


Figure 3. Mean, minimum and maximum daily temperatures during 2001 in the Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

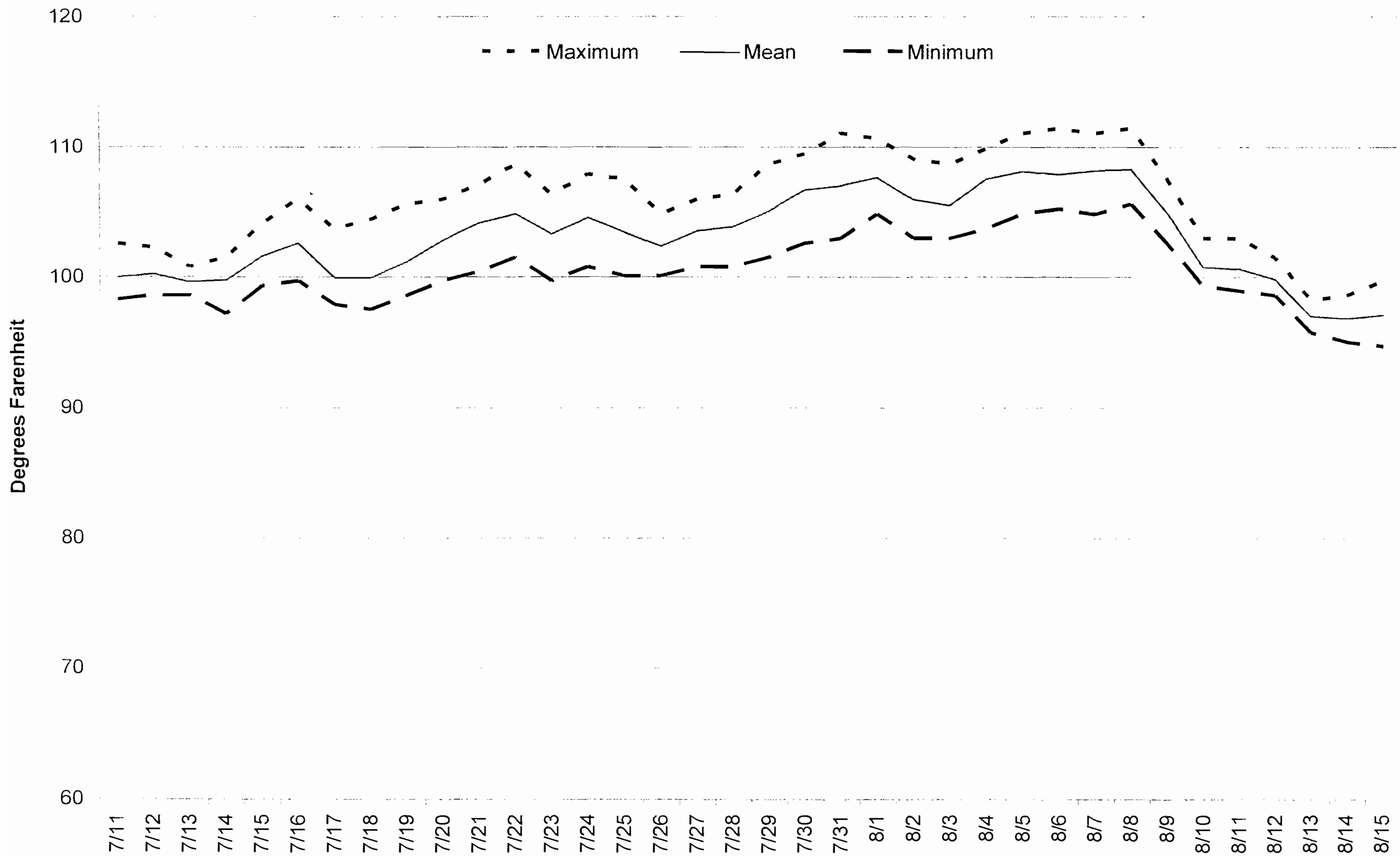


Figure 4. Mean, minimum and maximum daily temperatures during 2001in the Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

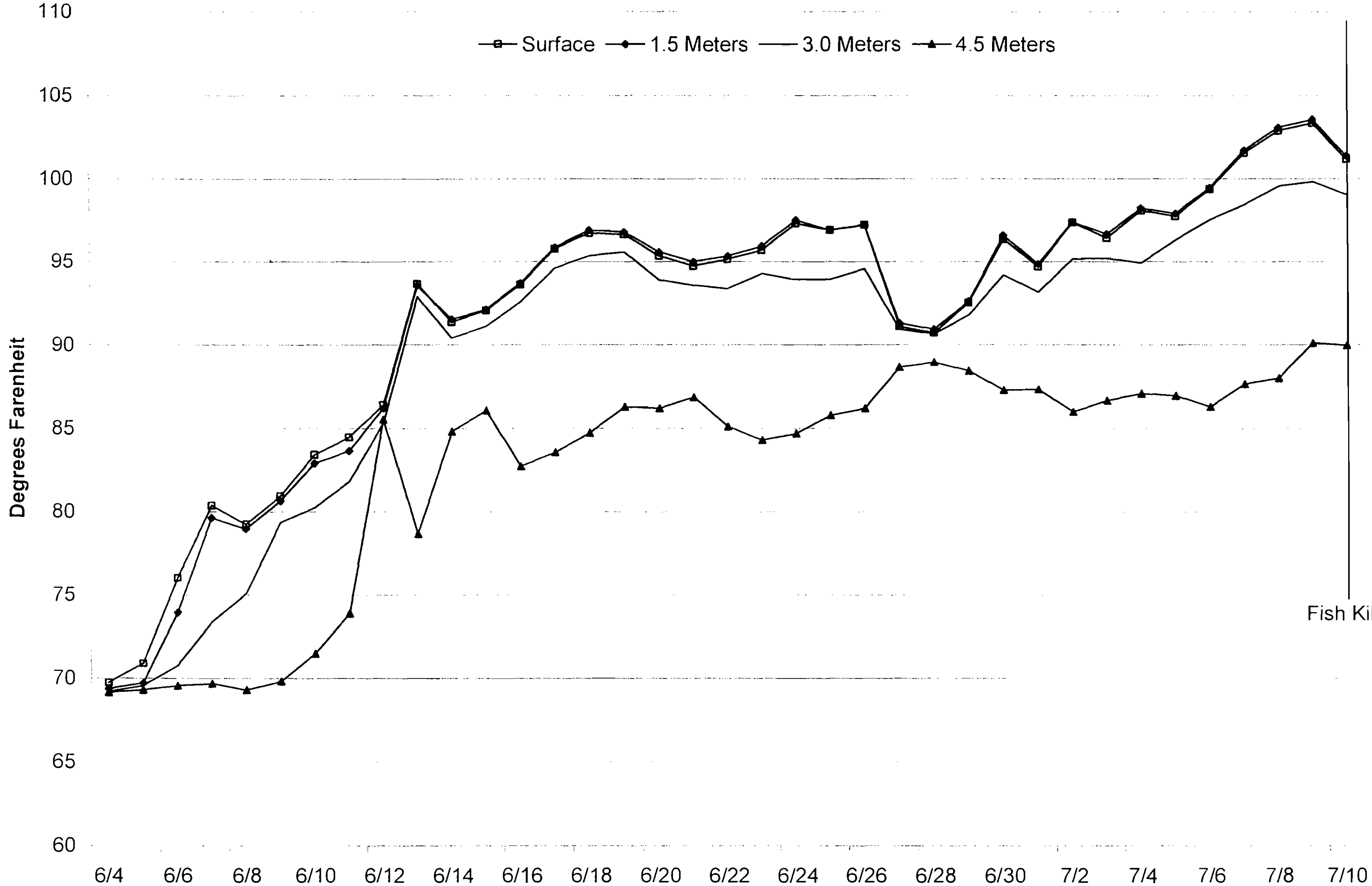


Figure 5. Mean daily temperatures at four water levels during 2001in the Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

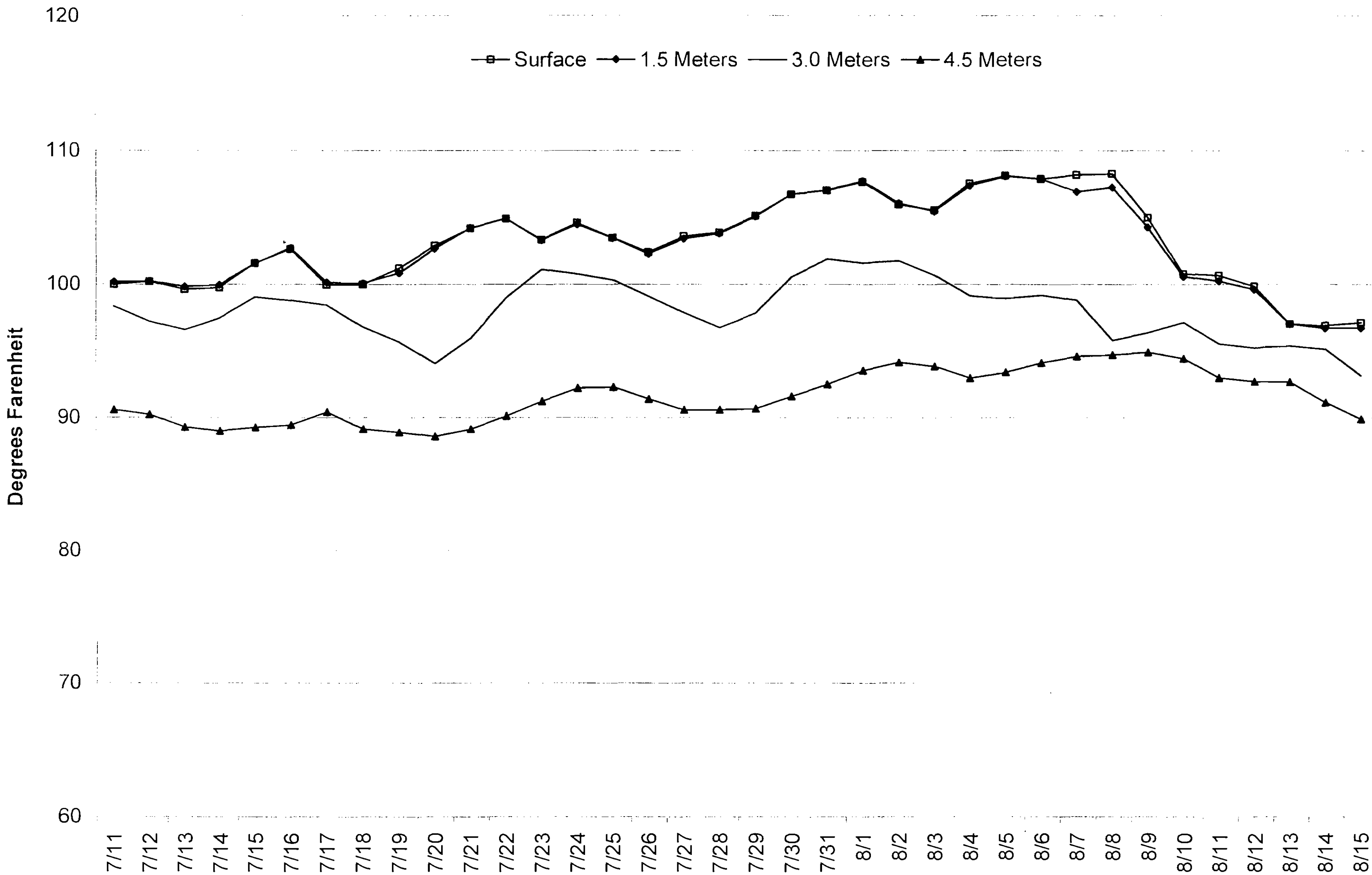


Figure 6. Mean daily temperatures at four water levels during 2001in the Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

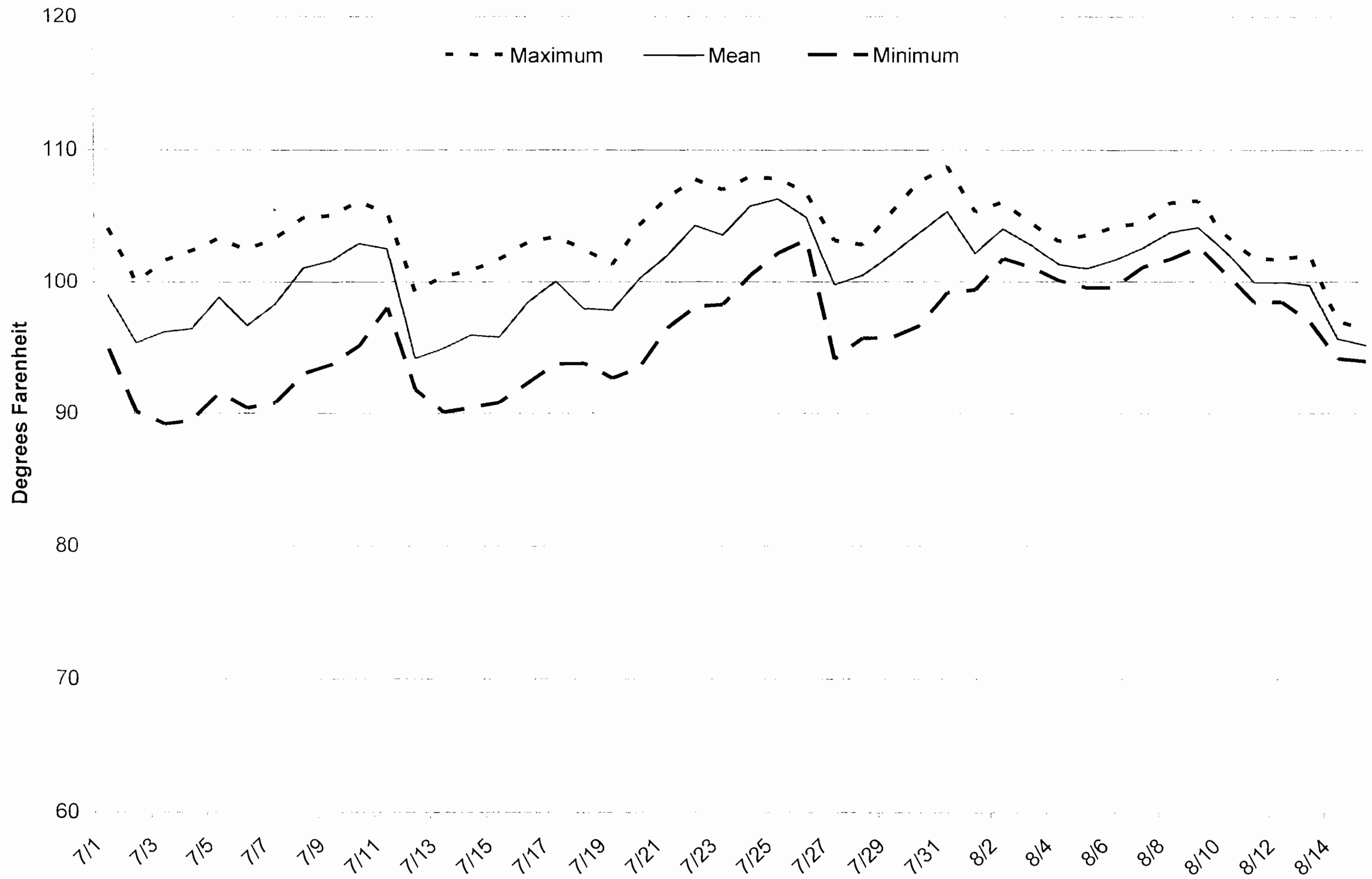


Figure 7. Mean daily temperatures at four water levels during 2001in the Newton Lake mixing zone. Lake bottom is approximately 18.0 feet.

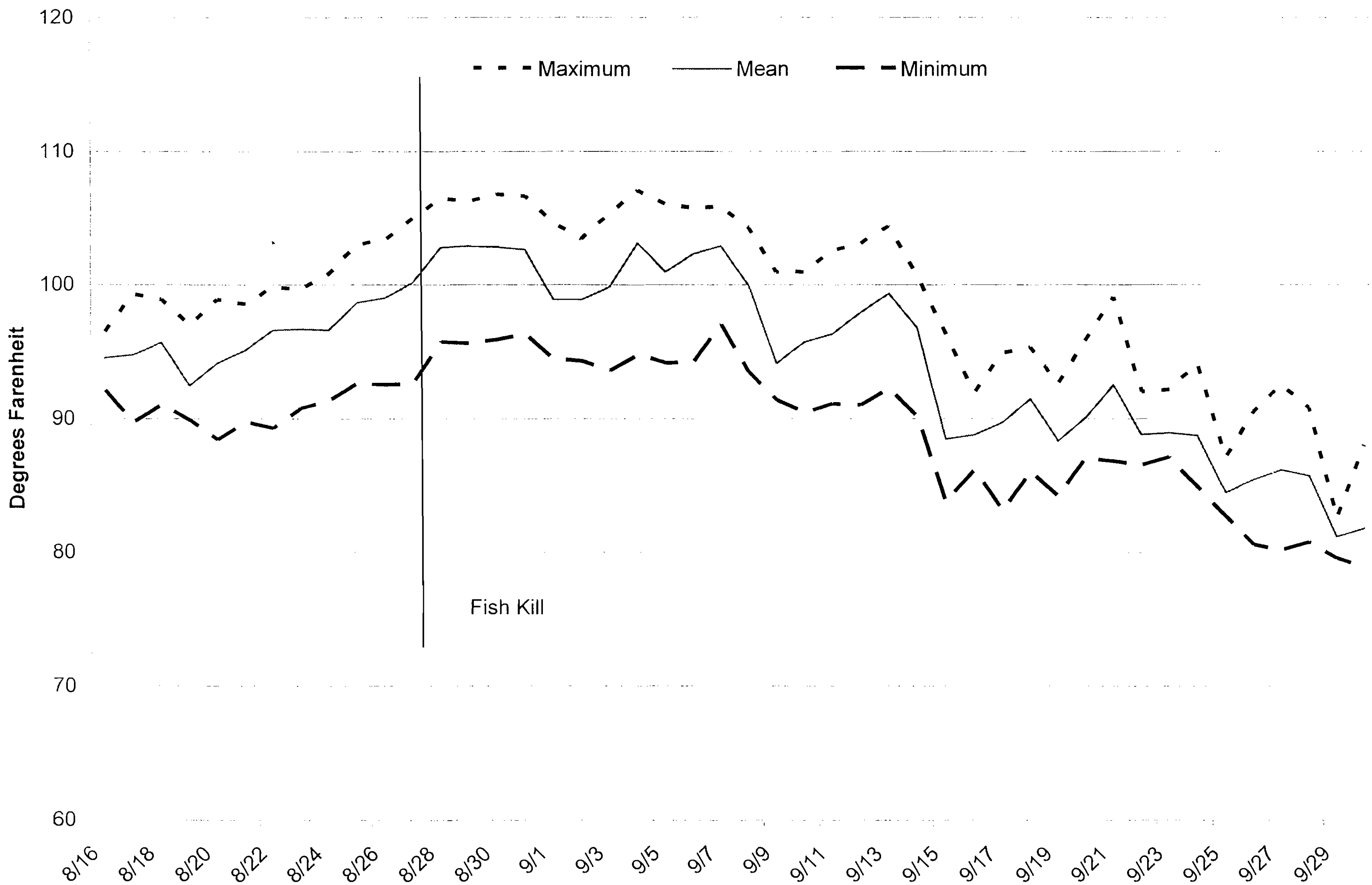


Figure 8. Mean daily temperatures at four water levels during 2001in the Newton Lake mixing zone. Lake bottom is approximately 18.0 feet.

Figure 9. Mean daily temperatures at four water levels during 2002 in the Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

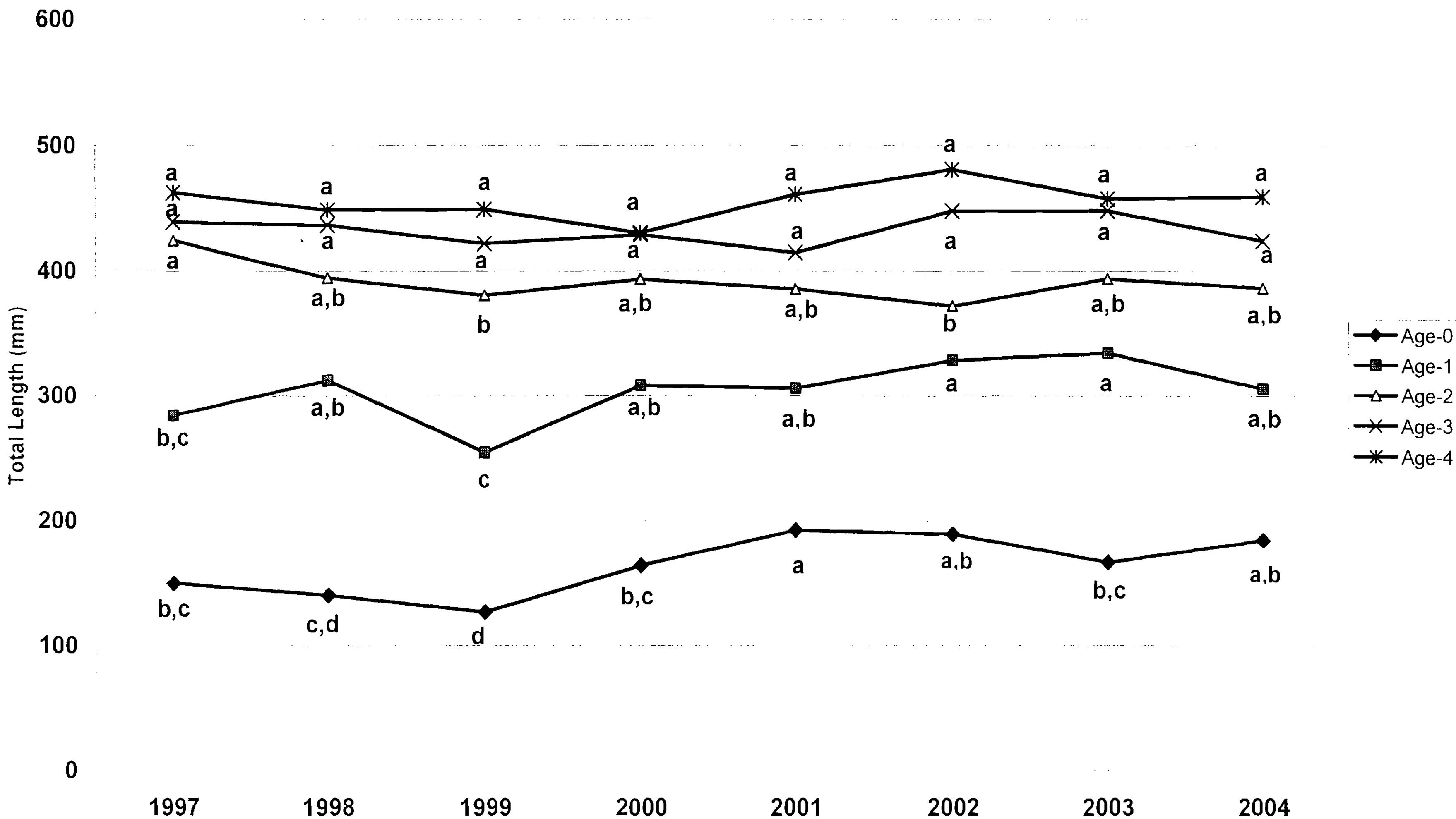


Figure 10. Growth rates of largemouth bass during 1997-2004 in Newton Lake based on fish aged from their otoliths. Lengths within ages that have the same letter are not statistically different at p=0.05.

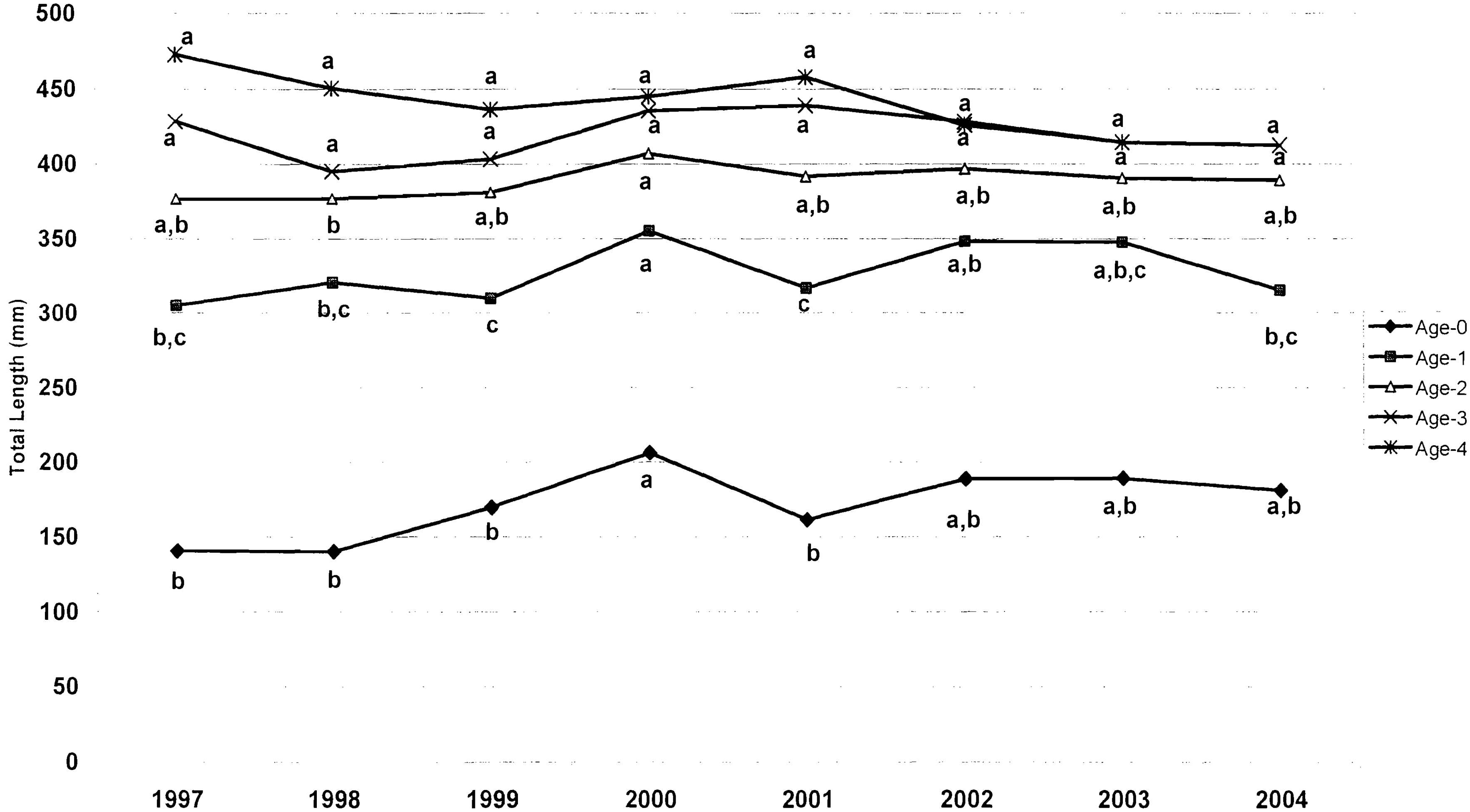


Figure 11. Growth rates of largemouth bass during 1997-2004 in Coffeen Lake based on fish aged from their otoliths. Lengths within ages that have the same letter are not statistically significant different at p=0.05.

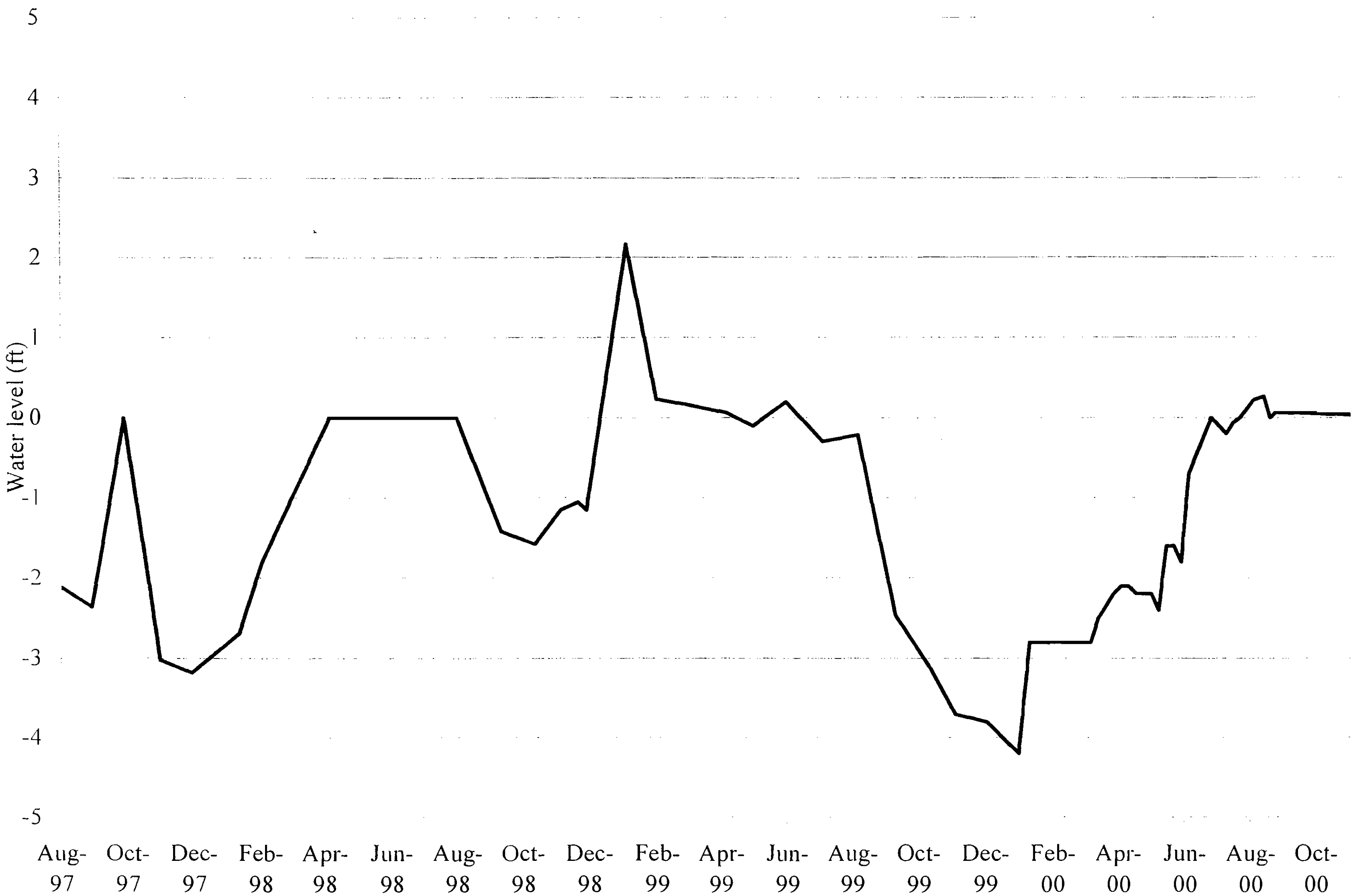


Figure 12. Water levels (feet) in relation to pool level in Newton Lake during 1997-2000.

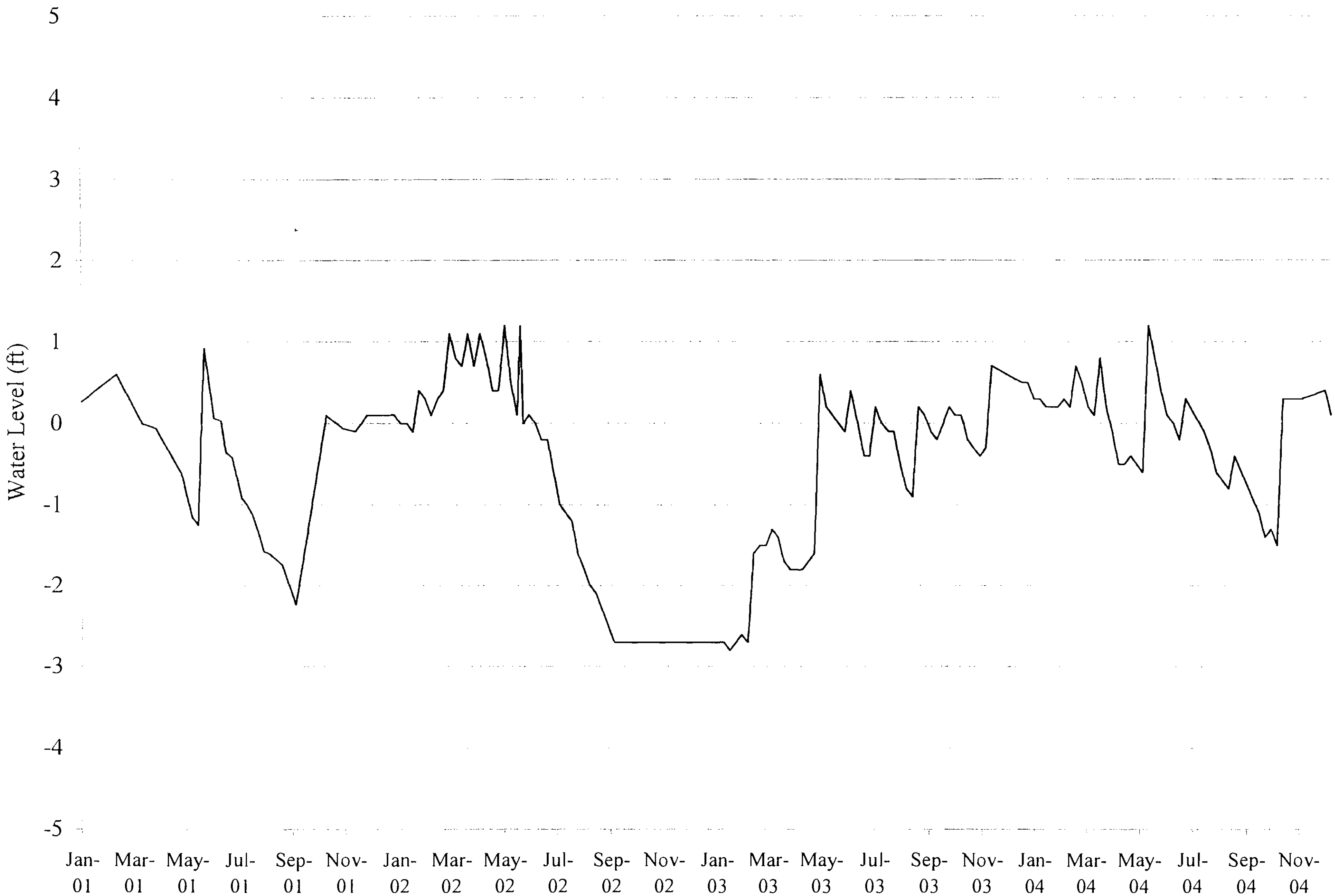


Figure 13. Water levels (feet) in relation to pool level in Newton Lake during 2001-2004.

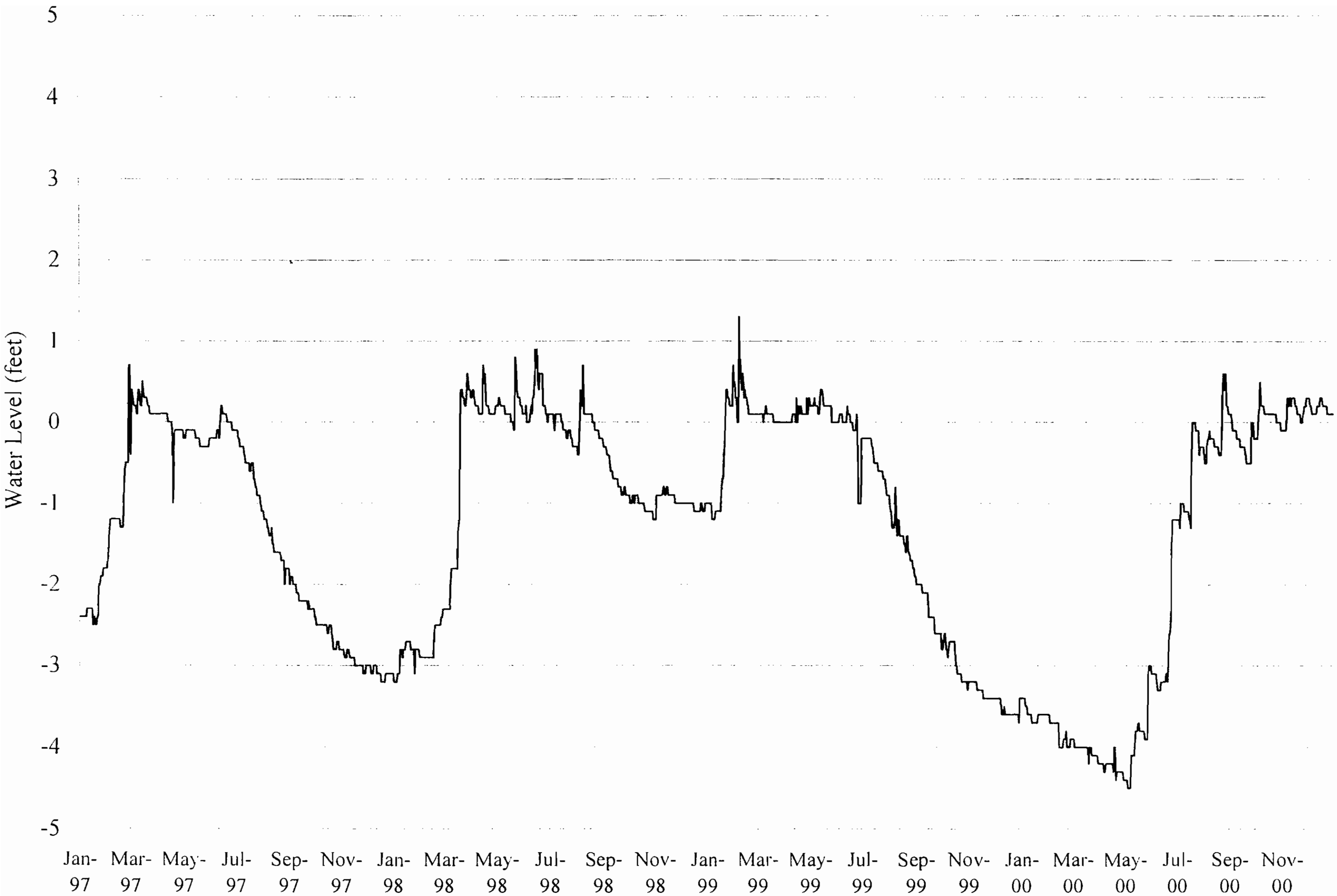


Figure 14. Water levels (feet) in relation to pool level in Coffeen Lake during 1997-2000.

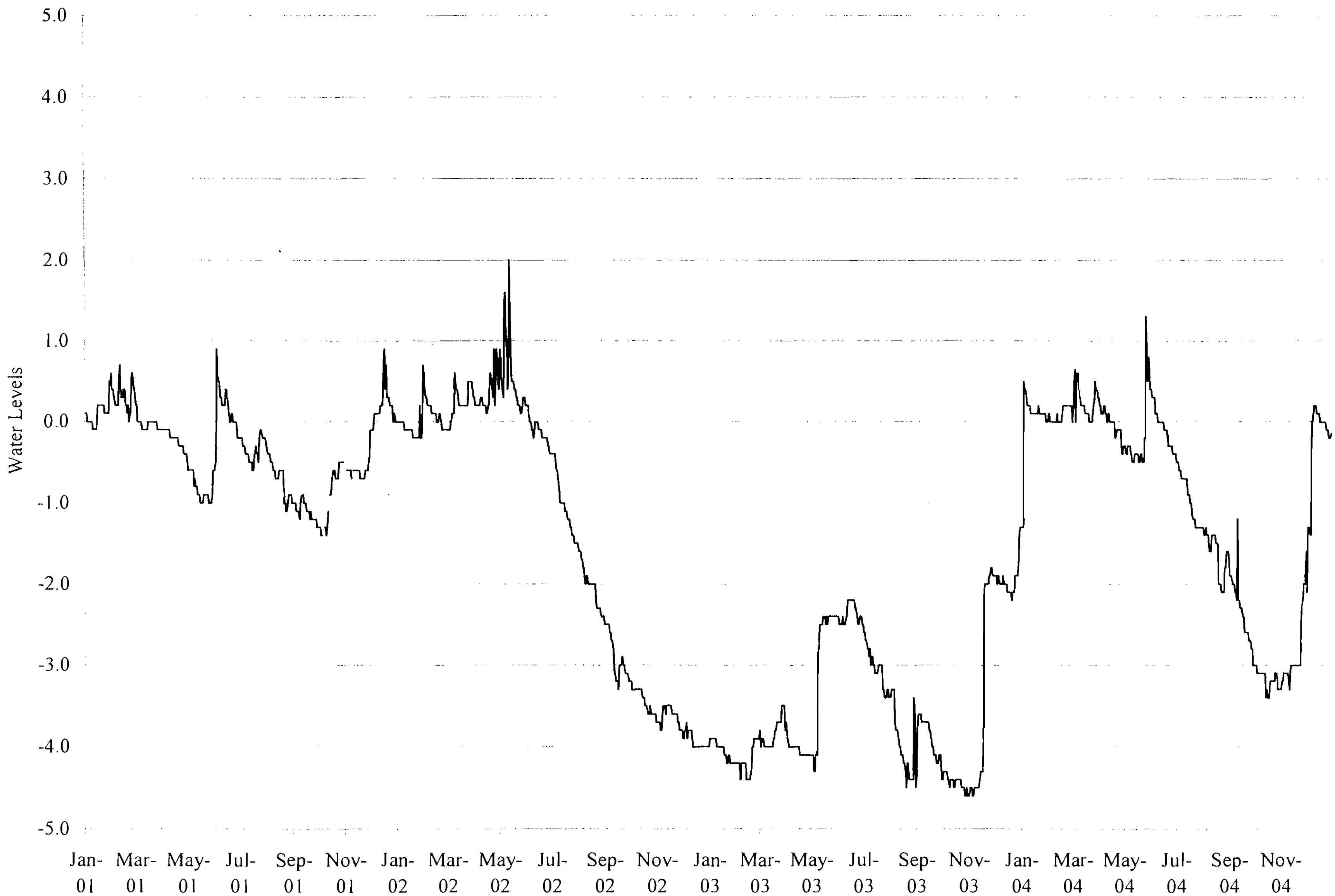


Figure 15. Water levels (feet) in relation to pool level in Coffeen Lake during 2001-2004.

Appendix A: Age, Growth, and Relative Weight

Introduction:

The purpose of this portion of the study is to compare the age, growth, and relative weight results of the 1997-2004 study to the results of the past year. This is being done to determine the impacts, if any, of the July 1999 fish kill on the fish population in Newton Lake and Coffeen Lake (Heidinger et. al. 2000).

Methods:

Fish were collected from Newton Lake during October, November, and December 1997-2004 for age and growth analysis. AC electrofishing was used in an attempt to capture 100 each largemouth bass, bluegill, channel catfish, and white crappie (1997-2004). It was recognized that it might not be possible to obtain 100 crappie and channel catfish from each lake. At least one additional trip was made in attempt to collect fish from age groups that were not collected during the first sampling trip.

Channel catfish were aged using pectoral spines. The spines were sectioned with a variable speed Isomet saw equipped with a diamond blade. The otolith is the only reliable structure for aging most scaled fish and has proven to be a reliable hard part for age and growth analysis on scaled fish in Illinois power cooling lakes (Heidinger and Clodfelter 1987). Thus, it was necessary to sacrifice scaled fish in order to obtain the paired saggittae otoliths. All fish were brought back to the laboratory on ice, identified, weighed, and measured. Their saggittae otoliths were removed, and age and growth were determined. All spines and otoliths were aged by two experienced readers. If ages differed, the readers tried to reach an agreement. If no agreement was possible, the fish was eliminated from the sample.

Back calculations were performed on all aged fish by year-class. For example, age-2+ fish were back calculated to 2 years old only, age-1+ fish were back calculated to 1 year old only, and so on. Back calculated weights were determined using a lake and species specific regression of length at capture versus weight at capture.

There were a few moribund fish collected during 1999 and measured but not weighed, and their saggitae otoliths were removed and utilized in analysis of age and growth data. Since they were not weighed, they were omitted from the relative weight analysis. Other fish which died while implanting temperature tags or which were returned with temperature tags were used for age and growth analyses but not relative weight analysis. Relative weights were calculated using the most recent formulas given in Anderson and Neumann (1996).

Literature Cited:

Anderson, R. O. and Neumann. 1996. Length, weight, and associated structural indices. Pages 447-482 *in* Brian R. Murphy and David W. Willis, editors, Fisheries techniques, second edition. Education Section, American Fisheries Society, Bethesda, Maryland, USA.

Heidinger, R.C., and K.C. Clodfelter. 1987. Validity of the otolith for determining age and growth of walleye, striped bass, and smallmouth bass in power cooling ponds. Pages 241-251 *In* R.C. Summerfelt and G.E. Hall (eds.). Age and Growth of Fish. Iowa State University Press, Ames Iowa.

Heidinger, R.C., R. Sheehan, and R. C. Brooks. 2000. Amerin CIPS Newton Lake Project Vol. I, Vol. II, Final Report 15 August 1997 - 30 August 1999. Fisheries Research Laboratory and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Table A1. The age, number, back-calculated mean length, and derived weight of largemouth bass collected from Newton Lake during 2000 - 2004. Numbers, relative weights, total number per sample, and mean relative weights are shown for the Fish Health Assessment during March (Spring) and Age and Growth during October and November (Fall) samples.

2000

Age	No.	Mean length (in.)	Mean weight[1] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	45	7.48	0.24	0	--	45	109
2	14	13.88	1.62	3	102	11	117
3	25	15.94	2.54	6	111	14	113
4	8	16.89	3.08	3	104	5	112
5	5	17.97	3.76	0	--	4	116
6	1	18.07	3.79	0	--	0	--
7	1	18.58	3.94	0	--	1	137
Total Numbers & Mean Relative Weights				12	107	80	112

2001

Age	No.	Mean length (in.)	Mean weight[3] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	66	6.78	0.14			63	109
2	45	12.47	1.08			44	114
3	5	15.32	2.13			5	103
4	18	17.29	3.17			13	99
5	3	18.30	3.83			2	103
6	3	17.61	3.37			3	96
7	2	19.26	4.53			2	107
8	2	19.40	4.63			1	99
Total Numbers & Mean Relative Weights						133	109

Table A1. Continued.

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	43	7.97	0.28			43	100
2	20	12.60	1.11			20	102
3	3	16.30	2.48			3	103
4	1	18.10	3.42			1	103
5	3	18.90	4.04			3	103
Total Numbers & Mean Relative Weights						70	100

2003

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	17	8.1	0.34			17	101
2	19	13.9	1.55			19	106
3	7	16.45	2.64			7	107
4	3	17.45	3.25			3	107
Total Numbers & Mean Relative Weights						46	104

2004

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	26	8.23	0.35			26	96
2	2	13.27	1.32			2	103
3	4	15.88	2.32			4	105
4	3	17.68	3.30			3	106
Total Numbers & Mean Relative Weights						35	104

[1] / Year 2000: Log (weight(lb)) = -3.4620732 + 3.2165256 (Log (length(in))) R^2 = 0.9999

[2] / Relative weight is based on length and weight at capture.

[3]/ Year 2001: Log (weight(lb)) = -3.582035 + 3.2989443 (Log (length(in))) R^2 = 0.9920.

[4] / Year 2002: Log (weight(lb)) = -3.53113 + 3.23442 (Log (length(in))) R^2 = 0.9754.

[5] / Year 2003: Log (weight(lb)) = -3.54714 + 3.26140 (Log (length(in))) R^2 = 0.9910.

[6] / Year 2004: Log (weight(lb)) = -3.61706 + 3.31372 (Log (length(in))) R^2 = 0.9852.

Table A2. The age, number, back-calculated mean length, and derived weight of largemouth bass collected from Coffeen Lake during 2000 - 2004. Numbers, relative weights, total number per sample, and mean relative weights are shown for the Fish Health Assessment during March (Spring) and Age and Growth during October and November (Fall) samples.

2000

				Spring		Fall	
Age	No.	Mean length (in.)	Mean weight[1] (lb)	No.	Relative weight[2]	No.	Relative weight[2]
1	28	9.14	0.44	0	--	28	106
2	26	13.95	1.61	4	94	22	113
3	29	16.07	2.48	9	101	19	107
4	9	16.34	2.65	1	88	8	110
5	2	17.15	3.04	0	--	2	102
6	--	--	--	0	--	0	--
7	1	18.58	3.94	0	--	1	137
8	--	--	--	0	--	0	--
9	--	--	--	0	--	0	--
10	--	--	--	0	--	0	--
11	1	20.98	5.84	0	--	0	--
Total Numbers & Mean Relative Weights				14	98	80	109

2001

				Spring		Fall	
Age	No.	Mean length (in.)	Mean weight[3] (lb)	No.	Relative weight[2]	No.	Relative weight[2]
1	58	6.48	0.13			58	110
2	24	13.20	1.31			24	109
3	5	16.23	2.56			5	115
4	9	17.25	3.13			9	104
5	--	--	--			0	--
6	1	18.58	3.98			1	92
7	--	--	--			0	--
8	--	--	--			0	--
9	--	--	--			0	--
10	1	18.02	3.60			1	93
Total Numbers & Mean Relative Weights						98	109

Table A2. Continued.

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	37	8.88	0.39			37	98
2	30	12.90	1.28			30	102
3	6	15.80	2.28			6	104
4		--	--			0	--
5	3	17.60	3.23			3	106
6	3	17.40	3.13			3	105
7	1	17.40	3.12			1	105
8		--	--			0	--
9	1	16.10	2.40			1	105
10	--	--	--			0	--
11	1	20.98	5.84			0	--
Total Numbers & Mean Relative Weights						81	100

2003

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Spring No.	Spring Relative weight[2]	Fall No.	Fall Relative weight[2]
1	20	9.54	0.44			20	96
2	36	13.27	1.35			36	101
3	26	15.09	2.08			26	102
4	3	16.05	2.43			3	103
5	2	14.74	1.77			2	102
12	1	20.91	5.66			1	107
Total Numbers & Mean Relative Weights						88	100

Table A2. Continued.

				2004			
				Spring		Fall	
Age	No.	Mean length (in.)	Mean weight[4] (lb)	No.	Relative weight[2]	No.	Relative weight[2]
1	14	8.67	0.45			14	104
2	18	13.29	1.33			18	104
3	17	14.65	1.81			17	104
4	6	15.20	2.01			6	105
5	3	17.76	3.30			3	105
6	1	17.09	2.90			1	105
Total Numbers & Mean Relative Weights						59	104

[1] / Year 2000: Log (weight(lb)) = -3.4390102 + 3.1806693 (Log (length(in))) $R^2 = 0.9999$.

[2] / Relative weight is based on length and weight at capture.

[3] / Year 2001: Log (weight(lb)) = -3.52719 + 3.2523198 (Log (length(in))) $R^2 = 0.9950$.

[4] / Year 2002: Log (weight(lb)) = -3.52719 + 3.2523198 (Log (length(in))) $R^2 = 0.9759$.

[5] / Year 2003: Log (weight(lb)) = -3.64022 + 3.32721 (Log (length(in))) $R^2 = 0.9536$.

[6] / Year 2004: Log (weight(lb)) = -3.48398 + 3.20190 (Log (length(in))) $R^2 = 0.9946$.

Table A3. The age, number, back-calculated mean length, and derived weight of bluegill collected from Newton Lake during 2000 - 2004. Numbers, relative weights (Wr), total number per sample, and mean relative weights are shown for the October and November samples.

2000

Age	No.	Mean length (in.)	Mean weight[1] (lb)	Relative weight[2]
1	89	2.76	0.01	89
2	34	4.36	0.05	92
3	14	5.14	0.09	88
Total	137		Mean Wr	90

2001

Age	No.	Mean length (in.)	Mean weight[3] (lb)	Relative weight[2]
1	39	2.13	0.01	94
2	40	4.32	0.05	83
3	5	4.80	0.06	80
4	4	5.02	0.07	74
Total	88		Mean Wr	87

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Relative weight[2]
1	44	2.50	0.01	93
2	23	3.97	0.04	88
3	7	5.22	0.09	85
4	1	5.16	0.08	85
Total	75		Mean Wr	91

Table A3. Continued.

		2003		
Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	50	3.06	0.01	70
2	36	3.89	0.03	72
3	5	4.56	0.05	73
Total	91		Mean Wr	71

		2004		
Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	24	3.37	0.02	78
2	10	4.51	0.05	78
3	7	5.30	0.09	78
Total	41		Mean Wr	78

[1] / Year 2000: Log (weight(lb)) = -3.5067474 + 3.4488285 (Log (length(in))) R^2 = 0.9993.

[2] / Relative weight is based on length and weight at capture.

[3] / Year 2001: Log (weight(lb)) = -3.273945 + 3.0604569 (Log (length(in))) R^2 = 0.9790.

[4] / Year 2002: Log (weight(lb)) = -3.3669 + 3.19791 (Log (length(in))) R^2 = 0.9717.

[5] / Year 2003: Log (weight(lb)) = -3.57431 + 3.41676(Log (length(in))) R^2 = 0.8816.

[6] / Year 2004: Log (weight(lb)) = -3.48818 + 3.32743 (Log (length(in))) R^2 = 0.9900.

Table A4. The age, number, back-calculated mean length, and derived weight of bluegill collected from Coffeen Lake during 2000 - 2004. Numbers, relative weights (Wr), total number per sample, and mean relative weights are shown for the October and November samples.

2000

Age	No.	Mean length (in.)	Mean weight[1] (lb)	Relative weight[2]
1	65	2.55	0.01	93
2	24	3.86	0.04	90
3	13	4.42	0.05	92
4	1	4.21	0.05	80
Total	103		Mean Wr	92

2001

Age	No.	Mean length (in.)	Mean weight[3] (lb)	Relative weight[2]
1	49	2.24	0.01	81
2	30	3.77	0.03	81
3	6	4.16	0.04	79
Total	85		Mean Wr	81

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Relative weight[2]
1	47	2.83	0.01	92
2	28	3.86	0.03	85
3	6	4.05	0.04	84
Total	81		Mean Wr	89

Table A4. Continued.

2003

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	50	2.4	0.01	84
2	33	3.75	0.03	78
3	5	4.28	0.04	76
4	1	4.61	0.05	75
Total	89		Mean Wr	81

2004

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	69	2.33	0.01	87
2	22	3.54	0.02	77
3				
4	1	4.49	0.04	72
Total	92		Mean Wr	84

[1] / Year: 2000: Log (weight(lb)) = -2.9604812 + 2.6174635 (Log (length(in)))R^2 = 0.9841.

[2] / Relative weight is based on length and weight at capture.

[3] / Year 2001: Log (weight(lb)) = -3.372721 + 3.1766147 (Log (length(in))) R^2 = 0.9650.

[4] / Year 2002: Log (weight(lb)) = -3.30150 + 3.07455 (Log (length(in))) R^2 = 0.9357.

[5] / Year 2003: Log (weight(lb)) = -3.38336 + 3.14553 (Log (length(in))) R^2 = 0.9291.

[6] / Year 2004: Log (weight(lb)) = -3.33248 + 3.03324 (Log (length(in))) R^2 = 0.9194.

Table A5. The age, number, back-calculated mean length, and derived weight of channel catfish collected from Newton Lake during 2000 - 2004. Numbers, relative weights (Wr), total number per sample, and mean relative weights are shown for the October and November samples.

2000

Age	No.	Mean length (in.)	Mean weight[1] (lb)	Relative weight[2]
1	0	--	--	--
2	6	8.63	0.14	82
3	9	10.17	0.26	82
4	22	10.78	0.32	84
5	10	11.85	0.48	86
6	16	12.43	0.53	84
7	10	13.20	0.70	88
8	8	14.61	0.94	90
9	5	14.58	0.93	90
10	3	14.72	0.93	92
11	2	13.35	0.68	83
12	2	14.96	0.96	92
Total	93		Mean Wr	86

2001

Age	No.	Mean length (in.)	Mean weight[3] (lb)	Relative weight[2]
1	2	7.54	0.09	78
2	7	8.61	0.14	89
3	13	10.03	0.25	87
4	24	10.81	0.32	90
5	21	12.09	0.47	87
6	7	12.37	0.51	87
7	11	13.40	0.67	90
8	2	14.82	0.96	81
9	1	17.55	1.72	126
10	1	14.45	1.69	91
Total	89		Mean Wr	88

Table A5. Continued.

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Relative weight[2]
1	1	3.39	0.01	122
2	1	8.46	0.17	102
3	3	8.81	0.20	101
4	8	9.19	0.22	100
5	7	9.20	0.23	100
6	16	10.80	0.38	97
7	11	11.90	0.52	96
8	14	11.70	0.50	96
9	11	11.70	0.47	96
10	5	12.60	0.62	95
11	7	14.40	0.96	92
12	4	14.90	1.02	92
13	3	14.00	0.90	93
14	2	15.00	1.10	92
15	1	19.70	2.35	87
Total	94		Mean Wr	97

2003

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	0	--	--	--
2	0	--	--	--
3	0	--	--	--
4	1	8.94	0.16	81
5	5	10.77	0.36	82
6	5	10.43	0.31	82
7	10	12.85	0.68	84
8	3	11.42	0.48	83
9	9	12.24	0.57	84
10	7	14.98	1.01	86
11	6	15.22	1.28	86
12	5	15.02	1.06	86
13	2	13.94	0.83	85
18	1	16.02	1.2	87
Total	54		Mean Wr	84

Table A5. Continued.

			2004	
Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	0	--	--	--
2	25	8.35	0.13	80
3	29	10.26	0.27	82
4	14	11.82	0.45	84
5	17	13.02	0.65	84
6	3	13.56	0.71	85
7	4	15.18	1.13	86
Total	92		Mean Wr	82

[1] / Year 2000: Log (weight(lb)) = -3.9049812 + 3.3222383 (Log (length(in))) $R^2 = 0.9970$.

[2] / Relative weight is based on length and weight at capture.

[3] / Year 2001: Log (weight(lb)) = -4.09543 + 3.4817214 (Log (length(in))) $R^2 = 0.9340$.

[4] / Year 2002: Log (weight(lb)) = -3.64269 + 3.10177 (Log (length(in))) $R^2 = 0.9127$.

[5] / Year 2003: Log (weight(lb)) = -4.04504 + 3.42223 (Log (length(in))) $R^2 = 0.9866$.

[6] / Year 2004: Log (weight(lb)) = -3.91399 + 3.30744 (Log (length(in))) $R^2 = 0.9774$.

Table A6. The age, number, back-calculated mean length, and derived weight of channel catfish collected from Coffeen Lake during 2000 - 2004. Numbers, relative weights (Wr), total number per sample, and mean relative weights are shown for the October and November samples.

2000

Age	No.	Mean length (in.)	Mean weight[1] (lb)	Relative weight[2]
1	1	6.26	0.10	90
2	15	8.45	0.22	90
3	20	9.95	0.33	84
4	12	11.59	0.47	95
5	11	12.54	0.56	94
6	3	14.20	0.74	85
7	4	16.14	1.03	87
Total	66		Mean Wr	89

2001

Age	No.	Mean length (in.)	Mean weight[3] (lb)	Relative weight[2]
1	0	--	--	--
2	1	8.26	0.15	88
3	7	10.00	0.29	99
4	6	11.07	0.40	95
5	6	12.37	0.57	98
6	1	12.71	0.62	93
Total	21		Mean Wr	97

Table A6. Continued.

2002

Age	No.	Mean length (in.)	Mean weight[4] (lb)	Relative weight[2]
1	0	--	--	--
2	0	--	--	--
3	0	--	--	--
4	1	10.40	0.34	102
5	1	11.10	0.42	101
6	14	12.30	0.63	100
7	11	12.30	0.65	100
8	16	13.90	0.92	98
9	24	14.50	0.99	98
10	13	14.30	0.97	98
11	6	14.60	1.00	97
12	6	15.30	1.17	97
13	2	15.80	1.27	96
14	1	16.10	1.33	96
Total	95		Mean Wr	98

2003

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	0	--	--	--
2	1	7.4	0.09	80
3	2	12.4	0.53	89
5	6	12.95	0.63	89
6	11	13.27	0.69	90
7	10	13.93	0.83	90
8	16	13.67	0.78	90
9	21	14.31	0.91	91
10	18	14.51	0.94	91
11	8	14.62	0.98	91
12	2	14.69	0.96	91
13	4	14.83	1.03	91
15	1	20.75	3.14	97
Total	100		Mean Wr	90

Table A6. Continued.

2004

Age	No.	Mean length (in.)	Mean weight[5] (lb)	Relative weight[2]
1	2	4.82	0.02	83
2	20	6.87	0.07	81
3	28	8.03	0.13	81
4	13	10.5	0.36	79
5	20	11.04	0.39	79
6	14	13.7	0.69	78
7	12	13.83	0.67	78
8	2	14.23	0.75	78
9	3	15.56	1	77
Total	114		Mean Wr	80

[1] / Year 2000: Log (weight(lb)) = -2.8711953 + 2.3853775 (Log (length(in))) R^2 = 0.9997.

[2] / Relative weight is based on length and weight at capture.

[3] / Year 2001: Log (weight(lb)) = -3.774206 + 3.2291283 (Log (length(in))) R^2 = 0.9290.

[4] / Year 2002: Log (weight(lb)) = -3.67923 + 3.15485 (Log (length(in))) R^2 = 0.9359.

[5] / Year 2003: Log (weight(lb)) = -4.08573 + 3.47999 (Log (length(in))) R^2 = 0.9709.

[6] / Year 2004: Log (weight(lb)) = -3.86875 + 3.23295 (Log (length(in))) R^2 = 0.9805.

Appendix B: Mortality

Introduction:

The purpose of this portion of the study is to compare the mortality results of 2000-2004. This is being done to determine the impacts, if any, of the July 1999 fish kill on the fish population in Newton Lake and Coffeen Lake (Heidinger et. al. 2000).

Methods:

The Chapman and Robson (1960) and the catch-curve methods were both used to calculate estimates of mortality for largemouth bass, bluegill, white crappie, and channel catfish captured within each of the study lakes. Mortality estimates were calculated using the first 100 fish collected during our fall sampling. Plots of the natural log of cohort age-frequency were used to determine the age at which each species could be used to calculate the mortality ratio. Due to the small sample size, it was determined that we would use the apex of the plot of the natural log of cohort age-frequency curve prior to the descending limb instead of the next oldest age group.

Literature Cited:

Chapman, D.G., and D.A. Robson. 1960. The analysis of a catch curve. Biometrics 16:354-368.

Heidinger, R.C., R. Sheehan, and R. C. Brooks. 2000. AmerenCIPS Newton Lake Project Vol. I, Vol. II, Final Report 15 August 1997 - 30 August 1999. Fisheries Research Laboratory and Illinois Aquaculture Center, Southern Illinois University at Carbondale.

Table B1. Chapman Robson (1960) estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October and November 2000 and October through December 2001.

Lake	Species	n	Ages when vulnerable	Survival	Mortality (Z)	95% C.I.	Annual Mortality
				2000			
Coffeen	Largemouth bass	99	0-7	0.52	0.65	0.64 - 0.7	0.48
	Bluegill	89	4-Jan	0.3	1.22	1.19 - 1.3	0.7
	White Crappie	81	4-Feb	0.32	1.13	1.10 - 1.2	0.68
	Channel Catfish	41	7-Mar	0.5	0.69	0.66 - 0.7	0.5
Newton	Largemouth bass	100	0-4	0.34	1.09	1.07 - 1.1	0.66
	Bluegill	89	3-Jan	0.19	1.65	1.61 - 1.7	0.81
	Channel Catfish	78	12-Apr	0.7	0.36	0.35 - 0.4	0.3
				2001			
Coffeen	Largemouth Bass	156	0-10	0.53	0.64	0.63 - 0.65	0.47
	Bluegill	85	1-3	0.33	1.10	1.07 - 1.13	0.67
	White Crappie	46	3-5	0.29	1.25	1.20 - 1.31	0.71
	Channel Catfish	21	3-6	0.53	0.64	0.60 - 0.71	0.47
Newton	Largemouth Bass	103	1-8	0.43	0.85	0.83 - 0.87	0.57
	Bluegill	49	2-4	0.21	1.55	1.48 - 1.62	0.79
	Channel Catfish	69	4-10	0.57	0.57	0.55 - 0.58	0.43

Table B2. Chapman Robson (1960) estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October 2002 and 2003.

Lake	Species	n	Ages when vulnerable	Survival	Mortality (Z)	95% C.I.	Annual Mortality
				2002			
Coffeen	Largemouth Bass	82	1-9	0.51	0.68	0.66 - 0.69	0.49
	Bluegill	82	1-3	0.34	1.09	1.06 - 1.12	0.66
	Channel Catfish	54	9-14	0.53	0.64	0.62 - 0.67	0.47
Newton	Largemouth Bass	70	1-5	0.37	0.99	0.96 - 1.02	0.63
	Bluegill	74	0-4	0.35	1.05	1.03 - 1.08	0.65
	Channel Catfish	75	6-15	0.73	0.32	0.31 - 0.33	0.27
				2003			
Coffeen	Largemouth Bass	69	2-12	0.41	0.88	0.86 - 0.91	0.59
	Bluegill	89	1-4	0.34	1.07	1.04 - 1.09	0.66
	Channel Catfish	54	9-15	0.54	0.62	0.59 - 0.64	0.46
Newton	Largemouth Bass	100	0-4	0.48	0.74	0.73 - 0.76	0.52
	Bluegill	91	1-3	0.34	1.08	1.06 - 1.11	0.66
	Channel Catfish	30	9-18	0.64	0.45	0.42 - 0.48	0.36

Table B3. Chapman Robson (1960) estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October 2004.

Lake	Species	n	Ages when vulnerable	Survival	Mortality (Z)	95% C.I.	Annual Mortality
				2004			
Coffeen	Largemouth Bass	106	0-6	0.58	0.54	0.53 - 0.55	0.42
	Bluegill	92	1-4	0.22	1.53	1.50 - 1.57	0.78
	Channel Catfish	93	3-9	0.65	0.43	0.42 - 0.44	0.35
Newton	Largemouth Bass	100	0-4	0.37	1.01	0.99 - 1.03	0.63
	Bluegill	142	0-3	0.32	1.15	1.14 - 1.17	0.68
	Channel Catfish	67	3-7	0.53	0.64	0.62 - 0.66	0.47

Table B4. Catch curve estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October and November 2000 (-- indicates an undeterminable value) and October through December 2001.

Lake	Species	n	Ages when vulnerable	Survival (S)	Mortality (Z)	95% C.I.	Annual mortality	R^2
				2000				
Coffeen	Largemouth bass	99	0-7	0.55	0.6	0.53 - 0.67	0.45	0.94
	Bluegill	89	4-Jan	0.26	1.34	1.19 - 1.49	0.74	0.98
	White Crappie	81	4-Feb	0.29	1.23	0.78 - 1.68	0.71	0.88
	Channel Catfish	41	7-Mar	0.58	0.54	0.41 - 0.67	0.42	0.86
Newton	Largemouth bass	100	0-4	0.38	0.96	0.67 - 1.25	0.62	0.79
	Bluegill	89	3-Jan	0.17	1.78	1.57 - 1.99	0.83	0.99
	Channel Catfish	78	12-Apr	0.73	0.31	0.28 - 0.34	0.27	0.92
				2001				
Coffeen	Largemouth Bass	156	0-10	0.63	0.46	0.28 - 0.65	0.37	0.83
	Bluegill	85	1-3	0.35	1.05	0.42 - 1.68	0.65	0.91
	White Crappie	46	3-5	0.19	1.68	0.45 - 2.92	0.81	0.87
	Channel Catfish	21	3-6	0.56	0.58	0.14 - 1.31	0.44	0.66
Newton	Largemouth Bass	103	1-8	0.53	0.64	0.38 - 0.90	0.47	0.82
	Bluegill	49	2-4	0.32	1.15	0.10 - 2.20	0.68	0.82
	Channel Catfish	69	4-10	0.54	0.61	0.44 - 0.78	0.46	0.91

Table B5. Catch curve estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October 2002 and 2003.

Lake	Species	n	Ages when vulnerable	Survival	Mortality (Z)	95% C.I.	Annual Mortality	R^2
				2002				
Coffeen	Largemouth Bass	82	1-9	0.61	0.49	0.36 - 0.61	0.39	0.90
	Bluegill	82	1-3	0.36	1.03	0.41 - 1.65	0.64	0.91
	Channel Catfish	54	9-14	0.54	0.63	0.38 - 0.87	0.46	0.96
Newton	Largemouth Bass	70	1-5	0.44	0.83	0.26 - 1.41	0.56	0.64
	Bluegill	74	0-4	0.29	1.25	0.80 - 1.70	0.71	0.95
	Channel Catfish	75	6-15	0.75	0.29	0.21 - 0.37	0.25	0.92
				2003				
Coffeen	Largemouth Bass	69	2-12	0.73	0.32	0.04 - 0.60	0.27	0.63
	Bluegill	89	1-4	0.26	1.36	0.92 - 1.80	0.74	0.95
	Channel Catfish	54	9-15	0.59	0.52	0.28 - 0.72	0.41	0.87
Newton	Largemouth Bass	100	0-4	0.52	0.66	0.45 - 0.88	0.49	0.92
	Bluegill	91	1-3	0.32	1.15	0.22 - 2.08	0.68	0.85
	Channel Catfish	30	9-18	0.78	0.25	0.18 - 0.34	0.22	0.92

Table B6. Catch curve estimates of mortality and survival for largemouth bass, bluegill, white crappie, and channel catfish calculated from catch data of fish captured in each lake sampled during October 2004.

Lake	Species	n	Ages when vulnerable	Survival	Mortality (Z)	95% C.I.	Annual Mortality	R^2
				2004				
Coffeen	Largemouth Bass	106	0-6	0.57	0.57	0.40 - 0.73	0.43	0.88
	Bluegill	92	1-4	0.24	1.40	1.23 - 1.63	0.76	0.99
	Channel Catfish	93	3-9	0.67	0.40	0.20 - 0.59	0.33	0.71
Newton	Largemouth Bass	100	0-4	0.45	0.80	0.21 - 1.40	0.55	0.60
	Bluegill	142	0-3	0.41	0.89	0.55 - 1.22	0.59	0.90
	Channel Catfish	67	3-7	0.58	0.55	0.23 - 0.87	0.42	0.73

Appendix C: Catch Per Unit Effort and Relative Abundance

Methods:

Historically, in Newton Lake, at least six (but usually twelve) hours of electrofishing per year has been done by the Illinois Department of Natural Resources (IDNR). Fish collected by Southern Illinois University Fisheries Lab personnel (SIUC) for age and growth and mortality during October and November 2000-2004 were also used to calculate CPUE and relative abundance. One person dipped fish while another maneuvered the boat. All fish of each target species were collected as required by age and growth and mortality data and total effort was recorded. Total effort for the different species was highly variable due to the abundance and availability of the different target species. All fish collected were identified, counted, and measured. We recognize that catch rates and length frequencies of a particular species can be affected by parameters including, but not limited to total effort, water temperature, weather patterns, and water clarity. In order to mitigate these factors, timing of the sampling was similar in all four years and IDNR data were used for comparison of CPUE trends.

Table C-1. Three phase electrofishing catch-per-unit effort of largemouth bass, bluegill, and channel catfish from Newton Lake during the fall of 1997-2004 by IDNR and SIU.

Year	Hours[a] IDNR	Hours[a] SIU	Catch per hour IDNR	Catch per hour SIU
		Largemouth bass		
1993	12	--	53	--
1994	12	--	94	--
1995	12	--	78	--
1996	12	--	83	--
1997	12	9.4	30	28
1998	12	6.3	59	44
1999	12	9.1	43	32
2000	12	5.0	35	76
2001	12	4.5	53	33
2002	12	2.8	55	39
2003	6	3.1	53	32
2004	8	2.4	78	42
		Bluegill		
1997	12	11.4	45	28
1998	12	8.1	44	51
1999	12	5.1	69	59
2000	12	1.0	42	115
2001	12	1.8	71	54
2002	12	0.8	73	149
2003	6	2.8	40	39
2004	8	0.7	43	198
		Channel catfish		
1993	12	--	6	--
1994	12	--	11	--
1995	12	--	44	--
1996	12	--	12	--
1997	12	16.6	4	2
1998	12	10.0	13	7
1999	12	17.8	12	7
2000	12	7.0	9	12
2001	12	12.0	14	8
2002	12	7.5	11	13
2003	6	12.9	4	4
2004	8	9.5	7	10

[a]/ IDNR collected fish from their standard sampling sites and SIU collected fish from each of their four sampling segments.

Table C-2. Three phase electrofishing catch-per-unit effort of largemouth bass, bluegill, and channel catfish from Coffeen lake during the fall of 1997-2004 by IDNR and SIU.

	Hours[a]		Catch per hour	
Year	IDNR	SIU	IDNR	SIU
		Largemouth bass		
1997	7.5	4.8	79	23
1998	7.5	7.3	43	14
1999	7	5.2	67	25
2000	7	12.1	20	16
2001	7	7.1	99	23
2002	7	2.8	93	39
2003	6.5	4.0	66	26
2004	6.5	4.8	100	22
		Bluegill		
1997	7.5	4.0	196	54
1998	7.5	2.6	99	49
1999	7	1.0	127	163
2000	7	1.1	89	97
2001	7	1.6	86	66
2002	7	0.6	179	166
2003	6.5	1.5	71	67
2004	6.5	1.7	65	67
		Channel catfish		
1997	7.5	6.0	9	5
1998	7.5	7.9	12	1
1999	7	10.2	16	5
2000	7	12.2	3	7
2001	7	7.1	6	3
2002	7	6.6	11	13
2003	6.5	15.7	4	6
2004	6.5	9.0	13	13

[a/] IDNR collected fish from their standard sampling sites and SIU collected fish from each of their two sampling segments.

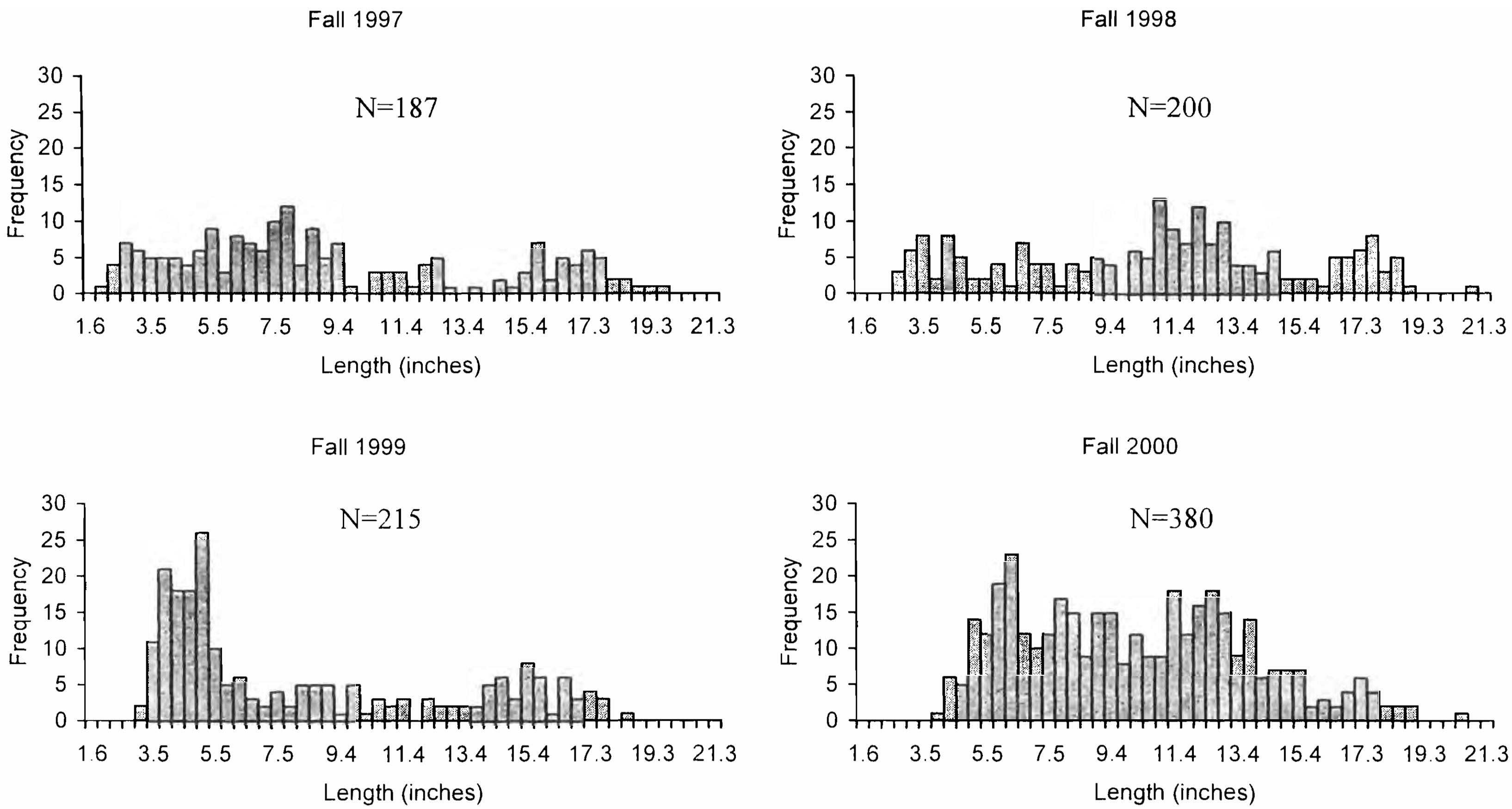


Figure C1. Length-frequency histograms of largemouth bass captured by SIUC in Newton Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

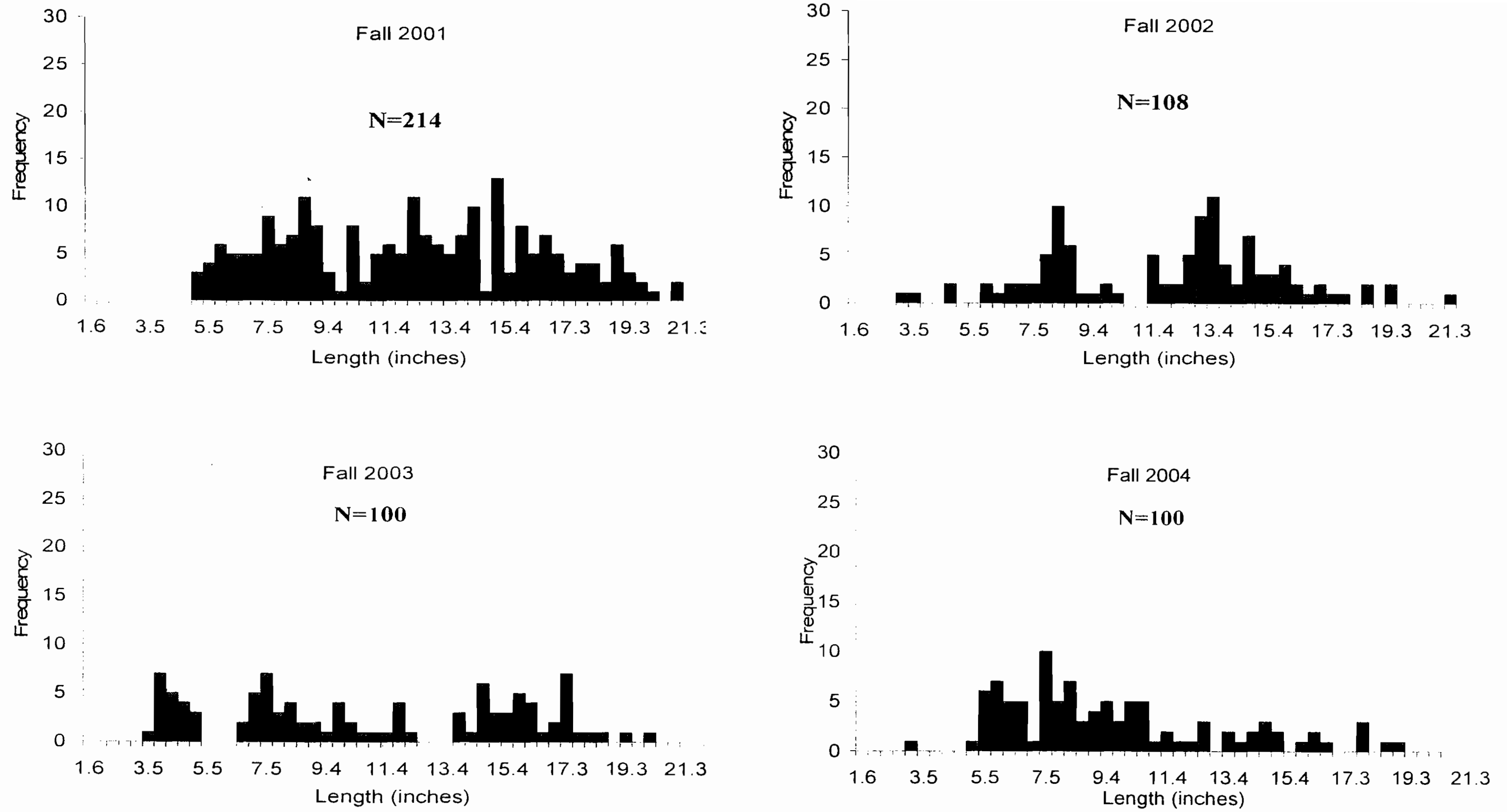


Figure C2. Length-frequency histogram of largemouth bass captured by SIUC in Newton Lake during October through December 2001, 2002, 2003, and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

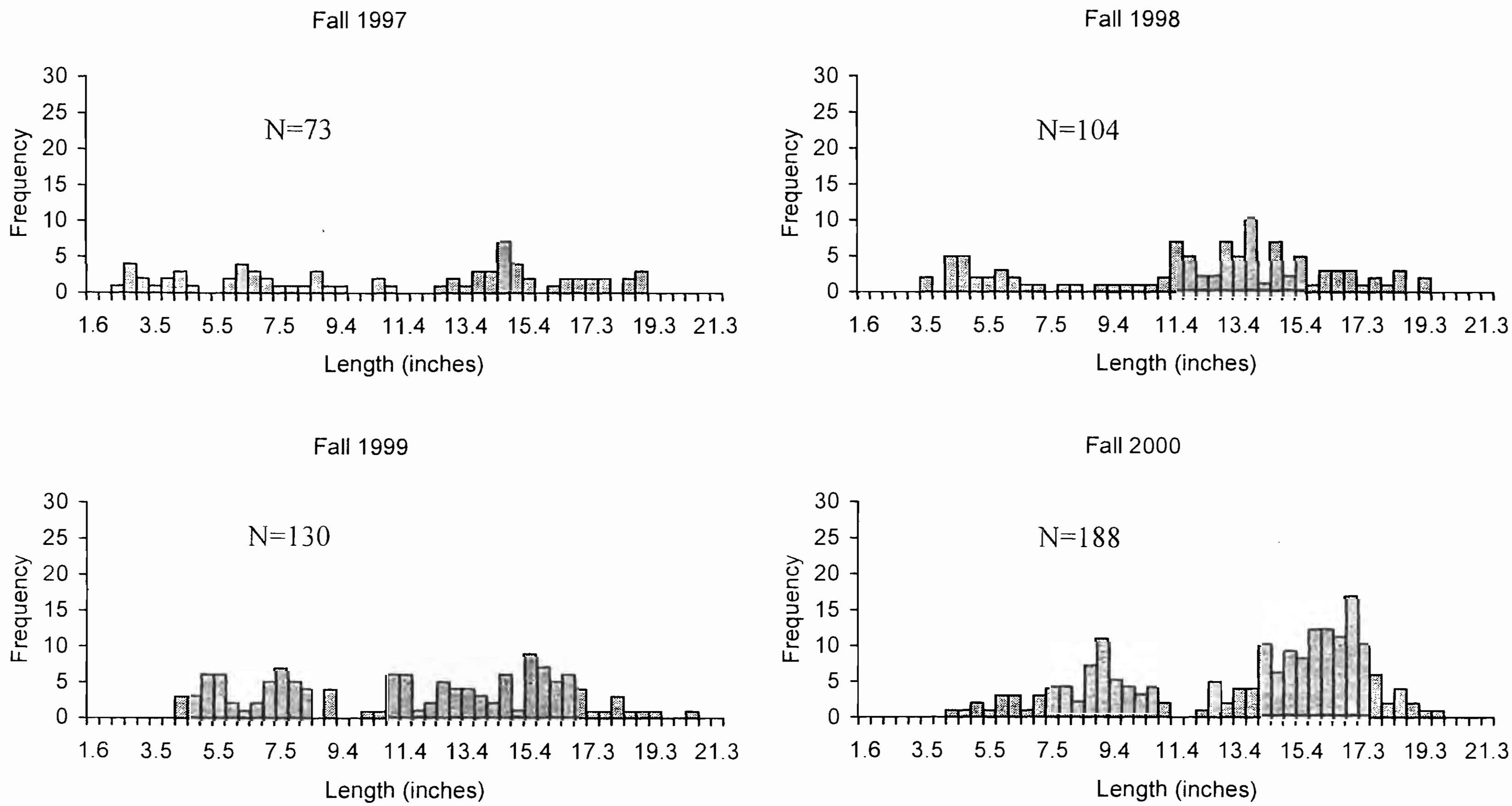


Figure C3. Length-frequency histograms of largemouth bass captured by SIUC in Coffeen Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

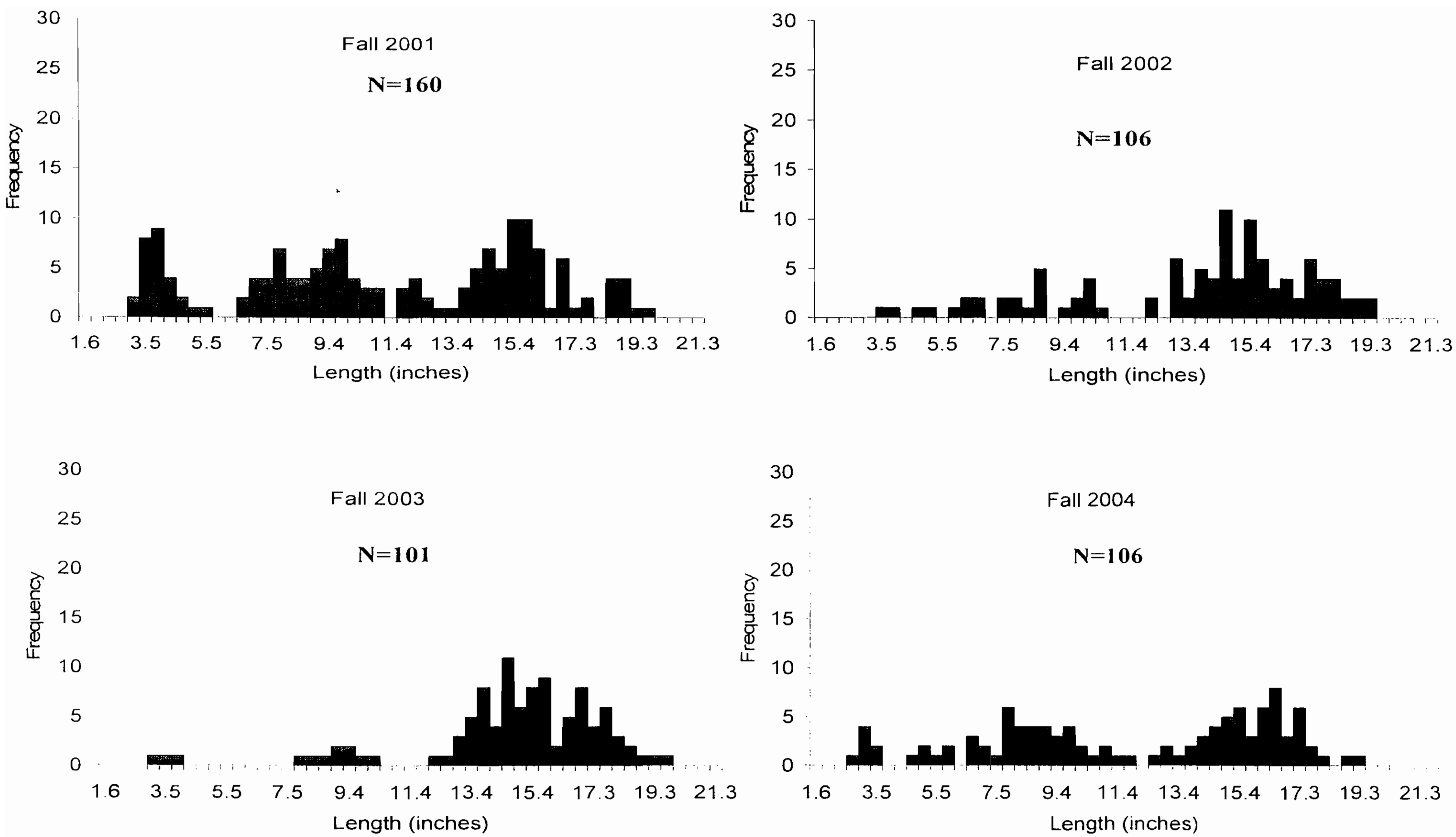


Figure C4. Length-frequency histogram of largemouth bass captured by SIUC in Coffeen Lake during October through December 2001, 2002, 2003, and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

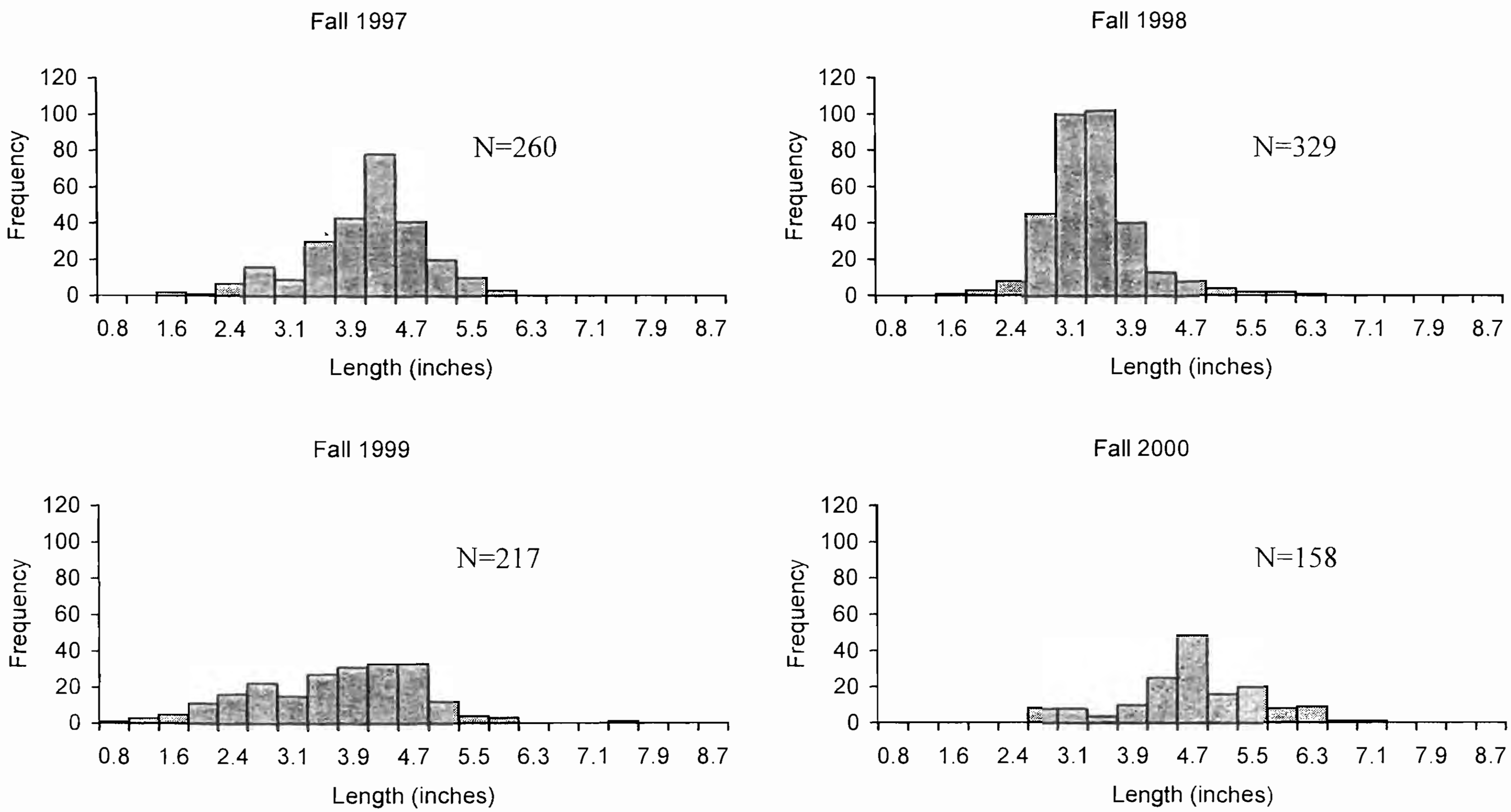


Figure C5. Length-frequency histograms of bluegill captured by SIUC in Newton Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

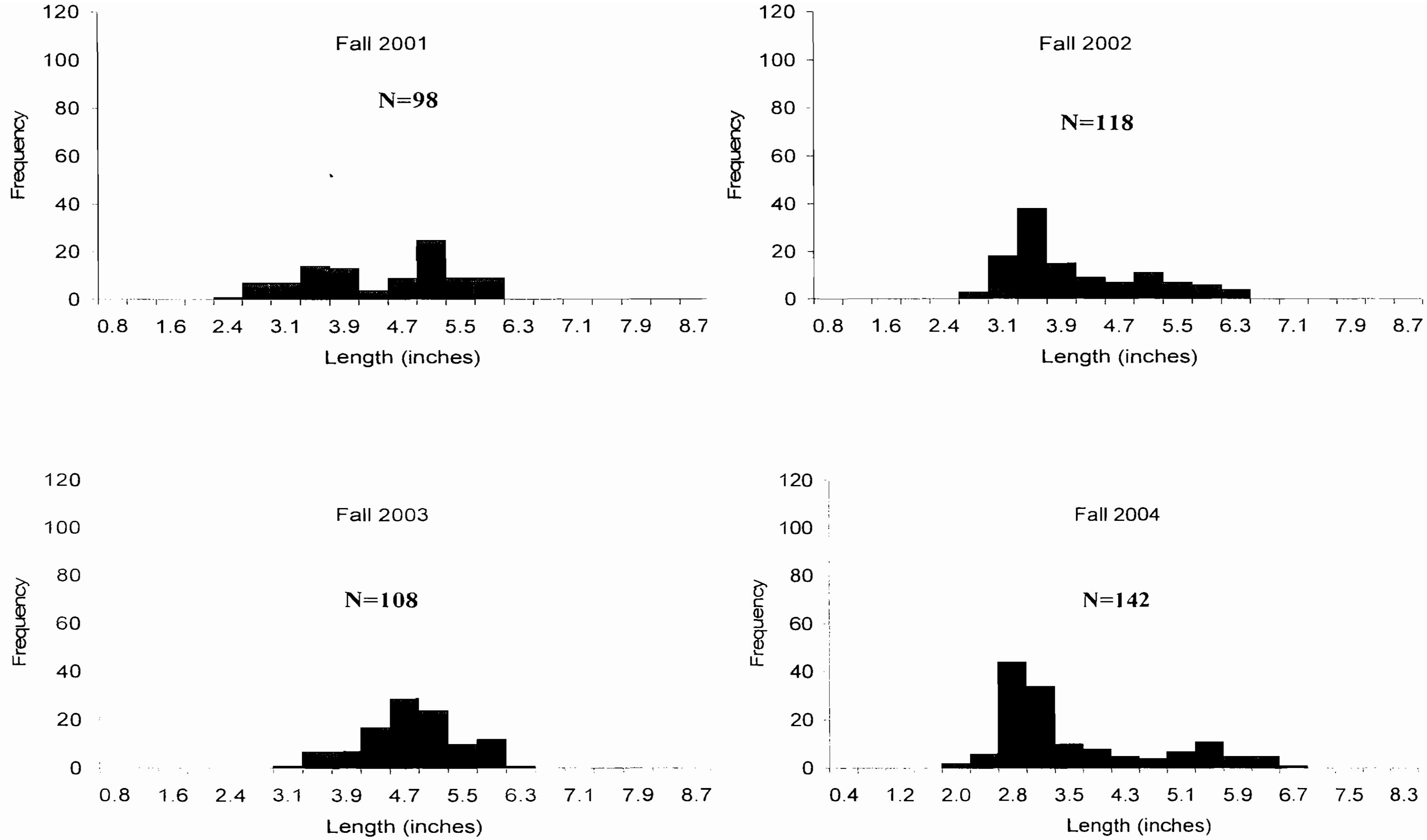


Figure C6. Length-frequency histogram of bluegill captured by SIUC in Newton Lake during October through December 2001, 2002, 2003, and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

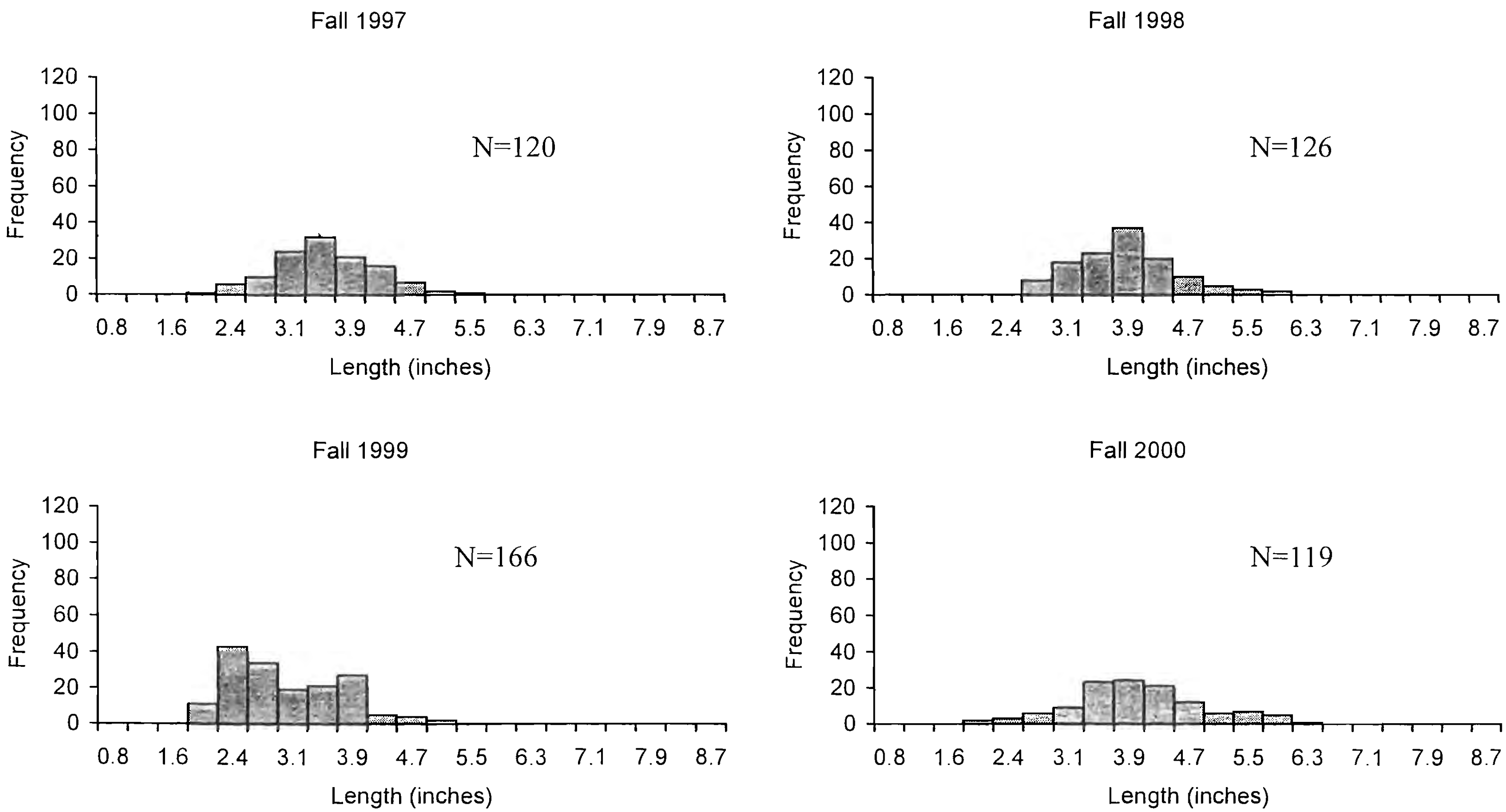


Figure C7. Length-frequency histograms of bluegill captured by SIUC in Coffeen Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

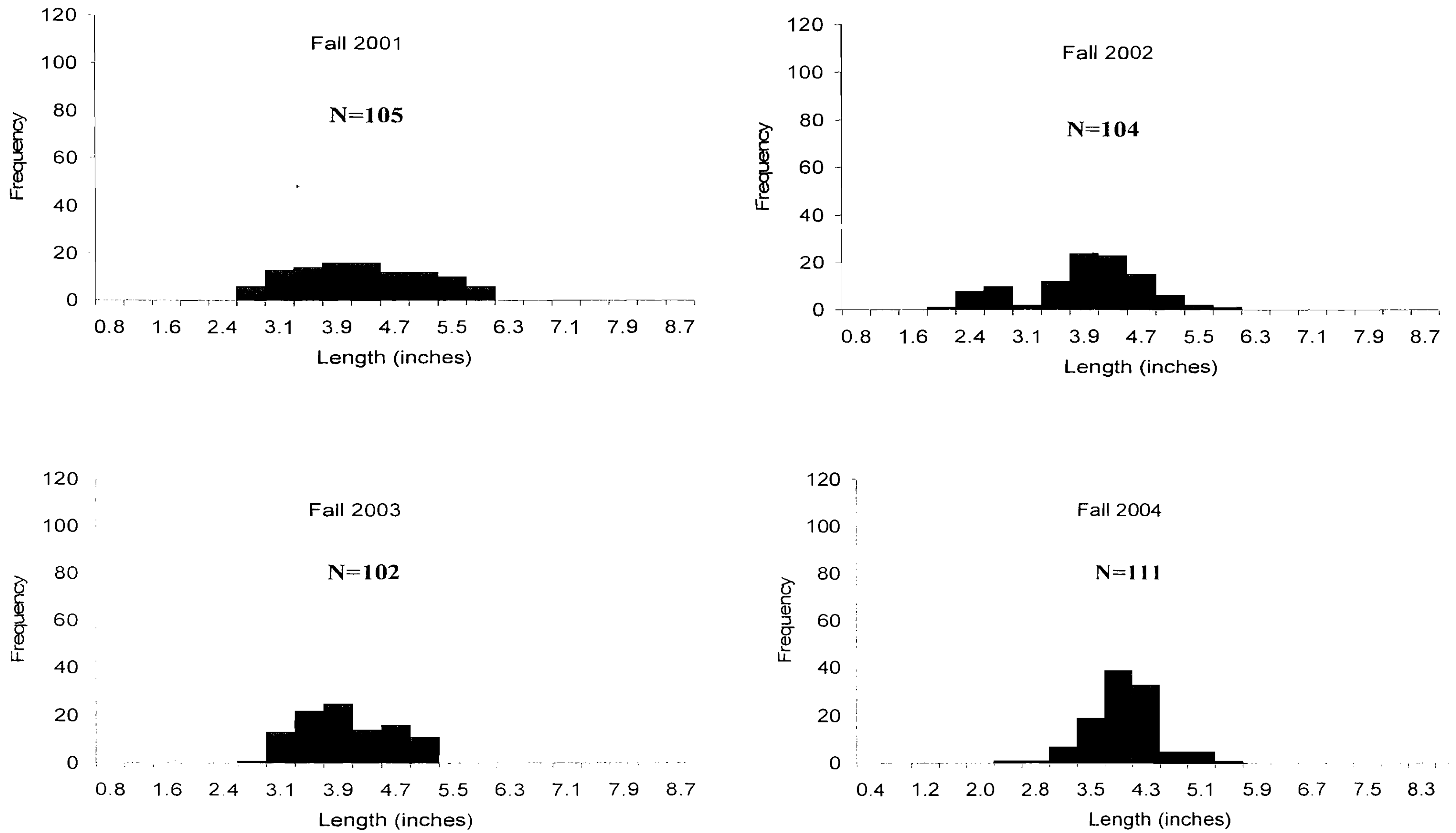


Figure C8. Length-frequency histogram of bluegill captured by SIUC in Coffeen Lake during October through December 2001, 2002, 2003, and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

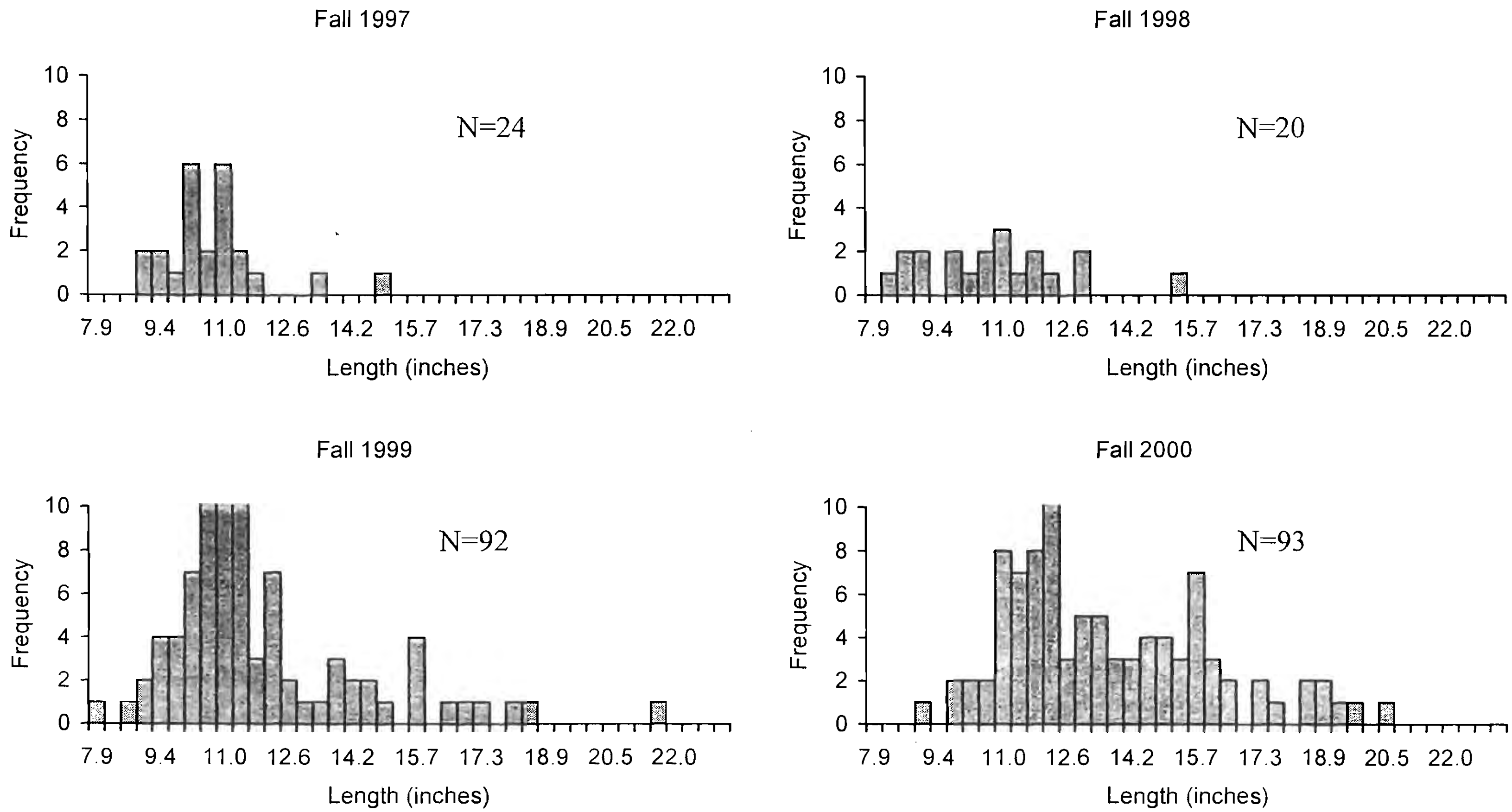


Figure C9. Length-frequency histograms of channel catfish captured by SIUC in Newton Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

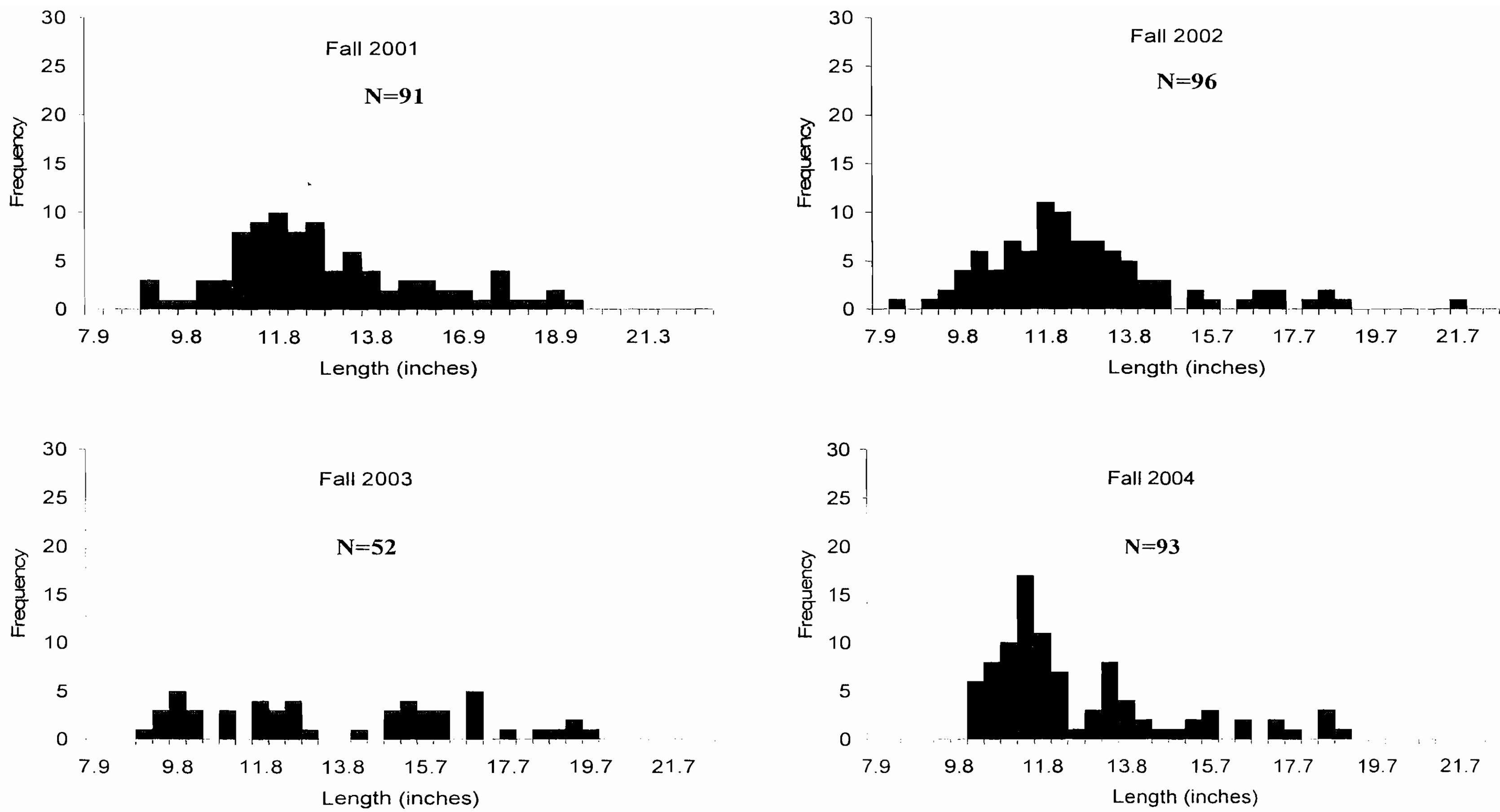


Figure C10. Length-frequency histogram of channel catfish captured by SIUC in Newton Lake during October through December 2001, 2002, 2003 and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

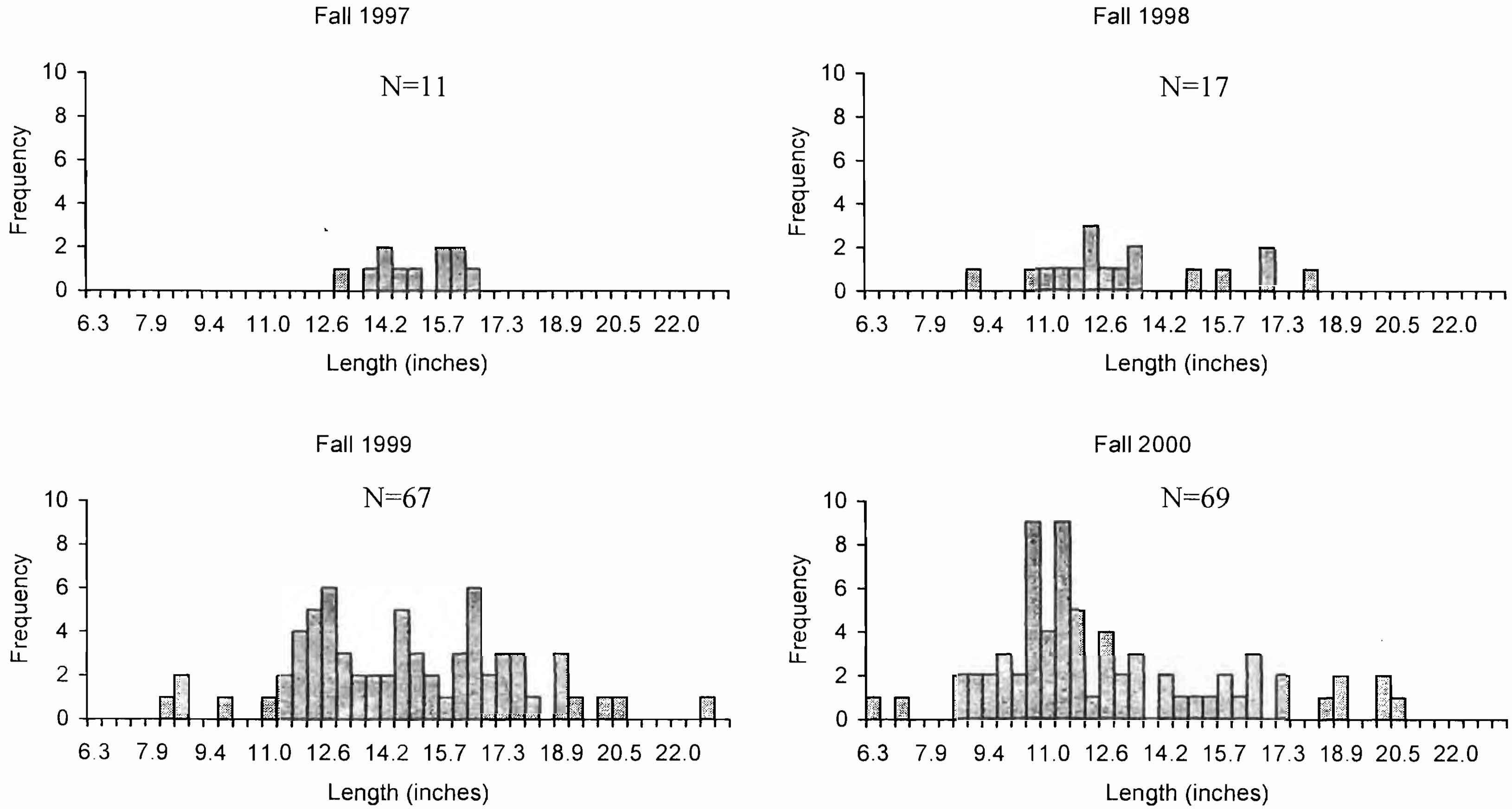


Figure C11. Length-frequency histograms of channel catfish captured by SIUC in Coffeen Lake during the months of October and November 1997, 1998, 1999, and 2000. Lengths are combined into 0.39-inch (10-mm) groups.

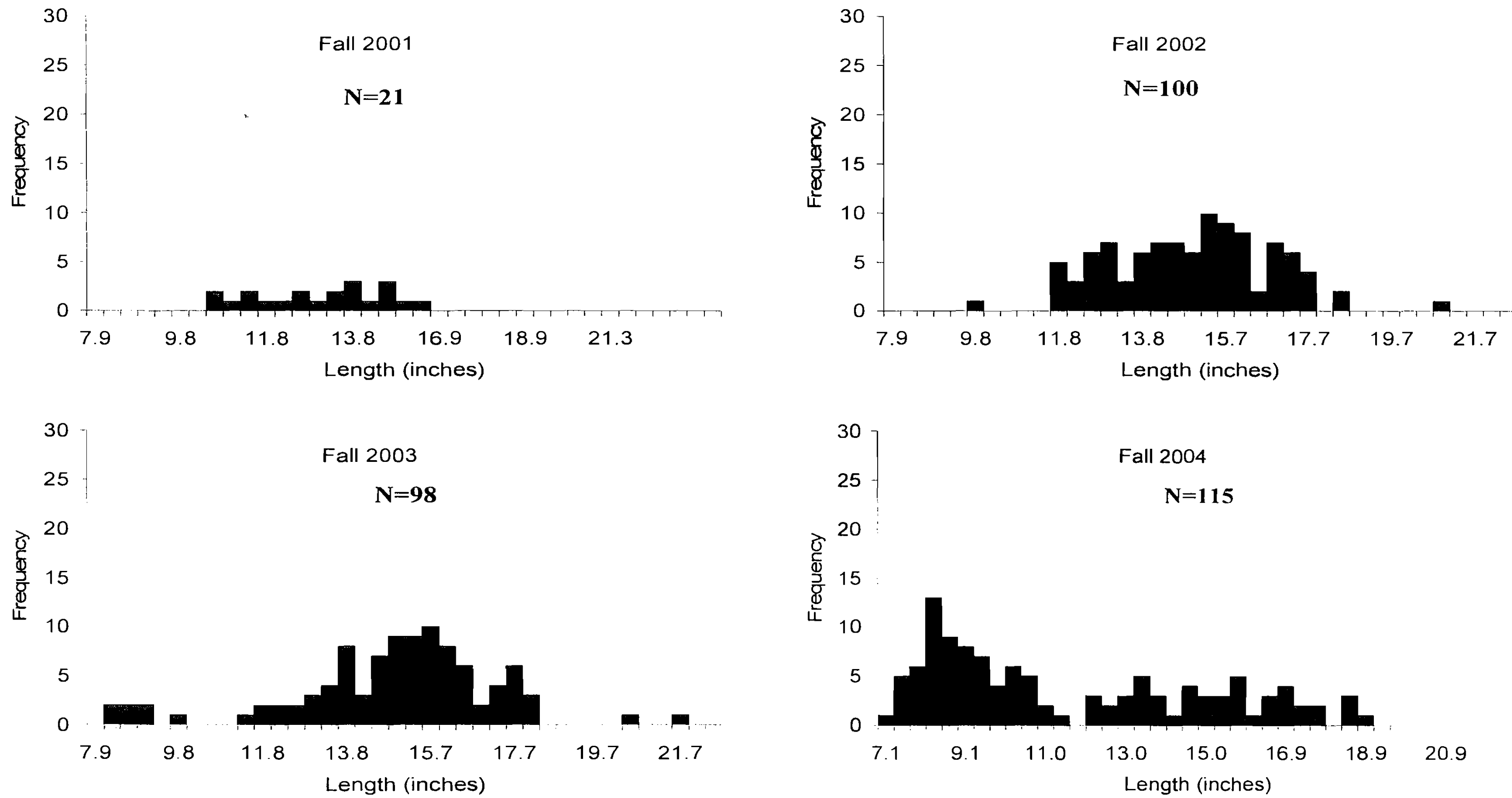


Figure C12. Length-frequency histogram of channel catfish captured by SIUC in Coffeen Lake during October through December 2001, 2002, 2003, and 2004. Lengths are combined into 0.39-inch (10-mm) groups.

Appendix D. Depth, Temperature, Oxygen Profile

Materials and Methods:

Methods used in 2004 to determine temperature and temperature, oxygen and depth profiles were the same as methods used during previous years of this study (1997-2003). The timeline was slightly different among the years due to the grant confirmations in each year. Temperature and oxygen were sampled weekly during 2004 beginning in May (Newton Lake) and June (Coffeen Lake), and sampling continued through September 2004 in both lakes. Temperature, oxygen, and depth profiles were taken in the same stations during the four years included in this report in Newton Lake (Figure F1) and Coffeen Lake (Figures F2). Two probes from YSI Model 550A temperature/oxygen meters were used in tandem for sampling. Measurements were taken at 0.5-m intervals from the surface to the bottom; therefore, the final reading taken each sample date is within 0.5 – m of the bottom of the lake. Measurements were taken at the midpoint of each of four segments of each lake. Oxygen membranes were changed frequently. Graphs depicting the temperature and depth profiles taken are given in this appendix.

In Newton Lake, temperature loggers were set for continuous readings (1-hr intervals) at three of AmerenCIPS' biostations in Newton Lake (Figure F1) beginning in May. The temperature loggers were programmed to measure temperature every 2 minutes, and the mean of these measurements was recorded every 1 hour to determine the hourly temperature. We had an additional station on the buoy line near the intake. Loggers were set at the surface and at 1.5-m intervals to a maximum of 4.5 m at each station. Thus, temperature loggers were set at the surface, 1.5 m (4.9 ft.), 3.0 m (9.8 ft.), and 4.5 m (14.8 ft.) in Segments 1 – 4 of Newton Lake.

In Coffeen Lake, temperature loggers were set at the same depth intervals as described for Newton Lake in five stations located at on either AmerenCips' biostations or buoys. The loggers were set at biostations at the mixing zone, near the dam, and near the intake (Figure F2). Additional loggers were set on buoys provided by IDNR near the railroad bridge and in Cemetery Cove across from the intake. The buoy and temperature loggers in Cemetary Cove were stolen at some time between August 5 and August 14, 2005, and no data is available for that segment after August 4, 2005.

In both lakes, mean daily temperature and maximum daily temperature was determined from the hourly readings. Monthly mean temperature was determined by averaging the mean daily temperatures each month. Table F1 gives temperatures recorded by AmerenCIPS's recorders located at the biostations in the mixing zones of Newton Lake during 1997 through 2004. Similar data is given for Coffeen Lake mixing zone temperatures in Table F2, except water mixing zone temperatures were not provided by AmerenCIPS in 2003.

Weekly temperature and oxygen profiles were used to estimate the amount of habitat available to the fish during the study periods. Combinations of temperature (range 87 to 97 degrees F) and oxygen (range from 1 to 4 ppm) were used to determine percent of habitat available. For any combination of temperature and oxygen, each 0.5 – m stratum was examined to determine if that stratum had water warmer than the given temperature provided in the tables or oxygen levels lower than the given oxygen provided in the tables. If either of these criteria were met, the stratum was considered unavailable as habitat for fish. Summing all unavailable strata for a given sampling date in a given segment and then dividing by the depth of the segment gave an estimate of the percent of habitat that was unavailable to the fish. Subtraction from 100% gave the percent habitat which was available. For example, if the water were 10 – m deep in a particular segment on a sampling date, and for a given set of temperature and oxygen criteria only 2.5 m was available as fish habitat; the percent habitat available would have been 25%.

The above method was calculated in two dimensions to provide an estimate of percent available habitat based upon assumptions of rectangular basin shape. Preliminary investigations suggest that even extreme changes in basin shape have little effect on the value calculated for percent available habitat.

Table D1. Mean monthly water surface temperatures at the outer edge of the Newton Lake mixing zone. Mean temperatures were calculated from hourly temperature data provided by AmerenCIPS.

Year	Month	Number of days	Surface temperature monthly average
1997	June	27	95.9
1997	July	31	101.7
1997	August	31	96.2
1997	September	30	94.9
1997	October	31	86.3
1997	November	21	69.5
1997	December	31	71.3
1998	January	31	62.6
1998	February	28	63.8
1998	March	31	67
1998	April	30	79.7
1998	May	31	89.8
1998	June	30	96.3
1998	July	31	101.7
1998	August	31	102.3
1998	September	30	94.6
1998	October	31	87.5
1998	November	30	72.4
1998	December	31	69.8
1999	January	31	54
1999	February	28	67
1999	March	31	72.3
1999	April	30	77.3
1999	May	31	88.4
1999	June	30	97
1999	July	31	104.1
1999	August	31	99.7
1999	September	30	93.1
1999	October	31	85.4
1999	November	16	80.9
1999	December	24	72.7

Table D1. Continued.

Year	Month	Number of days	Surface temperature monthly average
2000	January	27	67.7
2000	February	19	74.9
2000	March	31	76.7
2000	April	30	71.6
2000	May	19	82.5
2000	June	29	94.2
2000	July	31	98
2000	August	31	97.5
2000	September	30	92.8
2000	October	31	84.9
2000	November	30	75.8
2000	December	31	65.9
2001	January	--[a]	--[a]
2001	February	20	70.7
2001	March	17	73.6
2001	April	2	78.2
2001	May	31	91.7
2001	June	30	94.5
2001	July	31	100.1
2001	August	31	99.4
2001	September	30	92.9
2001	October	31	84.8
2001	November	30	75.0
2001	December	31	70.1
2002	January	30	70.9
2002	February	28	73.5
2002	March	31	72.5
2002	April	30	82.9
2002	May	31	84.8
2002	June	30	97.4
2002	July	31	99.1
2002	August	31	96.6
2002	September	30	94.0
2002	October	31	86.3
2002	November	30	79.2
2002	December	31	69.5

Table D1. Continued.

Year	Month	Number of days	Surface temperature monthly average
2003	January	31	68.9
2003	February	28	68.8
2003	March	31	76.3
2003	April	30	75.3
2003	May	31	84.6
2003	June	30	90.8
2003	July	31	96.9
2003	August	31	98.3
2003	September	24	92.7
2003	October	23	84.8
2003	November	30	77.8
2003	December	31	69.3
2004	January	31	68.0
2004	February	28	72.6
2004	March	31	--[a]
2004	April	30	81.5
2004	May	31	93.2
2004	June	30	96.7
2004	July	31	96.8
2004	August	31	95.3
2004	September	24	93.3
2004	October	23	84.2
2004	November	30	75.3
2004	December	31	67.2

[a]/ No data available.

Table D2. Mean monthly water surface temperatures at the outer edge of the Coffeen Lake mixing zone. Mean temperatures were calculated from hourly temperature data provided by AmerenCIPS.

Year	Month	Number of days	Surface temperature monthly average
1996	September	6	92.4
1996	October	19	83.2
1996	November	30	80.5
1996	December	31	76.6
1997	January	31	71.6
1997	February	28	69.6
1997	March	26	76.1
1997	April	15	70.2
1997	May	31	77.7
1997	June	30	87.9
1997	July	31	100.8
1997	August	31	98.7
1997	September	30	88.7
1997	October	31	81.6
1997	November	30	76
1997	December	31	73.3
1998	January	23	68.2
1998	February	--[a]	--[a]
1998	March	--[a]	--[a]
1998	April	15	82.8
1998	May	31	90.8
1998	June	30	94.9
1998	July	31	102.4
1998	August	31	100.1
1998	September	28	96.1
1998	October	31	79.9
1998	November	30	68.1
1998	December	25	66.4
1999	January	26	67.8
1999	February	24	64.9
1999	March	31	73.1
1999	April	18	85.5
1999	May	31	86.4
1999	June	30	90.5
1999	July	31	103.9
1999	August	31	101.5
1999	September	30	94.8
1999	October	31	83.6
1999	November	30	75.3
1999	December	12	70.8

Table D2. Continued.

Year	Month	Number of days	Surface temperature monthly average
2000	January	31	65.2
2000	February	29	76.3
2000	March	31	79.9
2000	April	30	81.2
2000	May	31	88
2000	June	30	93.9
2000	July	31	99.2
2000	August	31	99.2
2000	September	30	93.5
2000	October	6	83.4
2000	November	24	70.7
2000	December	31	70.3
2001	January	31	67.0
2001	February	28	71.1
2001	March	31	68.7
2001	April	30	82.4
2001	May	31	84.7
2001	June	30	86.6
2001	July	31	101.3
2001	August	31	102.4
2001	September	30	93.2
2001	October	31	64.2
2001	November	30	62.4
2001	December	31	71.0
2002	January	31	71.0
2002	February	12	75.9
2002	March	24	75.3
2002	April	30	81.8
2002	May	31	82.2
2002	June	30	96.9
2002	July	31	100.4
2002	August	31	100.4
2002	September	30	99.2
2002	October	31	80.8
2002	November	30	76.6
2002	December	31	68.4

Table D2. Continued.

Year	Month	Number of days	Surface temperature monthly average
2003	January	31	--[a]
2003	February	29	--[a]
2003	March	31	--[a]
2003	April	30	--[a]
2003	May	31	--[a]
2003	June	30	--[a]
2003	July	31	--[a]
2003	August	31	--[a]
2003	September	30	--[a]
2003	October	6	--[a]
2003	November	24	--[a]
2003	December	31	--[a]
2004	January	31	--[a]
2004	February	28	--[a]
2004	March	31	--[a]
2004	April	30	--[a]
2004	May	31	--[a]
2004	June	30	--[a]
2004	July	31	--[a]
2004	August	31	--[a]
2004	September	30	--[a]
2004	October	31	--[a]
2004	November	30	--[a]
2004	December	31	--[a]

[a]/ No data available.

Table D3. Estimated percent habitat available in Newton Lake at 1600 hours on 4 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available: Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	100	96	100	100	99
4	88	100	96	100	100	99
4	89	100	96	100	100	99
4	90	100	96	100	100	99
4	91	100	96	100	100	99
4	92	100	96	100	100	99
4	93	100	96	100	100	99
4	94	100	96	100	100	99
4	95	100	96	100	100	99
4	96	100	96	100	100	99
4	97	100	96	100	100	99
3	87	100	100	100	100	100
3	88	100	100	100	100	100
3	89	100	100	100	100	100
3	90	100	100	100	100	100
3	91	100	100	100	100	100
3	92	100	100	100	100	100
3	93	100	100	100	100	100
3	94	100	100	100	100	100
3	95	100	100	100	100	100
3	96	100	100	100	100	100
3	97	100	100	100	100	100
2	87	100	100	100	100	100
2	88	100	100	100	100	100
2	89	100	100	100	100	100
2	90	100	100	100	100	100
2	91	100	100	100	100	100
2	92	100	100	100	100	100
2	93	100	100	100	100	100
2	94	100	100	100	100	100
2	95	100	100	100	100	100
2	96	100	100	100	100	100
2	97	100	100	100	100	100
1	87	100	100	100	100	100
1	88	100	100	100	100	100
1	89	100	100	100	100	100
1	90	100	100	100	100	100
1	91	100	100	100	100	100
1	92	100	100	100	100	100
1	93	100	100	100	100	100
1	94	100	100	100	100	100
1	95	100	100	100	100	100
1	96	100	100	100	100	100
1	97	100	100	100	100	100

Table D4. Estimated percent habitat available in Newton Lake at 1200 hours on 11 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	33	50	94	44
4	88	0	33	50	94	44
4	89	13	33	50	94	48
4	90	25	33	50	94	51
4	91	38	33	50	94	54
4	92	38	40	50	94	56
4	93	50	47	50	94	60
4	94	63	63	50	94	68
4	95	81	63	50	94	72
4	96	81	63	50	94	72
4	97	81	63	50	94	72
3	87	0	40	66	100	52
3	88	0	40	66	100	52
3	89	13	40	66	100	55
3	90	25	40	66	100	58
3	91	38	40	66	100	61
3	92	38	47	66	100	63
3	93	50	53	66	100	67
3	94	63	70	66	100	75
3	95	81	70	66	100	79
3	96	81	70	66	100	79
3	97	81	70	66	100	79
2	87	0	47	76	100	56
2	88	0	47	76	100	56
2	89	13	47	76	100	59
2	90	25	47	76	100	62
2	91	38	47	76	100	65
2	92	38	53	76	100	67
2	93	50	60	76	100	72
2	94	63	77	76	100	79
2	95	81	77	76	100	84
2	96	81	77	76	100	84
2	97	81	77	76	100	84
1	87	19	47	82	100	62
1	88	19	47	82	100	62
1	89	31	47	82	100	65
1	90	44	47	82	100	68
1	91	56	47	82	100	71
1	92	56	53	82	100	73
1	93	69	60	82	100	78
1	94	81	77	82	100	85
1	95	100	77	82	100	90
1	96	100	77	82	100	90
1	97	100	77	82	100	90

Table D5. Estimated percent habitat available in Newton Lake at 1300 hours on 18 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	7	14	53	100	44
4	88	7	14	53	100	44
4	89	7	21	53	100	45
4	90	21	21	53	100	49
4	91	36	39	53	100	57
4	92	50	46	53	100	62
4	93	79	46	53	100	70
4	94	100	46	53	100	75
4	95	100	46	53	100	75
4	96	100	46	53	100	75
4	97	100	46	53	100	75
3	87	7	21	53	100	45
3	88	7	21	53	100	45
3	89	7	29	53	100	47
3	90	21	29	53	100	51
3	91	36	46	53	100	59
3	92	50	54	53	100	64
3	93	79	54	53	100	72
3	94	100	54	53	100	77
3	95	100	54	53	100	77
3	96	100	54	53	100	77
3	97	100	54	53	100	77
2	87	7	36	58	100	50
2	88	7	36	58	100	50
2	89	7	43	58	100	52
2	90	21	43	58	100	56
2	91	36	61	58	100	64
2	92	50	68	58	100	69
2	93	79	68	58	100	76
2	94	100	68	58	100	82
2	95	100	68	58	100	82
2	96	100	68	58	100	82
2	97	100	68	58	100	82
1	87	7	43	64	100	54
1	88	7	43	64	100	54
1	89	7	50	64	100	55
1	90	21	50	64	100	59
1	91	36	68	64	100	67
1	92	50	75	64	100	72
1	93	79	75	64	100	80
1	94	100	75	64	100	85
1	95	100	75	64	100	85
1	96	100	75	64	100	85
1	97	100	75	64	100	85

Table D6. Estimated percent habitat available in Newton Lake at 1200 hours on 25 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4). Segments 3 and 4 were unable to be completed due to inclement weather.

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	7			4
4	88	0	7			4
4	89	0	7			4
4	90	0	7			4
4	91	0	7			4
4	92	25	14			20
4	93	38	21			30
4	94	50	21			36
4	95	69	29			49
4	96	69	39			54
4	97	69	39			54
3	87	13	21			17
3	88	13	21			17
3	89	13	21			17
3	90	13	21			17
3	91	13	21			17
3	92	38	29			34
3	93	50	36			43
3	94	63	36			50
3	95	81	43			62
3	96	81	54			68
3	97	81	54			68
2	87	25	29			27
2	88	25	29			27
2	89	25	29			27
2	90	25	29			27
2	91	25	29			27
2	92	50	36			43
2	93	63	43			53
2	94	75	43			59
2	95	94	50			72
2	96	94	61			78
2	97	94	61			78
1	87	25	36			31
1	88	25	36			31
1	89	25	36			31
1	90	25	36			31
1	91	25	36			31
1	92	50	43			47
1	93	63	50			57
1	94	75	50			63
1	95	94	57			76
1	96	94	68			81
1	97	94	68			81

Table D7. Estimated percent habitat available in Newton Lake at 1700 hours on 1 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	50	71	100	55
4	88	11	50	71	100	58
4	89	11	50	71	100	58
4	90	44	50	71	100	66
4	91	67	50	71	100	72
4	92	94	50	71	100	79
4	93	94	50	71	100	79
4	94	94	50	71	100	79
4	95	94	50	71	100	79
4	96	94	50	71	100	79
4	97	94	50	71	100	79
3	87	0	57	71	100	57
3	88	11	57	71	100	60
3	89	11	57	71	100	60
3	90	44	57	71	100	68
3	91	67	57	71	100	74
3	92	94	57	71	100	81
3	93	94	57	71	100	81
3	94	94	57	71	100	81
3	95	94	57	71	100	81
3	96	94	57	71	100	81
3	97	94	57	71	100	81
2	87	0	70	76	100	62
2	88	11	70	76	100	64
2	89	11	70	76	100	64
2	90	44	70	76	100	73
2	91	67	70	76	100	78
2	92	94	70	76	100	85
2	93	94	70	76	100	85
2	94	94	70	76	100	85
2	95	94	70	76	100	85
2	96	94	70	76	100	85
2	97	94	70	76	100	85
1	87	6	77	82	100	66
1	88	17	77	82	100	69
1	89	17	77	82	100	69
1	90	50	77	82	100	77
1	91	72	77	82	100	83
1	92	100	77	82	100	90
1	93	100	77	82	100	90
1	94	100	77	82	100	90
1	95	100	77	82	100	90
1	96	100	77	82	100	90
1	97	100	77	82	100	90

Table D8. Estimated percent habitat available in Newton Lake at 1400 hours on 8 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	45	95	35
4	88	0	0	53	95	37
4	89	0	0	53	95	37
4	90	11	0	53	95	40
4	91	11	6	53	95	41
4	92	11	13	53	95	43
4	93	11	13	53	95	43
4	94	22	13	53	95	46
4	95	33	34	53	95	54
4	96	44	34	53	95	57
4	97	44	34	53	95	57
3	87	0	0	45	95	35
3	88	0	0	53	95	37
3	89	0	0	53	95	37
3	90	11	0	53	95	40
3	91	11	6	53	95	41
3	92	11	13	53	95	43
3	93	11	13	53	95	43
3	94	22	13	53	95	46
3	95	33	34	53	95	54
3	96	44	34	53	95	57
3	97	44	34	53	95	57
2	87	0	19	55	100	44
2	88	0	19	63	100	46
2	89	0	19	63	100	46
2	90	11	19	63	100	48
2	91	11	25	63	100	50
2	92	11	31	63	100	51
2	93	11	31	63	100	51
2	94	22	31	63	100	54
2	95	33	53	63	100	62
2	96	44	53	63	100	65
2	97	44	53	63	100	65
1	87	0	25	55	100	45
1	88	0	25	63	100	47
1	89	0	25	63	100	47
1	90	11	25	63	100	50
1	91	11	31	63	100	51
1	92	11	38	63	100	53
1	93	11	38	63	100	53
1	94	22	38	63	100	56
1	95	33	59	63	100	64
1	96	44	59	63	100	67
1	97	44	59	63	100	67

Table D9. Estimated percent habitat available in Newton Lake at 1500 hours on 15 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	5	30	9
4	88	0	0	11	50	15
4	89	0	0	16	85	25
4	90	0	0	39	85	31
4	91	0	0	39	85	31
4	92	0	0	39	85	31
4	93	0	0	39	85	31
4	94	0	0	39	85	31
4	95	0	0	39	85	31
4	96	13	0	39	85	34
4	97	13	7	39	85	36
3	87	0	7	5	30	11
3	88	0	13	11	50	19
3	89	0	13	16	85	29
3	90	0	13	39	85	34
3	91	0	13	39	85	34
3	92	0	13	39	85	34
3	93	0	13	39	85	34
3	94	13	20	39	85	39
3	95	13	20	39	85	39
3	96	25	20	39	85	42
3	97	25	27	39	85	44
2	87	0	7	11	30	12
2	88	0	13	16	50	20
2	89	0	13	21	85	30
2	90	0	13	45	85	36
2	91	0	13	45	85	36
2	92	0	13	45	85	36
2	93	0	13	45	85	36
2	94	13	20	45	85	41
2	95	13	20	45	85	41
2	96	25	20	45	85	44
2	97	25	27	45	85	46
1	87	0	13	16	40	17
1	88	0	20	21	60	25
1	89	0	20	26	95	35
1	90	0	20	50	95	41
1	91	0	20	50	95	41
1	92	0	20	50	95	41
1	93	0	20	50	95	41
1	94	13	27	50	95	46
1	95	13	27	50	95	46
1	96	25	27	50	95	49
1	97	25	33	50	95	51

Table D10. Estimated percent habitat available in Newton Lake at 1200 hours on 22 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	53	100	38
4	88	0	7	53	100	40
4	89	0	7	53	100	40
4	90	0	13	53	100	42
4	91	0	20	53	100	43
4	92	13	43	53	100	52
4	93	69	43	53	100	66
4	94	69	43	53	100	66
4	95	69	43	53	100	66
4	96	69	43	53	100	66
4	97	69	43	53	100	66
3	87	0	0	64	100	41
3	88	0	13	64	100	44
3	89	0	13	64	100	44
3	90	13	20	64	100	49
3	91	13	27	64	100	51
3	92	25	50	64	100	60
3	93	81	50	64	100	74
3	94	81	50	64	100	74
3	95	81	50	64	100	74
3	96	81	50	64	100	74
3	97	81	50	64	100	74
2	87	0	7	64	100	43
2	88	0	20	64	100	46
2	89	0	20	64	100	46
2	90	13	27	64	100	51
2	91	13	33	64	100	53
2	92	25	57	64	100	62
2	93	81	57	64	100	76
2	94	81	57	64	100	76
2	95	81	57	64	100	76
2	96	81	57	64	100	76
2	97	81	57	64	100	76
1	87	0	13	64	100	44
1	88	0	27	64	100	48
1	89	0	27	64	100	48
1	90	13	33	64	100	53
1	91	13	40	64	100	54
1	92	25	63	64	100	63
1	93	81	63	64	100	77
1	94	81	63	64	100	77
1	95	81	63	64	100	77
1	96	81	63	64	100	77
1	97	81	63	64	100	77

Table D11. Estimated percent habitat available in Newton Lake at 1500 hours on 29 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	32	55	22
4	88	0	0	32	68	25
4	89	0	6	37	68	28
4	90	0	6	37	68	28
4	91	0	13	45	68	32
4	92	0	19	45	68	33
4	93	13	25	45	68	38
4	94	38	25	45	68	44
4	95	56	34	45	68	51
4	96	56	34	45	68	51
4	97	56	34	45	68	51
3	87	0	6	37	55	25
3	88	0	6	37	68	28
3	89	0	13	42	68	31
3	90	0	13	42	68	31
3	91	0	19	50	68	34
3	92	0	25	50	68	36
3	93	13	31	50	68	41
3	94	38	31	50	68	47
3	95	56	41	50	68	54
3	96	56	41	50	68	54
3	97	56	41	50	68	54
2	87	0	6	42	64	28
2	88	0	6	42	77	31
2	89	0	13	47	77	34
2	90	13	13	47	77	38
2	91	13	19	55	77	41
2	92	13	25	55	77	43
2	93	25	31	55	77	47
2	94	50	31	55	77	53
2	95	69	41	55	77	61
2	96	69	41	55	77	61
2	97	69	41	55	77	61
1	87	0	19	47	73	35
1	88	0	19	47	86	38
1	89	0	25	53	86	41
1	90	13	25	53	86	44
1	91	13	31	61	86	48
1	92	13	38	61	86	50
1	93	25	44	61	86	54
1	94	50	44	61	86	60
1	95	69	53	61	86	67
1	96	69	53	61	86	67
1	97	69	53	61	86	67

Table D12. Estimated percent habitat available in Newton Lake at 1800 hours on 6 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	39	95	34
4	88	0	13	47	95	39
4	89	0	25	47	95	42
4	90	6	31	47	95	45
4	91	19	38	47	95	50
4	92	81	53	47	95	69
4	93	100	53	47	95	74
4	94	100	53	47	95	74
4	95	100	53	47	95	74
4	96	100	53	47	95	74
4	97	100	53	47	95	74
3	87	0	0	44	100	36
3	88	0	13	53	100	42
3	89	0	25	53	100	45
3	90	6	31	53	100	48
3	91	19	38	53	100	53
3	92	81	53	53	100	72
3	93	100	53	53	100	77
3	94	100	53	53	100	77
3	95	100	53	53	100	77
3	96	100	53	53	100	77
3	97	100	53	53	100	77
2	87	0	0	50	100	38
2	88	0	13	58	100	43
2	89	0	25	58	100	46
2	90	6	31	58	100	49
2	91	19	38	58	100	54
2	92	81	53	58	100	73
2	93	100	53	58	100	78
2	94	100	53	58	100	78
2	95	100	53	58	100	78
2	96	100	53	58	100	78
2	97	100	53	58	100	78
1	87	0	0	56	100	39
1	88	0	13	64	100	44
1	89	0	25	64	100	47
1	90	6	31	64	100	50
1	91	19	38	64	100	55
1	92	81	53	64	100	75
1	93	100	53	64	100	79
1	94	100	53	64	100	79
1	95	100	53	64	100	79
1	96	100	53	64	100	79
1	97	100	53	64	100	79

Table D13. Estimated percent habitat available in Newton Lake at 1800 hours on 13 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	6	0	2
4	90	0	0	6	17	6
4	91	0	0	11	25	9
4	92	0	0	36	63	25
4	93	0	0	36	63	25
4	94	0	0	36	63	25
4	95	0	6	36	63	26
4	96	0	13	36	63	28
4	97	0	28	36	63	32
3	87	0	0	0	0	0
3	88	0	0	6	0	2
3	89	0	0	11	0	3
3	90	0	0	11	17	7
3	91	0	0	17	25	11
3	92	0	0	42	63	26
3	93	0	0	42	63	26
3	94	0	0	42	63	26
3	95	0	6	42	63	28
3	96	0	13	42	63	30
3	97	0	28	42	63	33
2	87	0	0	6	8	4
2	88	0	0	11	8	5
2	89	0	0	17	8	6
2	90	0	0	17	25	11
2	91	0	6	22	33	15
2	92	0	6	47	71	31
2	93	14	6	47	71	35
2	94	14	6	47	71	35
2	95	14	13	47	71	36
2	96	14	19	47	71	38
2	97	14	34	47	71	42
1	87	0	0	6	8	4
1	88	0	0	11	8	5
1	89	0	6	17	8	8
1	90	0	6	17	25	12
1	91	0	13	22	33	17
1	92	0	13	47	71	33
1	93	14	13	47	71	36
1	94	14	13	47	71	36
1	95	14	19	47	71	38
1	96	14	25	47	71	39
1	97	14	41	47	71	43

Table D14. Estimated percent habitat available in Newton Lake at 1600 hours on 20 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	17	4
4	88	0	0	6	61	17
4	89	0	0	11	100	28
4	90	0	0	53	100	38
4	91	0	0	53	100	38
4	92	0	0	53	100	38
4	93	0	0	53	100	38
4	94	0	43	53	100	49
4	95	25	43	53	100	55
4	96	63	43	53	100	65
4	97	94	43	53	100	73
3	87	0	0	6	17	6
3	88	0	0	11	61	18
3	89	0	0	17	100	29
3	90	0	0	58	100	40
3	91	0	0	58	100	40
3	92	0	0	58	100	40
3	93	0	0	58	100	40
3	94	0	43	58	100	50
3	95	25	43	58	100	57
3	96	63	43	58	100	66
3	97	94	43	58	100	74
2	87	0	0	6	17	6
2	88	0	0	11	61	18
2	89	0	0	17	100	29
2	90	0	0	58	100	40
2	91	0	7	58	100	41
2	92	0	7	58	100	41
2	93	0	7	58	100	41
2	94	0	50	58	100	52
2	95	25	50	58	100	58
2	96	63	50	58	100	68
2	97	94	50	58	100	76
1	87	0	0	6	17	6
1	88	0	0	11	61	18
1	89	0	0	17	100	29
1	90	0	0	58	100	40
1	91	0	7	58	100	41
1	92	0	7	58	100	41
1	93	0	7	58	100	41
1	94	0	50	58	100	52
1	95	25	50	58	100	58
1	96	63	50	58	100	68
1	97	94	50	58	100	76

Table D15. Estimated percent habitat available in Newton Lake at 1500 hours on 27 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	13	58	86	88	61
4	88	25	58	86	88	64
4	89	50	58	86	88	71
4	90	69	58	86	88	75
4	91	81	58	86	88	78
4	92	81	58	86	88	78
4	93	81	58	86	88	78
4	94	81	58	86	88	78
4	95	81	58	86	88	78
4	96	81	58	86	88	78
4	97	81	58	86	88	78
3	87	13	63	86	88	63
3	88	25	63	86	88	66
3	89	50	63	86	88	72
3	90	69	63	86	88	77
3	91	81	63	86	88	80
3	92	81	63	86	88	80
3	93	81	63	86	88	80
3	94	81	63	86	88	80
3	95	81	63	86	88	80
3	96	81	63	86	88	80
3	97	81	63	86	88	80
2	87	13	68	86	88	64
2	88	25	68	86	88	67
2	89	50	68	86	88	73
2	90	69	68	86	88	78
2	91	81	68	86	88	81
2	92	81	68	86	88	81
2	93	81	68	86	88	81
2	94	81	68	86	88	81
2	95	81	68	86	88	81
2	96	81	68	86	88	81
2	97	81	68	86	88	81
1	87	25	78	86	88	69
1	88	38	78	86	88	73
1	89	63	78	86	88	79
1	90	81	78	86	88	83
1	91	94	78	86	88	87
1	92	94	78	86	88	87
1	93	94	78	86	88	87
1	94	94	78	86	88	87
1	95	94	78	86	88	87
1	96	94	78	86	88	87
1	97	94	78	86	88	87

Table D16. Estimated percent habitat available in Newton Lake at 1500 hours on 3 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	16	9	6
4	88	0	0	16	9	6
4	89	10	0	16	27	13
4	90	10	0	21	45	19
4	91	20	0	21	55	24
4	92	20	0	26	64	28
4	93	20	0	32	68	30
4	94	20	6	39	68	33
4	95	20	6	39	68	33
4	96	30	11	39	68	37
4	97	30	25	39	68	41
3	87	0	0	16	18	9
3	88	0	0	16	18	9
3	89	10	0	16	36	16
3	90	10	0	21	55	22
3	91	20	0	21	64	26
3	92	20	0	26	73	30
3	93	20	0	32	77	32
3	94	20	6	39	77	36
3	95	20	6	39	77	36
3	96	30	11	39	77	39
3	97	30	25	39	77	43
2	87	0	11	21	18	13
2	88	0	11	21	18	13
2	89	10	11	21	36	20
2	90	10	11	26	55	26
2	91	20	11	26	64	30
2	92	20	11	32	73	34
2	93	20	11	37	77	36
2	94	20	17	45	77	40
2	95	20	17	45	77	40
2	96	30	22	45	77	44
2	97	30	36	45	77	47
1	87	0	17	32	18	17
1	88	10	22	32	18	21
1	89	20	22	32	36	28
1	90	20	22	37	55	34
1	91	30	22	37	64	38
1	92	30	22	42	73	42
1	93	30	22	47	77	44
1	94	30	28	55	77	48
1	95	30	28	55	77	48
1	96	40	33	55	77	51
1	97	40	47	55	77	55

Table D17. Estimated percent habitat available in Newton Lake at 1600 hours on 10 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available				
		Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	28	88	29
4	88	0	0	58	88	37
4	89	0	0	58	88	37
4	90	22	0	58	88	42
4	91	22	0	58	88	42
4	92	44	6	58	88	49
4	93	44	6	58	88	49
4	94	83	12	58	88	60
4	95	83	26	58	88	64
4	96	83	26	58	88	64
4	97	83	26	58	88	64
3	87	0	0	33	88	30
3	88	0	0	64	88	38
3	89	0	0	64	88	38
3	90	22	0	64	88	44
3	91	22	0	64	88	44
3	92	44	6	64	88	51
3	93	44	6	64	88	51
3	94	83	12	64	88	62
3	95	83	26	64	88	65
3	96	83	26	64	88	65
3	97	83	26	64	88	65
2	87	0	0	39	88	32
2	88	0	0	69	88	39
2	89	0	6	69	88	41
2	90	22	6	69	88	46
2	91	22	6	69	88	46
2	92	44	12	69	88	53
2	93	44	12	69	88	53
2	94	83	18	69	88	65
2	95	83	32	69	88	68
2	96	83	32	69	88	68
2	97	83	32	69	88	68
1	87	0	12	44	88	36
1	88	0	12	75	88	44
1	89	0	18	75	88	45
1	90	22	18	75	88	51
1	91	22	18	75	88	51
1	92	44	24	75	88	58
1	93	44	24	75	88	58
1	94	83	29	75	88	69
1	95	83	44	75	88	73
1	96	83	44	75	88	73
1	97	83	44	75	88	73

Table D18. Estimated percent habitat available in Newton Lake at 1600 hours on 17 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

Minimum oxygen (ppm)	Maximum temperature (°F)	Percent habitat available Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	6	81	95	46
4	88	0	25	81	95	50
4	89	0	47	81	95	56
4	90	0	47	81	95	56
4	91	22	47	81	95	61
4	92	56	47	81	95	70
4	93	67	47	81	95	73
4	94	83	47	81	95	77
4	95	83	47	81	95	77
4	96	83	47	81	95	77
4	97	83	47	81	95	77
3	87	0	6	81	95	46
3	88	0	25	81	95	50
3	89	0	47	81	95	56
3	90	0	47	81	95	56
3	91	22	47	81	95	61
3	92	56	47	81	95	70
3	93	67	47	81	95	73
3	94	83	47	81	95	77
3	95	83	47	81	95	77
3	96	83	47	81	95	77
3	97	83	47	81	95	77
2	87	0	13	86	95	49
2	88	0	31	86	95	53
2	89	0	53	86	95	59
2	90	0	53	86	95	59
2	91	22	53	86	95	64
2	92	56	53	86	95	73
2	93	67	53	86	95	75
2	94	83	53	86	95	79
2	95	83	53	86	95	79
2	96	83	53	86	95	79
2	97	83	53	86	95	79
1	87	0	13	92	95	50
1	88	0	31	92	95	55
1	89	0	53	92	95	60
1	90	0	53	92	95	60
1	91	22	53	92	95	66
1	92	56	53	92	95	74
1	93	67	53	92	95	77
1	94	83	53	92	95	81
1	95	83	53	92	95	81
1	96	83	53	92	95	81
1	97	83	53	92	95	81

Table D19. Estimated percent habitat available in Newton Lake at 1100 hours on 25 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	69	86	39
4	88	0	0	69	86	39
4	89	0	0	69	86	39
4	90	0	17	69	86	43
4	91	0	17	69	86	43
4	92	94	54	69	86	76
4	93	94	54	69	86	76
4	94	94	54	69	86	76
4	95	94	54	69	86	76
4	96	94	54	69	86	76
4	97	94	54	69	86	76
3	87	0	0	75	86	40
3	88	0	0	75	86	40
3	89	0	0	75	86	40
3	90	0	17	75	86	45
3	91	0	17	75	86	45
3	92	94	54	75	86	77
3	93	94	54	75	86	77
3	94	94	54	75	86	77
3	95	94	54	75	86	77
3	96	94	54	75	86	77
3	97	94	54	75	86	77
2	87	0	0	75	86	40
2	88	0	0	75	86	40
2	89	0	0	75	86	40
2	90	0	17	75	86	45
2	91	0	17	75	86	45
2	92	94	54	75	86	77
2	93	94	54	75	86	77
2	94	94	54	75	86	77
2	95	94	54	75	86	77
2	96	94	54	75	86	77
2	97	94	54	75	86	77
1	87	0	17	75	86	45
1	88	0	25	75	86	47
1	89	0	25	75	86	47
1	90	6	42	75	86	52
1	91	6	42	75	86	52
1	92	100	79	75	86	85
1	93	100	79	75	86	85
1	94	100	79	75	86	85
1	95	100	79	75	86	85
1	96	100	79	75	86	85
1	97	100	79	75	86	85

Table D20. Estimated percent habitat available in Newton Lake at 1800 hours on 31 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	25	53	73	38
4	88	11	31	61	86	47
4	89	11	31	61	86	47
4	90	22	38	61	86	52
4	91	22	38	61	86	52
4	92	44	44	61	86	59
4	93	44	44	61	86	59
4	94	72	53	61	86	68
4	95	72	53	61	86	68
4	96	72	53	61	86	68
4	97	72	53	61	86	68
3	87	0	25	68	82	44
3	88	11	31	76	95	53
3	89	11	31	76	95	53
3	90	22	38	76	95	58
3	91	22	38	76	95	58
3	92	44	44	76	95	65
3	93	44	44	76	95	65
3	94	72	53	76	95	74
3	95	72	53	76	95	74
3	96	72	53	76	95	74
3	97	72	53	76	95	74
2	87	11	31	68	82	48
2	88	22	38	76	95	58
2	89	22	38	76	95	58
2	90	33	44	76	95	62
2	91	33	44	76	95	62
2	92	56	50	76	95	69
2	93	56	50	76	95	69
2	94	83	59	76	95	78
2	95	83	59	76	95	78
2	96	83	59	76	95	78
2	97	83	59	76	95	78
1	87	22	38	74	82	54
1	88	33	44	82	95	64
1	89	33	44	82	95	64
1	90	44	50	82	95	68
1	91	44	50	82	95	68
1	92	67	56	82	95	75
1	93	67	56	82	95	75
1	94	94	66	82	95	84
1	95	94	66	82	95	84
1	96	94	66	82	95	84
1	97	94	66	82	95	84

Table D21. Estimated percent habitat available in Newton Lake at 1600 hours on 7 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	81	85	42
4	88	0	7	81	85	43
4	89	0	20	81	85	47
4	90	0	57	81	85	56
4	91	0	57	81	85	56
4	92	11	57	81	85	59
4	93	22	57	81	85	61
4	94	50	57	81	85	68
4	95	50	57	81	85	68
4	96	50	57	81	85	68
4	97	50	57	81	85	68
3	87	0	0	81	85	42
3	88	0	7	81	85	43
3	89	0	20	81	85	47
3	90	0	57	81	85	56
3	91	0	57	81	85	56
3	92	22	57	81	85	61
3	93	33	57	81	85	64
3	94	61	57	81	85	71
3	95	61	57	81	85	71
3	96	61	57	81	85	71
3	97	61	57	81	85	71
2	87	0	0	81	95	44
2	88	0	7	81	95	46
2	89	0	20	81	95	49
2	90	0	57	81	95	58
2	91	0	57	81	95	58
2	92	22	57	81	95	64
2	93	33	57	81	95	67
2	94	61	57	81	95	74
2	95	61	57	81	95	74
2	96	61	57	81	95	74
2	97	61	57	81	95	74
1	87	0	0	81	95	44
1	88	0	7	81	95	46
1	89	0	20	81	95	49
1	90	0	57	81	95	58
1	91	0	57	81	95	58
1	92	22	57	81	95	64
1	93	33	57	81	95	67
1	94	61	57	81	95	74
1	95	61	57	81	95	74
1	96	61	57	81	95	74
1	97	61	57	81	95	74

Table D22. Estimated percent habitat available in Newton Lake at 1500 hours on 14 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	74	100	44
4	88	0	0	74	100	44
4	89	0	7	74	100	45
4	90	0	20	74	100	49
4	91	0	43	74	100	54
4	92	63	43	74	100	70
4	93	94	43	74	100	78
4	94	94	43	74	100	78
4	95	94	43	74	100	78
4	96	94	43	74	100	78
4	97	94	43	74	100	78
3	87	0	0	74	100	44
3	88	0	0	74	100	44
3	89	0	7	74	100	45
3	90	0	20	74	100	49
3	91	6	43	74	100	56
3	92	69	43	74	100	72
3	93	100	43	74	100	79
3	94	100	43	74	100	79
3	95	100	43	74	100	79
3	96	100	43	74	100	79
3	97	100	43	74	100	79
2	87	0	0	79	100	45
2	88	0	0	79	100	45
2	89	0	7	79	100	47
2	90	0	20	79	100	50
2	91	6	43	79	100	57
2	92	69	43	79	100	73
2	93	100	43	79	100	81
2	94	100	43	79	100	81
2	95	100	43	79	100	81
2	96	100	43	79	100	81
2	97	100	43	79	100	81
1	87	0	0	79	100	45
1	88	0	0	79	100	45
1	89	0	7	79	100	47
1	90	0	20	79	100	50
1	91	6	43	79	100	57
1	92	69	43	79	100	73
1	93	100	43	79	100	81
1	94	100	43	79	100	81
1	95	100	43	79	100	81
1	96	100	43	79	100	81
1	97	100	43	79	100	81

Table D23. Estimated percent habitat available in Newton Lake at 1500 hours on 21 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1) to intake area (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	13	81	100	49
4	88	0	20	81	100	50
4	89	25	27	81	100	58
4	90	25	37	81	100	61
4	91	50	37	81	100	67
4	92	63	37	81	100	70
4	93	81	37	81	100	75
4	94	81	37	81	100	75
4	95	81	37	81	100	75
4	96	81	37	81	100	75
4	97	81	37	81	100	75
3	87	0	13	92	100	51
3	88	0	20	92	100	53
3	89	25	27	92	100	61
3	90	25	37	92	100	64
3	91	50	37	92	100	70
3	92	63	37	92	100	73
3	93	81	37	92	100	78
3	94	81	37	92	100	78
3	95	81	37	92	100	78
3	96	81	37	92	100	78
3	97	81	37	92	100	78
2	87	13	27	92	100	58
2	88	13	33	92	100	60
2	89	38	40	92	100	68
2	90	38	50	92	100	70
2	91	63	50	92	100	76
2	92	75	50	92	100	79
2	93	94	50	92	100	84
2	94	94	50	92	100	84
2	95	94	50	92	100	84
2	96	94	50	92	100	84
2	97	94	50	92	100	84
1	87	13	53	92	100	65
1	88	13	60	92	100	66
1	89	38	67	92	100	74
1	90	38	77	92	100	77
1	91	63	77	92	100	83
1	92	75	77	92	100	86
1	93	94	77	92	100	91
1	94	94	77	92	100	91
1	95	94	77	92	100	91
1	96	94	77	92	100	91
1	97	94	77	92	100	91

Table D24. Estimated percent habitat available in Coffeen Lake at 1200 hours on 5 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	50	65	100	100	79
4	88	55	65	100	100	80
4	89	63	65	100	100	82
4	90	63	65	100	100	82
4	91	63	65	100	100	82
4	92	63	65	100	100	82
4	93	63	65	100	100	82
4	94	63	65	100	100	82
4	95	63	65	100	100	82
4	96	63	65	100	100	82
4	97	63	65	100	100	82
3	87	60	73	100	100	83
3	88	65	73	100	100	85
3	89	73	73	100	100	87
3	90	73	73	100	100	87
3	91	73	73	100	100	87
3	92	73	73	100	100	87
3	93	73	73	100	100	87
3	94	73	73	100	100	87
3	95	73	73	100	100	87
3	96	73	73	100	100	87
3	97	73	73	100	100	87
2	87	70	90	100	100	90
2	88	75	90	100	100	91
2	89	83	90	100	100	93
2	90	83	90	100	100	93
2	91	83	90	100	100	93
2	92	83	90	100	100	93
2	93	83	90	100	100	93
2	94	83	90	100	100	93
2	95	83	90	100	100	93
2	96	83	90	100	100	93
2	97	83	90	100	100	93
1	87	80	98	100	100	95
1	88	85	98	100	100	96
1	89	93	98	100	100	98
1	90	93	98	100	100	98
1	91	93	98	100	100	98
1	92	93	98	100	100	98
1	93	93	98	100	100	98
1	94	93	98	100	100	98
1	95	93	98	100	100	98
1	96	93	98	100	100	98
1	97	93	98	100	100	98

Table D25. Estimated percent habitat available in Coffeen Lake at 1200 hours on 12 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	53	43	100	90	72
4	88	53	43	100	90	72
4	89	53	43	100	90	72
4	90	53	43	100	90	72
4	91	53	43	100	90	72
4	92	53	43	100	90	72
4	93	53	43	100	90	72
4	94	53	43	100	90	72
4	95	53	43	100	90	72
4	96	53	43	100	90	72
4	97	53	43	100	90	72
3	87	58	43	100	97	75
3	88	58	43	100	97	75
3	89	58	43	100	97	75
3	90	58	43	100	97	75
3	91	58	43	100	97	75
3	92	58	43	100	97	75
3	93	58	43	100	97	75
3	94	58	43	100	97	75
3	95	58	43	100	97	75
3	96	58	43	100	97	75
3	97	58	43	100	97	75
2	87	63	57	100	97	79
2	88	63	57	100	97	79
2	89	63	57	100	97	79
2	90	63	57	100	97	79
2	91	63	57	100	97	79
2	92	63	57	100	97	79
2	93	63	57	100	97	79
2	94	63	57	100	97	79
2	95	63	57	100	97	79
2	96	63	57	100	97	79
2	97	63	57	100	97	79
1	87	68	69	100	100	84
1	88	68	69	100	100	84
1	89	68	69	100	100	84
1	90	68	69	100	100	84
1	91	68	69	100	100	84
1	92	68	69	100	100	84
1	93	68	69	100	100	84
1	94	68	69	100	100	84
1	95	68	69	100	100	84
1	96	68	69	100	100	84
1	97	68	69	100	100	84

Table D26. Estimated percent habitat available in Coffeen Lake at 1300 hours on 19 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	58	52	97	96	76
4	88	58	52	97	96	76
4	89	58	52	97	96	76
4	90	58	52	97	96	76
4	91	58	52	97	96	76
4	92	58	52	97	96	76
4	93	58	52	97	96	76
4	94	58	52	97	96	76
4	95	58	52	97	96	76
4	96	58	52	97	96	76
4	97	58	52	97	96	76
3	87	63	52	100	100	79
3	88	63	52	100	100	79
3	89	63	52	100	100	79
3	90	63	52	100	100	79
3	91	63	52	100	100	79
3	92	63	52	100	100	79
3	93	63	52	100	100	79
3	94	63	52	100	100	79
3	95	63	52	100	100	79
3	96	63	52	100	100	79
3	97	63	52	100	100	79
2	87	68	60	100	100	82
2	88	68	60	100	100	82
2	89	68	60	100	100	82
2	90	68	60	100	100	82
2	91	68	60	100	100	82
2	92	68	60	100	100	82
2	93	68	60	100	100	82
2	94	68	60	100	100	82
2	95	68	60	100	100	82
2	96	68	60	100	100	82
2	97	68	60	100	100	82
1	87	83	63	100	100	87
1	88	83	63	100	100	87
1	89	83	63	100	100	87
1	90	83	63	100	100	87
1	91	83	63	100	100	87
1	92	83	63	100	100	87
1	93	83	63	100	100	87
1	94	83	63	100	100	87
1	95	83	63	100	100	87
1	96	83	63	100	100	87
1	97	83	63	100	100	87

Table D27. Estimated percent habitat available in Coffeen Lake at 1500 hours on 26 May 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	29	46	78	94	62
4	88	33	46	78	94	63
4	89	33	46	78	94	63
4	90	43	46	78	94	65
4	91	50	46	78	94	67
4	92	55	46	78	94	68
4	93	55	46	78	94	68
4	94	55	46	78	94	68
4	95	55	46	78	94	68
4	96	55	46	78	94	68
4	97	55	46	78	94	68
3	87	33	54	84	94	66
3	88	38	54	84	94	68
3	89	38	54	84	94	68
3	90	48	54	84	94	70
3	91	55	54	84	94	72
3	92	60	54	84	94	73
3	93	60	54	84	94	73
3	94	60	54	84	94	73
3	95	60	54	84	94	73
3	96	60	54	84	94	73
3	97	60	54	84	94	73
2	87	33	63	91	94	70
2	88	38	63	91	94	72
2	89	38	63	91	94	72
2	90	48	63	91	94	74
2	91	55	63	91	94	76
2	92	60	63	91	94	77
2	93	60	63	91	94	77
2	94	60	63	91	94	77
2	95	60	63	91	94	77
2	96	60	63	91	94	77
2	97	60	63	91	94	77
1	87	48	67	91	94	75
1	88	52	67	91	94	76
1	89	52	67	91	94	76
1	90	62	67	91	94	79
1	91	69	67	91	94	80
1	92	74	67	91	94	82
1	93	74	67	91	94	82
1	94	74	67	91	94	82
1	95	74	67	91	94	82
1	96	74	67	91	94	82
1	97	74	67	91	94	82

Table D28. Estimated percent habitat available in Coffeen Lake at 1300 hours on 2 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	14	50	96	74	59
4	88	14	50	96	74	59
4	89	14	50	96	74	59
4	90	29	50	96	74	62
4	91	33	50	96	74	63
4	92	38	50	96	74	65
4	93	50	50	96	74	68
4	94	50	50	96	74	68
4	95	50	50	96	74	68
4	96	50	50	96	74	68
4	97	50	50	96	74	68
3	87	19	59	96	85	65
3	88	19	59	96	85	65
3	89	19	59	96	85	65
3	90	33	59	96	85	68
3	91	38	59	96	85	70
3	92	43	59	96	85	71
3	93	55	59	96	85	74
3	94	55	59	96	85	74
3	95	55	59	96	85	74
3	96	55	59	96	85	74
3	97	55	59	96	85	74
2	87	24	63	96	91	69
2	88	24	63	96	91	69
2	89	24	63	96	91	69
2	90	38	63	96	91	72
2	91	43	63	96	91	73
2	92	48	63	96	91	75
2	93	60	63	96	91	78
2	94	60	63	96	91	78
2	95	60	63	96	91	78
2	96	60	63	96	91	78
2	97	60	63	96	91	78
1	87	29	67	96	91	71
1	88	29	67	96	91	71
1	89	29	67	96	91	71
1	90	43	67	96	91	74
1	91	48	67	96	91	76
1	92	52	67	96	91	77
1	93	64	67	96	91	80
1	94	64	67	96	91	80
1	95	64	67	96	91	80
1	96	64	67	96	91	80
1	97	64	67	96	91	80

Table D29. Estimated percent habitat available in Coffeen Lake at 1600 hours on 9 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	20	19	17	53	27
4	88	20	19	70	60	42
4	89	20	23	70	70	46
4	90	25	27	70	70	48
4	91	30	27	70	70	49
4	92	30	40	70	70	53
4	93	30	40	70	70	53
4	94	30	40	70	70	53
4	95	30	40	70	70	53
4	96	30	40	70	70	53
4	97	30	40	70	70	53
3	87	30	27	23	53	33
3	88	30	27	77	60	49
3	89	30	31	77	70	52
3	90	35	35	77	70	54
3	91	40	35	77	70	56
3	92	40	48	77	70	59
3	93	40	48	77	70	59
3	94	40	48	77	70	59
3	95	40	48	77	70	59
3	96	40	48	77	70	59
3	97	40	48	77	70	59
2	87	30	27	43	60	40
2	88	30	27	97	67	55
2	89	30	31	97	77	59
2	90	35	35	97	77	61
2	91	40	35	97	77	62
2	92	40	48	97	77	66
2	93	40	48	97	77	66
2	94	40	48	97	77	66
2	95	40	48	97	77	66
2	96	40	48	97	77	66
2	97	40	48	97	77	66
1	87	35	31	47	67	45
1	88	35	31	100	73	60
1	89	35	35	100	83	63
1	90	40	38	100	83	65
1	91	45	38	100	83	67
1	92	45	52	100	83	70
1	93	45	52	100	83	70
1	94	45	52	100	83	70
1	95	45	52	100	83	70
1	96	45	52	100	83	70
1	97	45	52	100	83	70

Table D30. Estimated percent habitat available in Coffeen Lake at 1200 hours on 16 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	7	7	4
4	89	0	4	13	20	9
4	90	0	8	63	67	35
4	91	5	12	83	83	46
4	92	5	16	83	83	47
4	93	5	38	83	83	52
4	94	5	42	83	83	53
4	95	10	42	83	83	55
4	96	10	42	83	83	55
4	97	10	42	83	83	55
3	87	0	0	7	0	2
3	88	0	0	13	7	5
3	89	5	4	20	20	12
3	90	10	8	70	67	39
3	91	15	12	90	83	50
3	92	15	16	90	83	51
3	93	15	38	90	83	57
3	94	15	42	90	83	58
3	95	20	42	90	83	59
3	96	20	42	90	83	59
3	97	20	42	90	83	59
2	87	5	0	13	0	5
2	88	10	4	20	7	10
2	89	20	8	27	20	19
2	90	25	12	77	67	45
2	91	30	16	97	83	57
2	92	30	20	97	83	58
2	93	30	42	97	83	63
2	94	30	46	97	83	64
2	95	35	46	97	83	65
2	96	35	46	97	83	65
2	97	35	46	97	83	65
1	87	5	8	13	0	7
1	88	10	12	20	7	12
1	89	20	16	27	20	21
1	90	25	20	77	67	47
1	91	30	24	97	83	59
1	92	30	28	97	83	60
1	93	30	50	97	83	65
1	94	30	54	97	83	66
1	95	35	54	97	83	67
1	96	35	54	97	83	67
1	97	35	54	97	83	67

Table D31. Estimated percent habitat available in Coffeen Lake at 1400 hours on 23 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	32	56	60	37
4	88	0	37	63	73	43
4	89	0	37	75	80	48
4	90	0	42	81	80	51
4	91	0	47	88	87	56
4	92	0	53	97	93	61
4	93	0	53	97	97	62
4	94	0	53	97	97	62
4	95	5	53	97	97	63
4	96	5	66	97	97	66
4	97	5	66	97	97	66
3	87	0	37	56	60	38
3	88	0	47	63	73	46
3	89	0	47	75	80	51
3	90	5	53	81	80	55
3	91	5	58	88	87	60
3	92	5	63	97	93	65
3	93	5	63	97	97	66
3	94	5	63	97	97	66
3	95	10	63	97	97	67
3	96	10	76	97	97	70
3	97	10	76	97	97	70
2	87	0	42	56	60	40
2	88	0	53	63	73	47
2	89	5	53	75	80	53
2	90	10	58	81	80	57
2	91	10	63	88	87	62
2	92	10	68	97	93	67
2	93	10	68	97	97	68
2	94	10	68	97	97	68
2	95	15	68	97	97	69
2	96	15	82	97	97	73
2	97	15	82	97	97	73
1	87	0	42	56	60	40
1	88	5	53	63	73	49
1	89	10	53	75	80	55
1	90	15	58	81	80	59
1	91	15	63	88	87	63
1	92	15	68	97	93	68
1	93	15	68	97	97	69
1	94	15	68	97	97	69
1	95	20	68	97	97	71
1	96	20	82	97	97	74
1	97	20	82	97	97	74

Table D32. Estimated percent habitat available in Coffeen Lake at 1300 hours on 30 June 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	7	0	2
4	88	0	4	14	13	8
4	89	0	8	14	27	12
4	90	0	8	21	40	17
4	91	0	15	43	53	28
4	92	0	15	57	53	31
4	93	0	15	71	67	38
4	94	0	15	79	77	43
4	95	5	19	82	77	46
4	96	5	23	82	77	47
4	97	5	33	82	77	49
3	87	0	4	21	0	6
3	88	0	12	29	13	14
3	89	0	15	29	27	18
3	90	5	15	36	40	24
3	91	5	23	57	53	35
3	92	5	23	71	53	38
3	93	5	23	86	67	45
3	94	5	23	93	77	50
3	95	10	27	96	77	53
3	96	10	31	96	77	54
3	97	10	40	96	77	56
2	87	0	4	25	0	7
2	88	0	12	32	13	14
2	89	5	15	32	27	20
2	90	10	15	39	40	26
2	91	10	23	61	53	37
2	92	10	23	75	53	40
2	93	10	23	89	67	47
2	94	10	23	96	77	52
2	95	15	27	100	77	55
2	96	15	31	100	77	56
2	97	15	40	100	77	58
1	87	0	12	25	0	9
1	88	0	19	32	13	16
1	89	10	23	32	27	23
1	90	15	23	39	40	29
1	91	15	31	61	53	40
1	92	15	31	75	53	44
1	93	15	31	89	67	51
1	94	15	31	96	77	55
1	95	20	35	100	77	58
1	96	20	38	100	77	59
1	97	20	48	100	77	61

Table D33. Estimated percent habitat available in Coffeen Lake at 1500 hours on 7 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	7	35	11
4	88	0	20	63	100	46
4	89	10	46	63	100	55
4	90	10	46	63	100	55
4	91	10	46	63	100	55
4	92	15	46	63	100	56
4	93	15	46	63	100	56
4	94	20	46	63	100	57
4	95	25	46	63	100	59
4	96	30	46	63	100	60
4	97	38	46	63	100	62
3	87	0	0	13	35	12
3	88	5	24	70	100	50
3	89	15	50	70	100	59
3	90	15	50	70	100	59
3	91	15	50	70	100	59
3	92	20	50	70	100	60
3	93	20	50	70	100	60
3	94	25	50	70	100	61
3	95	30	50	70	100	63
3	96	35	50	70	100	64
3	97	43	50	70	100	66
2	87	0	4	40	35	20
2	88	10	28	97	100	59
2	89	20	54	97	100	68
2	90	20	54	97	100	68
2	91	20	54	97	100	68
2	92	25	54	97	100	69
2	93	25	54	97	100	69
2	94	30	54	97	100	70
2	95	35	54	97	100	72
2	96	40	54	97	100	73
2	97	48	54	97	100	75
1	87	0	8	40	35	21
1	88	15	32	97	100	61
1	89	25	58	97	100	70
1	90	25	58	97	100	70
1	91	25	58	97	100	70
1	92	30	58	97	100	71
1	93	30	58	97	100	71
1	94	35	58	97	100	73
1	95	40	58	97	100	74
1	96	45	58	97	100	75
1	97	53	58	97	100	77

Table D34. Estimated percent habitat available in Coffeen Lake at 1500 hours on 14 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	0	21	29	13
4	91	0	4	46	50	25
4	92	10	40	46	82	45
4	93	10	40	46	82	45
4	94	10	40	46	82	45
4	95	10	40	46	82	45
4	96	10	40	46	82	45
4	97	15	40	46	82	46
3	87	0	0	0	0	0
3	88	0	0	0	7	2
3	89	0	0	0	7	2
3	90	0	4	21	36	15
3	91	5	8	46	57	29
3	92	15	44	46	89	49
3	93	15	44	46	89	49
3	94	15	44	46	89	49
3	95	15	44	46	89	49
3	96	15	44	46	89	49
3	97	20	44	46	89	50
2	87	0	0	0	0	0
2	88	0	0	0	7	2
2	89	0	0	7	7	4
2	90	10	4	29	36	20
2	91	15	8	54	57	34
2	92	25	44	54	89	53
2	93	25	44	54	89	53
2	94	25	44	54	89	53
2	95	25	44	54	89	53
2	96	25	44	54	89	53
2	97	30	44	54	89	54
1	87	0	0	0	0	0
1	88	0	0	7	7	4
1	89	10	4	14	7	9
1	90	20	8	36	36	25
1	91	25	12	61	57	39
1	92	35	48	61	89	58
1	93	35	48	61	89	58
1	94	35	48	61	89	58
1	95	35	48	61	89	58
1	96	35	48	61	89	58
1	97	40	48	61	89	60

Table D35. Estimated percent habitat available in Coffeen Lake at 1600 hours on 21 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	13	0	8	5
4	90	10	17	14	38	20
4	91	20	22	21	62	31
4	92	20	26	43	69	40
4	93	20	30	57	88	49
4	94	20	30	82	88	55
4	95	25	30	82	88	56
4	96	25	30	82	88	56
4	97	25	35	82	88	58
3	87	0	0	11	0	3
3	88	0	0	18	0	5
3	89	10	17	18	8	13
3	90	20	22	32	38	28
3	91	30	26	39	62	39
3	92	30	30	61	69	48
3	93	30	35	75	88	57
3	94	30	35	100	88	63
3	95	35	35	100	88	65
3	96	35	35	100	88	65
3	97	35	39	100	88	66
2	87	0	0	11	0	3
2	88	0	4	18	8	8
2	89	15	22	18	15	18
2	90	25	26	32	46	32
2	91	35	30	39	69	43
2	92	35	35	61	77	52
2	93	35	39	75	96	61
2	94	35	39	100	96	68
2	95	40	39	100	96	69
2	96	40	39	100	96	69
2	97	40	43	100	96	70
1	87	0	0	11	0	3
1	88	0	13	18	8	10
1	89	20	30	18	15	21
1	90	30	35	32	46	36
1	91	40	39	39	69	47
1	92	40	43	61	77	55
1	93	40	48	75	96	65
1	94	40	48	100	96	71
1	95	45	48	100	96	72
1	96	45	48	100	96	72
1	97	45	52	100	96	73

Table D36. Estimated percent habitat available in Coffeen Lake at 1600 hours on 28 July 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	13			7
4	88	0	21			11
4	89	0	29			15
4	90	0	29			15
4	91	0	33			17
4	92	0	38			19
4	93	0	38			19
4	94	0	42			21
4	95	0	42			21
4	96	0	46			23
4	97	0	52			26
3	87	0	21			11
3	88	0	29			15
3	89	0	38			19
3	90	5	38			22
3	91	5	42			24
3	92	5	46			26
3	93	5	46			26
3	94	5	50			28
3	95	5	50			28
3	96	5	54			30
3	97	5	60			33
2	87	14	29			22
2	88	14	38			26
2	89	14	46			30
2	90	19	46			33
2	91	19	50			35
2	92	19	54			37
2	93	19	54			37
2	94	19	58			39
2	95	19	58			39
2	96	19	63			41
2	97	19	69			44
1	87	19	33			26
1	88	19	42			31
1	89	19	50			35
1	90	24	50			37
1	91	24	54			39
1	92	24	58			41
1	93	24	58			41
1	94	24	63			44
1	95	24	63			44
1	96	24	67			46
1	97	24	73			49

Table D37. Estimated percent habitat available in Coffeen Lake at 1500 hours on 4 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	4	8	7	5
4	91	5	9	8	7	7
4	92	14	13	29	32	22
4	93	14	20	54	68	39
4	94	14	46	54	68	46
4	95	19	46	54	68	47
4	96	19	46	54	68	47
4	97	19	46	54	68	47
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	0	0
3	90	0	4	8	7	5
3	91	10	9	8	7	9
3	92	19	13	29	32	23
3	93	19	20	54	68	40
3	94	19	46	54	68	47
3	95	24	46	54	68	48
3	96	24	46	54	68	48
3	97	24	46	54	68	48
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	8	7	4
2	90	5	9	17	14	11
2	91	14	13	17	14	15
2	92	24	17	38	39	30
2	93	24	24	63	75	47
2	94	24	50	63	75	53
2	95	29	50	63	75	54
2	96	29	50	63	75	54
2	97	29	50	63	75	54
1	87	0	0	0	0	0
1	88	0	4	8	0	3
1	89	0	4	17	7	7
1	90	10	13	25	14	16
1	91	19	17	25	14	19
1	92	29	22	46	39	34
1	93	29	28	71	75	51
1	94	29	54	71	75	57
1	95	33	54	71	75	58
1	96	33	54	71	75	58
1	97	33	54	71	75	58

Table D38. Estimated percent habitat available in Coffeen Lake at 1500 hours on 11 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	20	60	50	33
4	88	0	35	97	96	57
4	89	0	35	97	96	57
4	90	17	63	97	96	68
4	91	17	63	97	96	68
4	92	17	63	97	96	68
4	93	17	63	97	96	68
4	94	17	63	97	96	68
4	95	25	63	97	96	70
4	96	25	63	97	96	70
4	97	25	63	97	96	70
3	87	0	30	60	50	35
3	88	8	45	97	96	62
3	89	8	45	97	96	62
3	90	33	73	97	96	75
3	91	33	73	97	96	75
3	92	33	73	97	96	75
3	93	33	73	97	96	75
3	94	33	73	97	96	75
3	95	42	73	97	96	77
3	96	42	73	97	96	77
3	97	42	73	97	96	77
2	87	0	35	60	50	36
2	88	8	50	97	96	63
2	89	8	50	97	96	63
2	90	33	78	97	96	76
2	91	33	78	97	96	76
2	92	33	78	97	96	76
2	93	33	78	97	96	76
2	94	33	78	97	96	76
2	95	42	78	97	96	78
2	96	42	78	97	96	78
2	97	42	78	97	96	78
1	87	0	35	60	50	36
1	88	17	50	97	96	65
1	89	17	50	97	96	65
1	90	42	78	97	96	78
1	91	42	78	97	96	78
1	92	42	78	97	96	78
1	93	42	78	97	96	78
1	94	42	78	97	96	78
1	95	50	78	97	96	80
1	96	50	78	97	96	80
1	97	50	78	97	96	80

Table D39. Estimated percent habitat available in Coffeen Lake at 1600 hours on 18 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	14	14	29	40	24
4	88	19	18	57	53	37
4	89	19	23	64	63	42
4	90	19	23	82	77	50
4	91	24	27	82	77	53
4	92	24	43	82	77	57
4	93	24	43	82	77	57
4	94	24	43	82	77	57
4	95	24	43	82	77	57
4	96	24	43	82	77	57
4	97	24	43	82	77	57
3	87	19	23	36	40	30
3	88	24	27	64	53	42
3	89	24	32	71	63	48
3	90	24	32	89	77	56
3	91	29	36	89	77	58
3	92	29	52	89	77	62
3	93	29	52	89	77	62
3	94	29	52	89	77	62
3	95	29	52	89	77	62
3	96	29	52	89	77	62
3	97	29	52	89	77	62
2	87	24	27	43	47	35
2	88	29	32	71	60	48
2	89	29	36	79	70	54
2	90	29	36	96	83	61
2	91	33	41	96	83	63
2	92	33	57	96	83	67
2	93	33	57	96	83	67
2	94	33	57	96	83	67
2	95	33	57	96	83	67
2	96	33	57	96	83	67
2	97	33	57	96	83	67
1	87	24	45	43	47	40
1	88	29	50	71	60	53
1	89	29	55	79	70	58
1	90	29	55	96	83	66
1	91	33	59	96	83	68
1	92	33	75	96	83	72
1	93	33	75	96	83	72
1	94	33	75	96	83	72
1	95	33	75	96	83	72
1	96	33	75	96	83	72
1	97	33	75	96	83	72

Table D40. Estimated percent habitat available in Coffeen Lake at 1600 hours on 25 August 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	8	16	43	17
4	88	9	13	91	96	52
4	89	9	13	91	96	52
4	90	9	21	91	96	54
4	91	9	21	91	96	54
4	92	13	48	91	96	62
4	93	13	48	91	96	62
4	94	13	48	91	96	62
4	95	13	48	91	96	62
4	96	13	48	91	96	62
4	97	13	48	91	96	62
3	87	0	13	16	43	18
3	88	13	17	91	96	54
3	89	13	17	91	96	54
3	90	13	25	91	96	56
3	91	13	25	91	96	56
3	92	17	52	91	96	64
3	93	17	52	91	96	64
3	94	17	52	91	96	64
3	95	17	52	91	96	64
3	96	17	52	91	96	64
3	97	17	52	91	96	64
2	87	4	21	16	43	21
2	88	17	25	91	96	57
2	89	17	25	91	96	57
2	90	17	33	91	96	59
2	91	17	33	91	96	59
2	92	22	60	91	96	67
2	93	22	60	91	96	67
2	94	22	60	91	96	67
2	95	22	60	91	96	67
2	96	22	60	91	96	67
2	97	22	60	91	96	67
1	87	9	21	16	43	22
1	88	22	25	91	96	59
1	89	22	25	91	96	59
1	90	22	33	91	96	61
1	91	22	33	91	96	61
1	92	26	60	91	96	68
1	93	26	60	91	96	68
1	94	26	60	91	96	68
1	95	26	60	91	96	68
1	96	26	60	91	96	68
1	97	26	60	91	96	68

Table D41. Estimated percent habitat available in Coffeen Lake at 1600 hours on 1 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	8	27	0	9
4	88	0	12	33	7	13
4	89	5	12	33	14	16
4	90	10	20	33	36	25
4	91	10	20	47	43	30
4	92	10	24	47	50	33
4	93	10	24	53	50	34
4	94	10	24	90	68	48
4	95	10	24	90	68	48
4	96	10	24	90	68	48
4	97	15	24	90	68	49
3	87	0	12	33	14	15
3	88	5	16	40	21	21
3	89	10	16	40	29	24
3	90	15	24	40	50	32
3	91	15	24	53	57	37
3	92	15	28	53	64	40
3	93	15	28	60	64	42
3	94	15	28	97	82	56
3	95	15	28	97	82	56
3	96	15	28	97	82	56
3	97	20	28	97	82	57
2	87	0	20	33	21	19
2	88	10	24	40	29	26
2	89	15	24	40	36	29
2	90	20	32	40	57	37
2	91	20	32	53	64	42
2	92	20	36	53	71	45
2	93	20	36	60	71	47
2	94	20	36	97	89	61
2	95	20	36	97	89	61
2	96	20	36	97	89	61
2	97	25	36	97	89	62
1	87	10	28	33	29	25
1	88	20	32	40	36	32
1	89	25	32	40	43	35
1	90	30	40	40	64	44
1	91	30	40	53	71	49
1	92	30	44	53	79	52
1	93	30	44	60	79	53
1	94	30	44	97	96	67
1	95	30	44	97	96	67
1	96	30	44	97	96	67
1	97	35	44	97	96	68

Table D42. Estimated percent habitat available in Coffeen Lake at 1400 hours on 10 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	32	27	50	27
4	88	0	32	33	63	32
4	89	0	36	47	69	38
4	90	0	40	70	84	49
4	91	0	40	90	91	55
4	92	0	40	90	91	55
4	93	0	40	90	91	55
4	94	5	44	90	91	58
4	95	5	54	90	91	60
4	96	5	54	90	91	60
4	97	5	54	90	91	60
3	87	5	40	27	50	31
3	88	5	40	33	63	35
3	89	11	44	47	69	43
3	90	11	48	70	84	53
3	91	11	48	90	91	60
3	92	11	48	90	91	60
3	93	11	48	90	91	60
3	94	16	52	90	91	62
3	95	16	62	90	91	65
3	96	16	62	90	91	65
3	97	16	62	90	91	65
2	87	37	44	27	50	40
2	88	37	44	33	63	44
2	89	42	48	47	69	52
2	90	42	52	70	84	62
2	91	42	52	90	91	69
2	92	42	52	90	91	69
2	93	42	52	90	91	69
2	94	47	56	90	91	71
2	95	47	66	90	91	74
2	96	47	66	90	91	74
2	97	47	66	90	91	74
1	87	53	44	27	50	44
1	88	53	44	33	63	48
1	89	58	48	47	69	56
1	90	58	52	70	84	66
1	91	58	52	90	91	73
1	92	58	52	90	91	73
1	93	58	52	90	91	73
1	94	63	56	90	91	75
1	95	63	66	90	91	78
1	96	63	66	90	91	78
1	97	63	66	90	91	78

Table D43. Estimated percent habitat available in Coffeen Lake at 1200 hours on 15 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	0	14	11	29	14
4	88	5	14	47	79	36
4	89	10	14	81	79	46
4	90	10	30	81	79	50
4	91	10	52	81	79	56
4	92	10	52	81	79	56
4	93	10	52	81	79	56
4	94	10	52	81	79	56
4	95	10	52	81	79	56
4	96	15	52	81	79	57
4	97	15	52	81	79	57
3	87	5	18	11	41	19
3	88	10	18	47	91	42
3	89	15	18	81	91	51
3	90	15	34	81	91	55
3	91	15	57	81	91	61
3	92	15	57	81	91	61
3	93	15	57	81	91	61
3	94	15	57	81	91	61
3	95	15	57	81	91	61
3	96	20	57	81	91	62
3	97	20	57	81	91	62
2	87	5	23	11	41	20
2	88	10	23	47	91	43
2	89	15	23	81	91	53
2	90	15	39	81	91	57
2	91	15	61	81	91	62
2	92	15	61	81	91	62
2	93	15	61	81	91	62
2	94	15	61	81	91	62
2	95	15	61	81	91	62
2	96	20	61	81	91	63
2	97	20	61	81	91	63
1	87	10	23	11	41	21
1	88	15	23	47	91	44
1	89	20	23	81	91	54
1	90	20	39	81	91	58
1	91	20	61	81	91	63
1	92	20	61	81	91	63
1	93	20	61	81	91	63
1	94	20	61	81	91	63
1	95	20	61	81	91	63
1	96	25	61	81	91	65
1	97	25	61	81	91	65

Table D44. Estimated percent habitat available in Coffeen Lake at 1500 hours on 22 September 2004. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated. Segment numbers correspond to areas sampled immediately outside discharge mixung zone (1), intake area (2), near the boat launch (3), and near the railroad levee (4).

		Percent habitat available				
Minimum oxygen (ppm)	Maximum temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	Mean
4	87	10	25	71	71	44
4	88	10	29	79	79	49
4	89	10	29	96	96	58
4	90	10	29	96	96	58
4	91	10	33	96	96	59
4	92	10	38	96	96	60
4	93	10	38	96	96	60
4	94	15	48	96	96	64
4	95	15	48	96	96	64
4	96	15	48	96	96	64
4	97	15	48	96	96	64
3	87	20	33	75	71	50
3	88	20	38	82	79	55
3	89	20	38	100	96	64
3	90	20	38	100	96	64
3	91	20	42	100	96	65
3	92	20	46	100	96	66
3	93	20	46	100	96	66
3	94	25	56	100	96	69
3	95	25	56	100	96	69
3	96	25	56	100	96	69
3	97	25	56	100	96	69
2	87	25	38	75	71	52
2	88	25	42	82	79	57
2	89	25	42	100	96	66
2	90	25	42	100	96	66
2	91	25	46	100	96	67
2	92	25	50	100	96	68
2	93	25	50	100	96	68
2	94	30	60	100	96	72
2	95	30	60	100	96	72
2	96	30	60	100	96	72
2	97	30	60	100	96	72
1	87	35	42	75	71	56
1	88	35	46	82	79	61
1	89	35	46	100	96	69
1	90	35	46	100	96	69
1	91	35	50	100	96	70
1	92	35	54	100	96	71
1	93	35	54	100	96	71
1	94	40	65	100	96	75
1	95	40	65	100	96	75
1	96	40	65	100	96	75
1	97	40	65	100	96	75

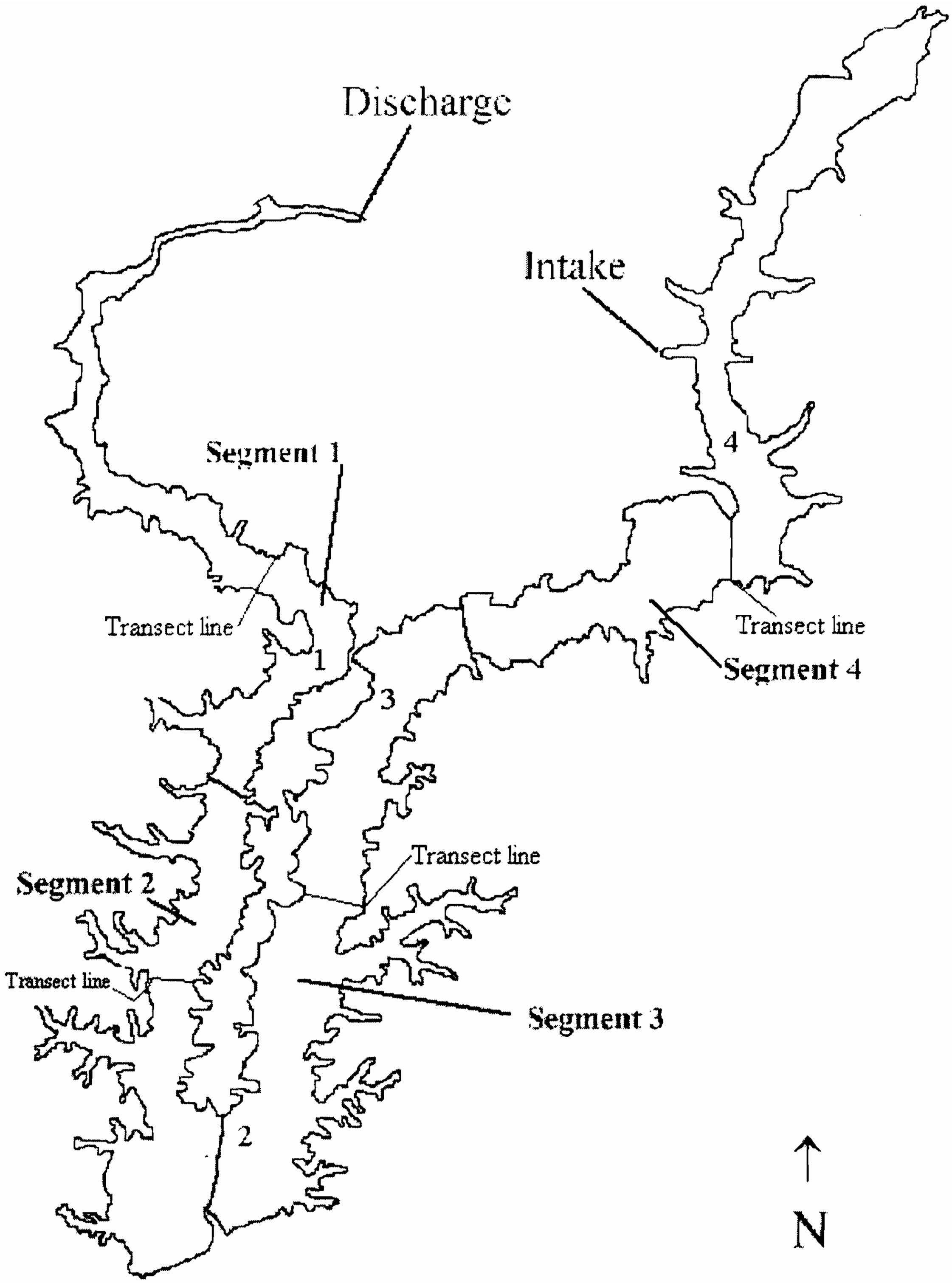


Figure D1. Four segments in Newton Lake where water temperature and dissolved oxygen were sampled. Data were collected weekly at each transect line from May 2004 through September 2004. Numbers in lake boundaries represent locations of continuous temperature recorders set during same periods.

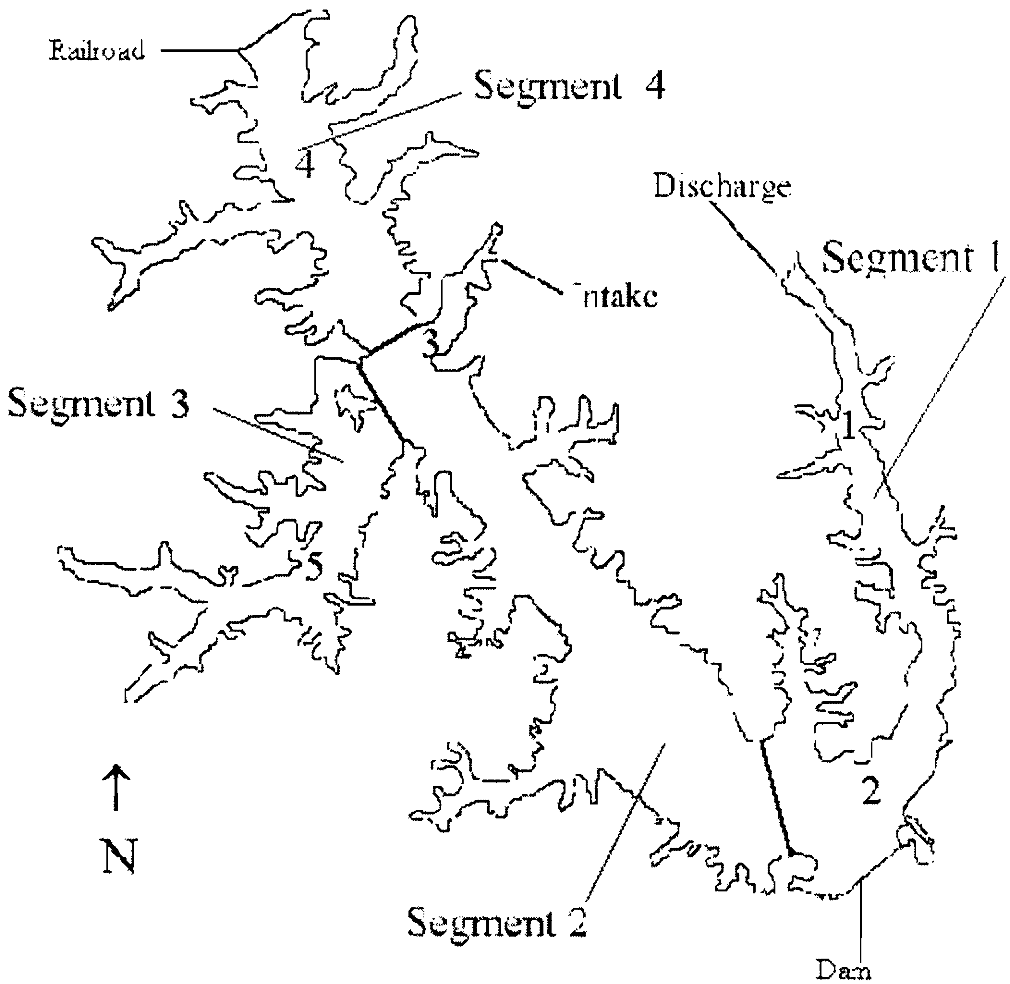


Figure D2. Four segments in Coffeen Lake where water temperature and dissolved oxygen were sampled. Data were collected weekly at each segment number from May 2004 through September 2004. Numbers in lake boundaries represent locations of continuous temperature recorders set during same periods.

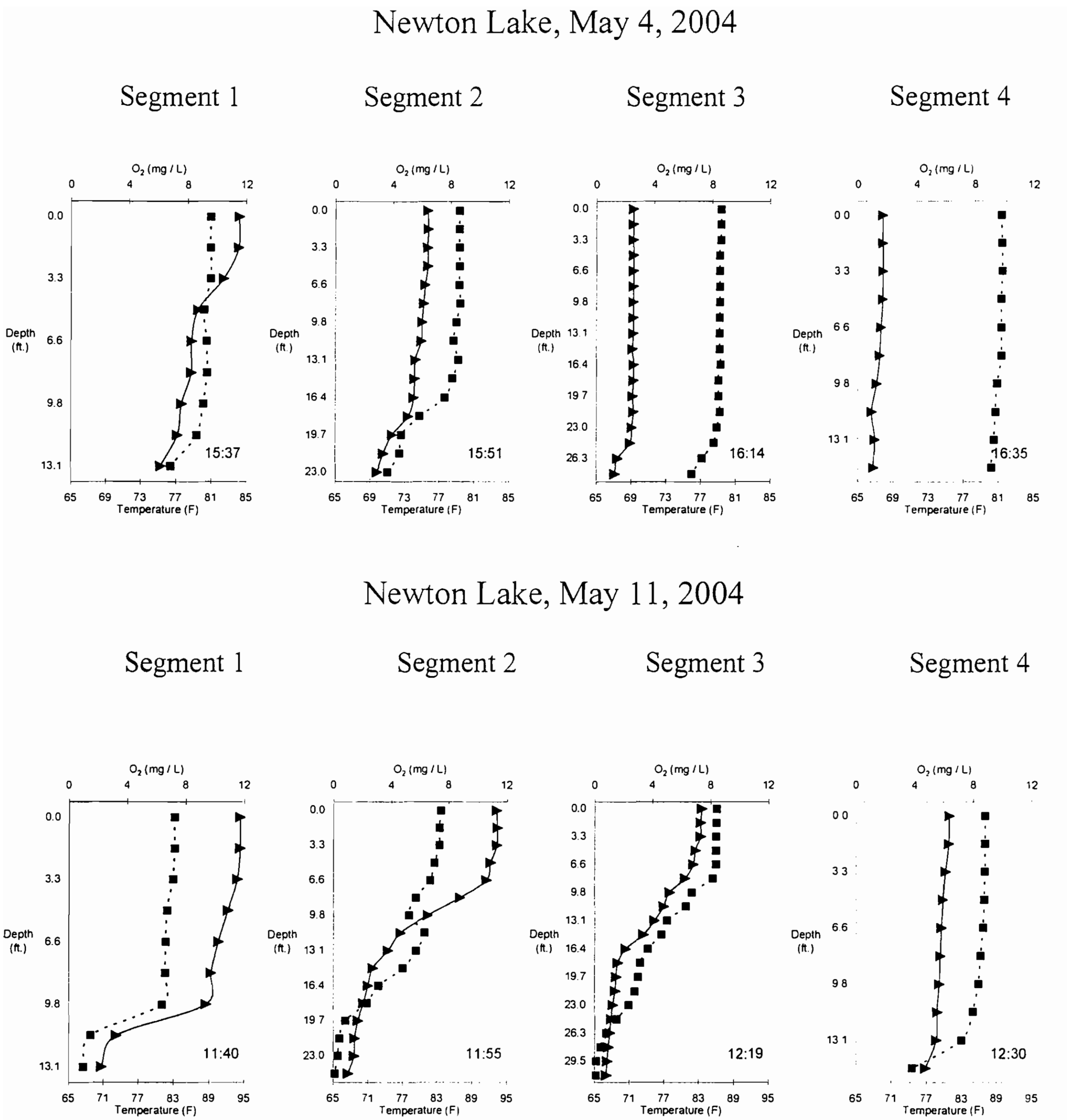


Figure D3. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

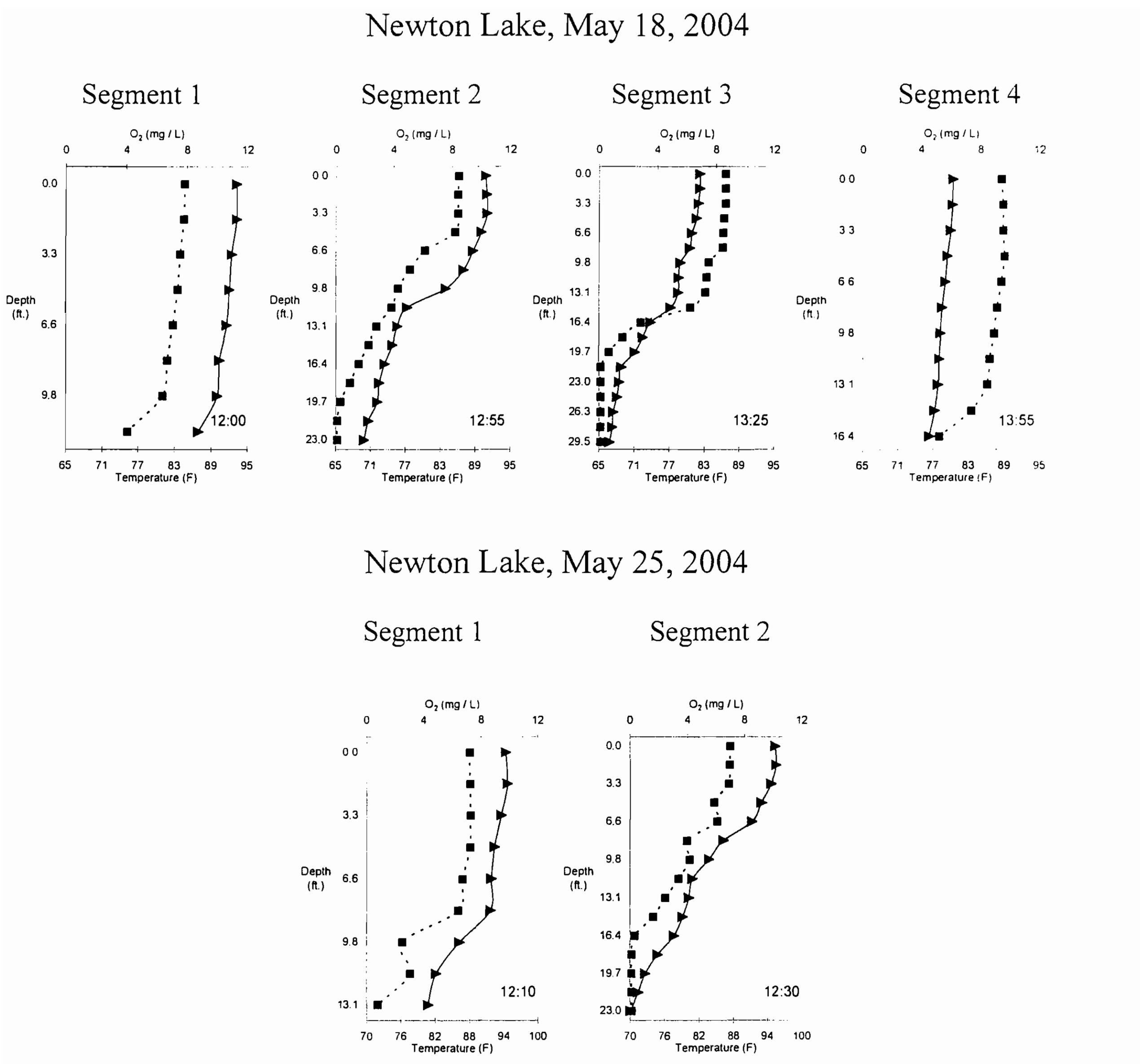


Figure D4. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

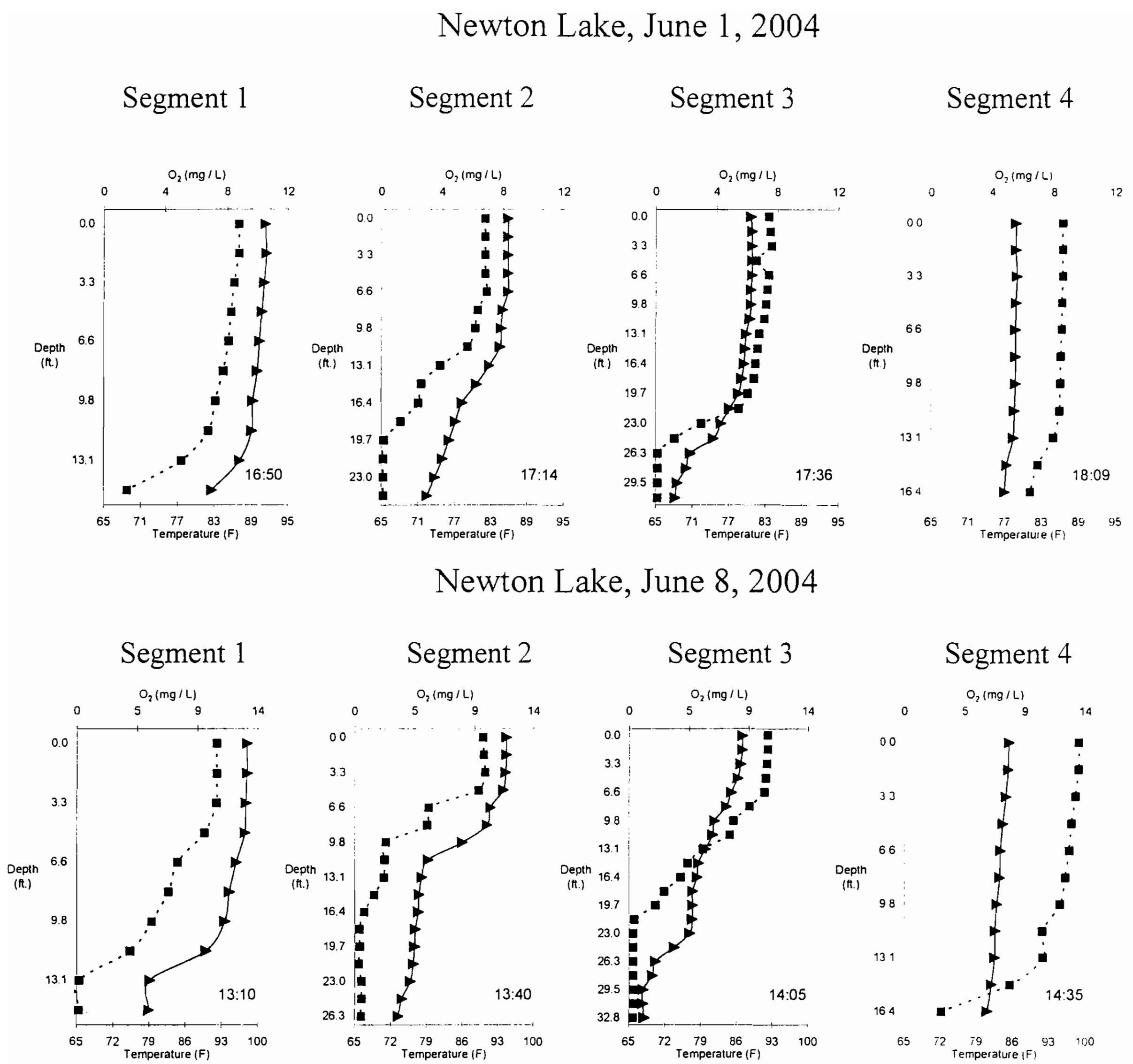
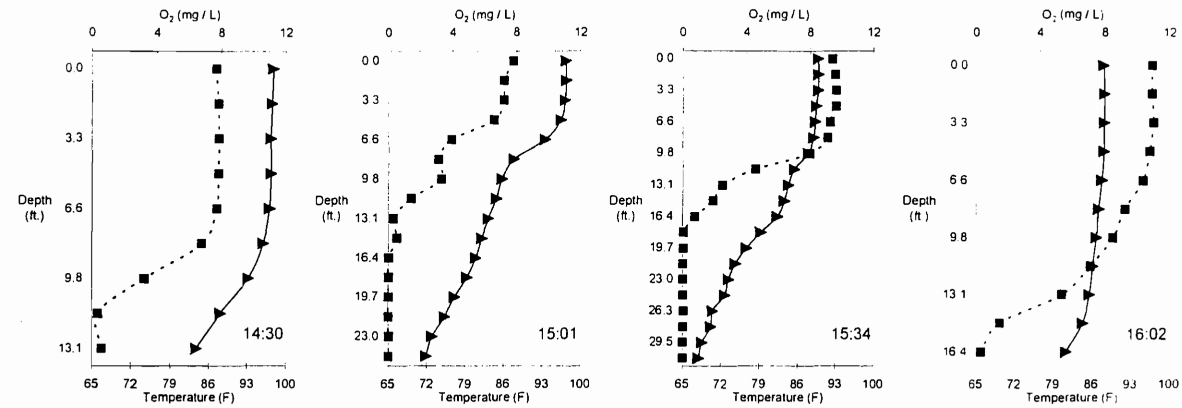


Figure D5. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, June 15, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Newton Lake, June 22, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

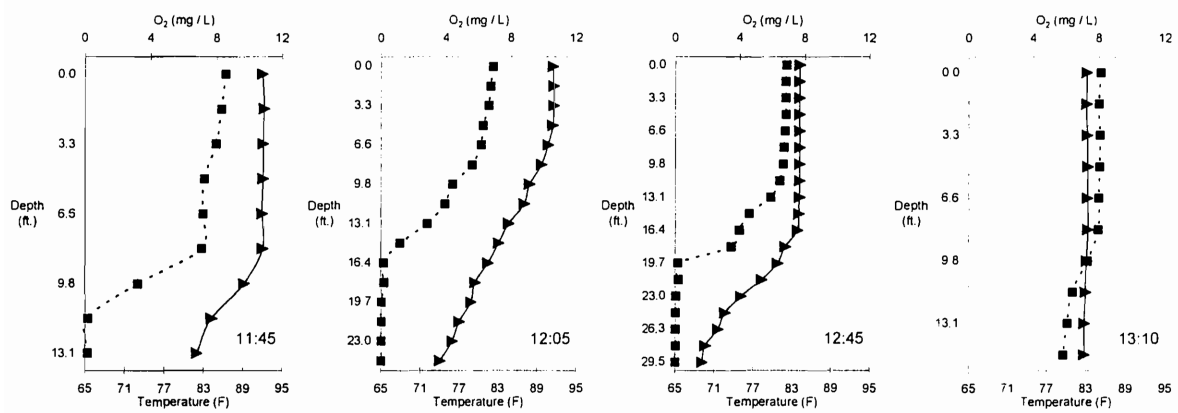


Figure D6. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

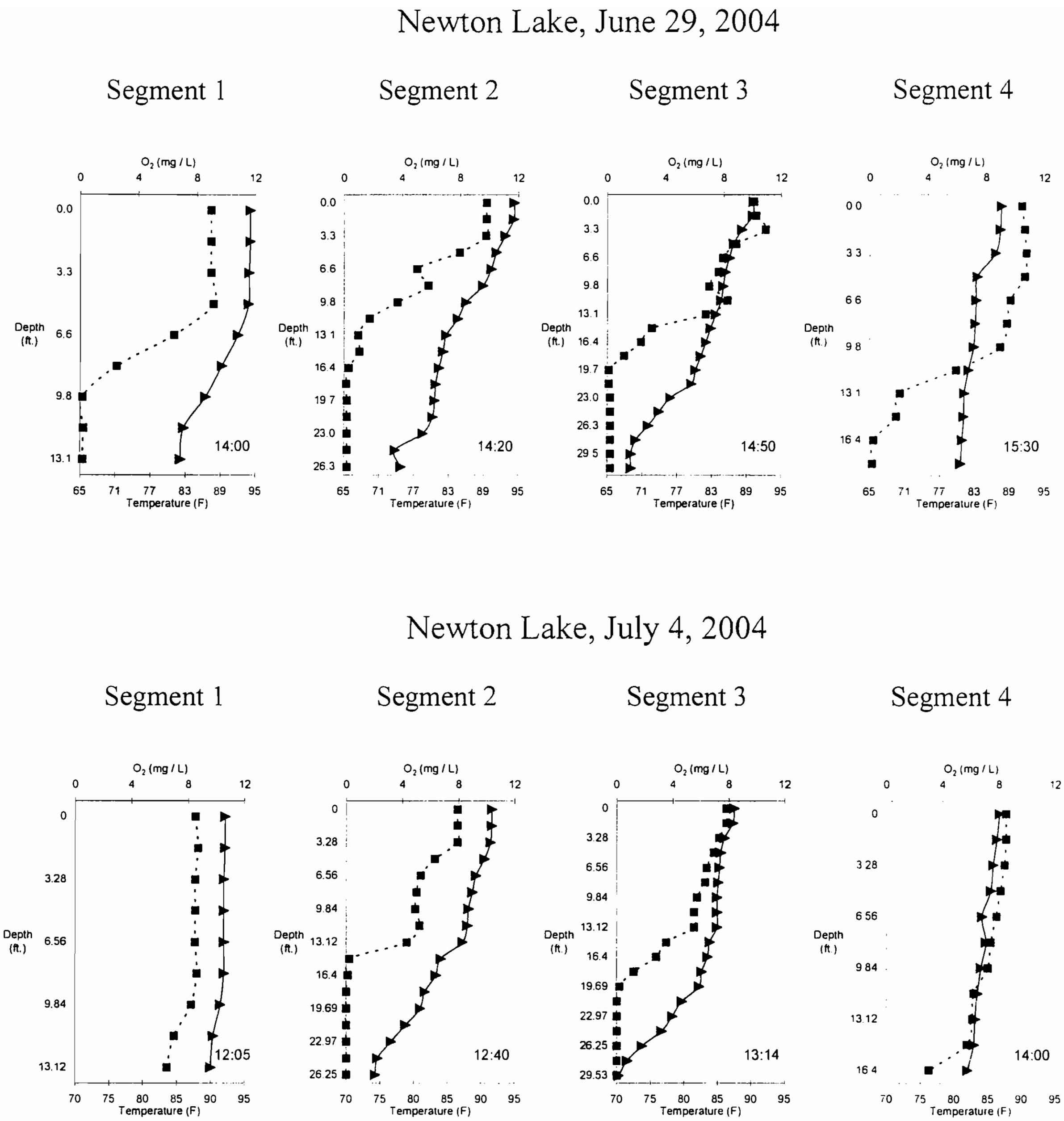


Figure D7. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

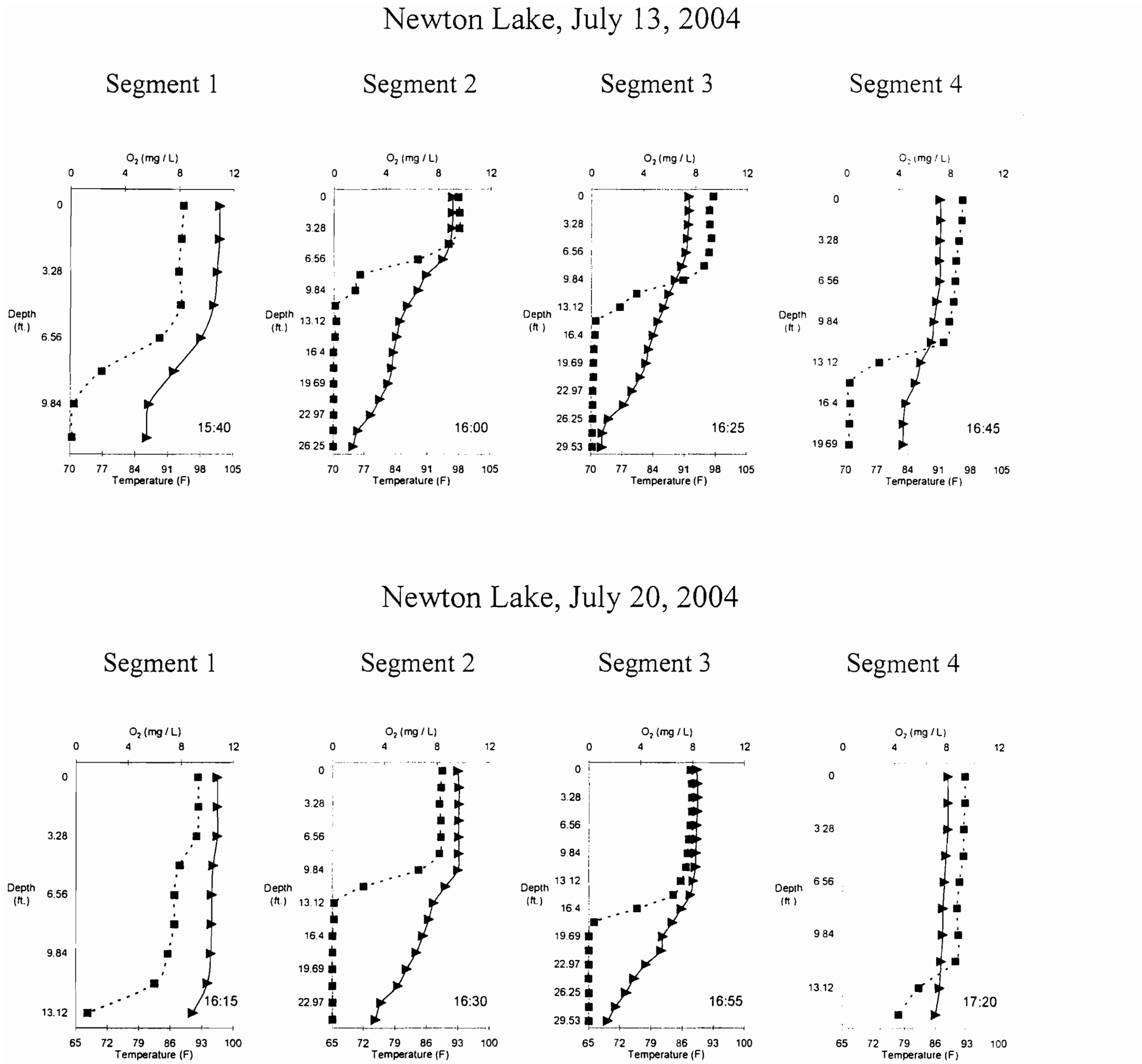


Figure D8. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

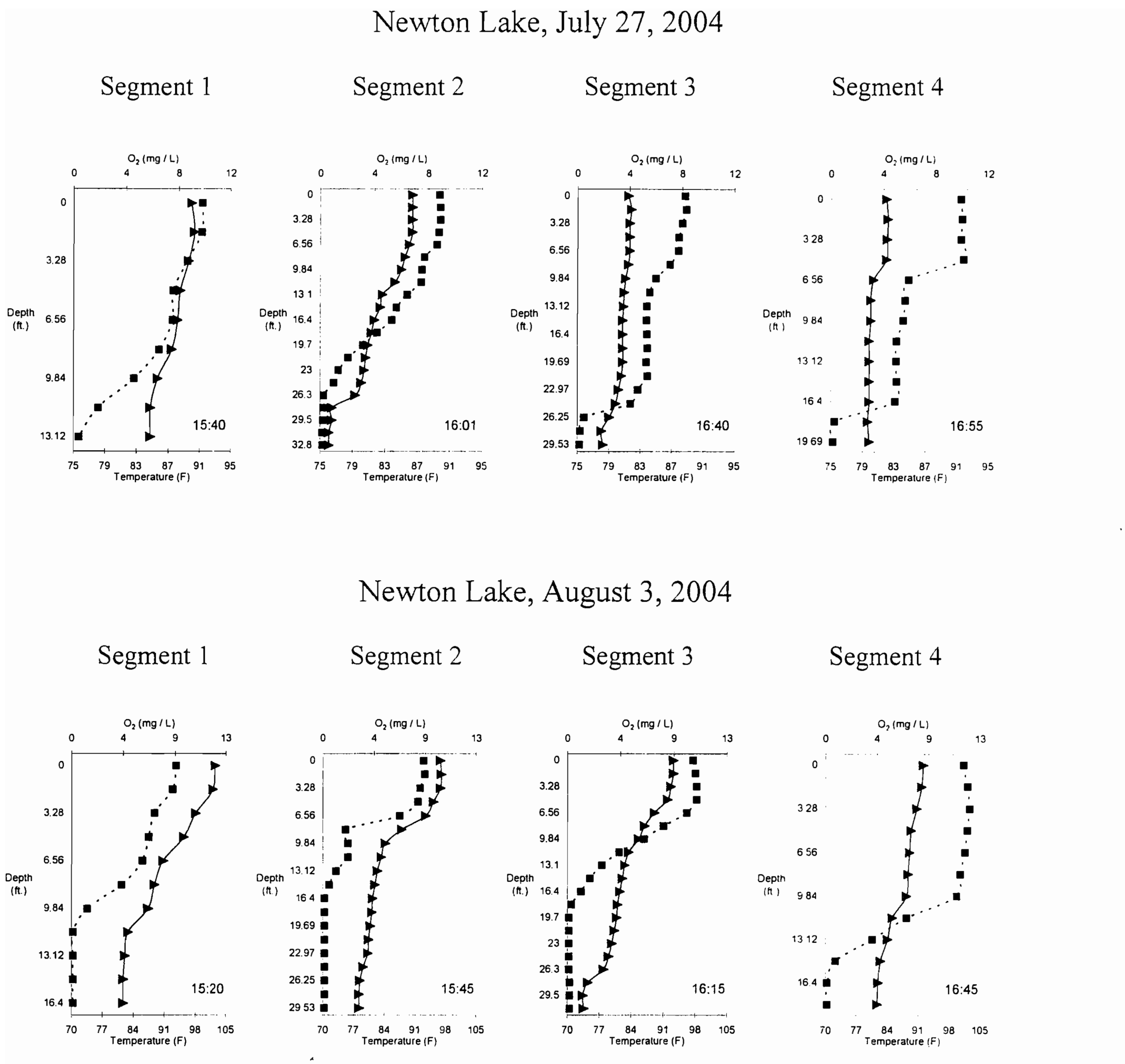
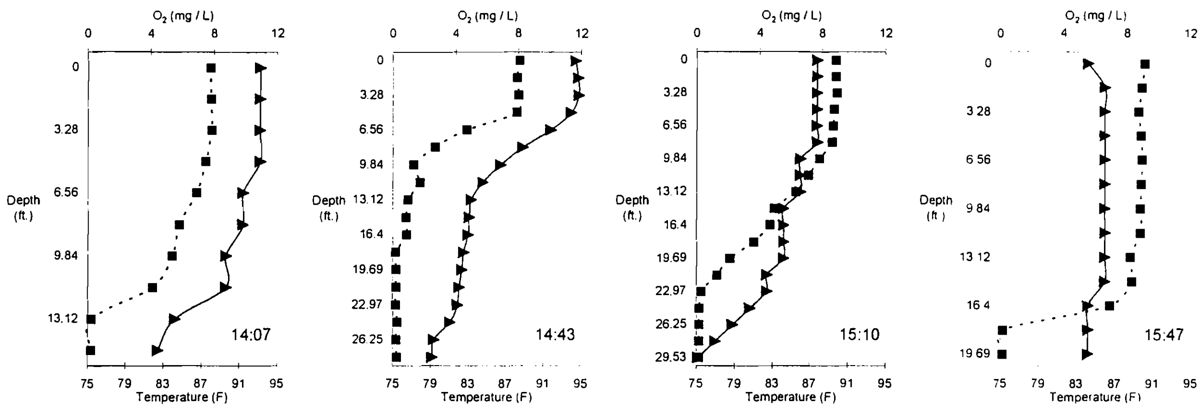


Figure D9. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, August 10, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Newton Lake, August 17, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

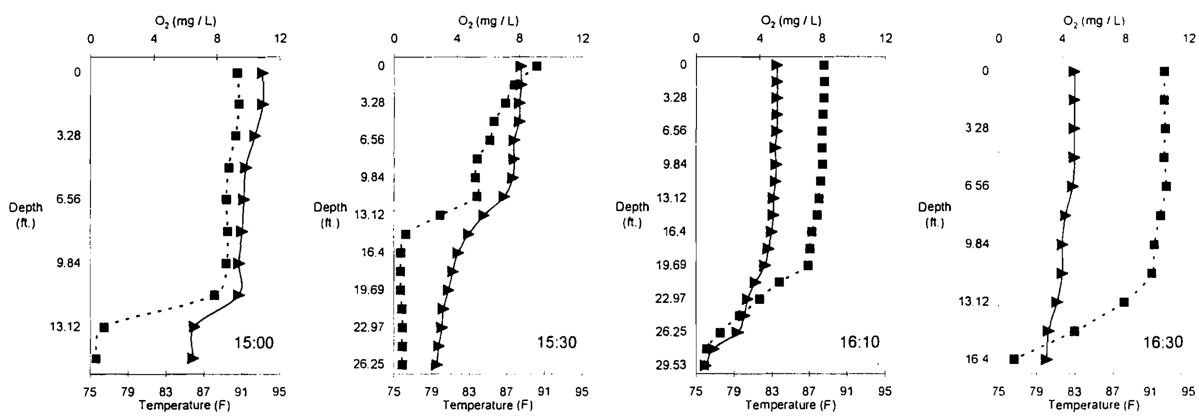
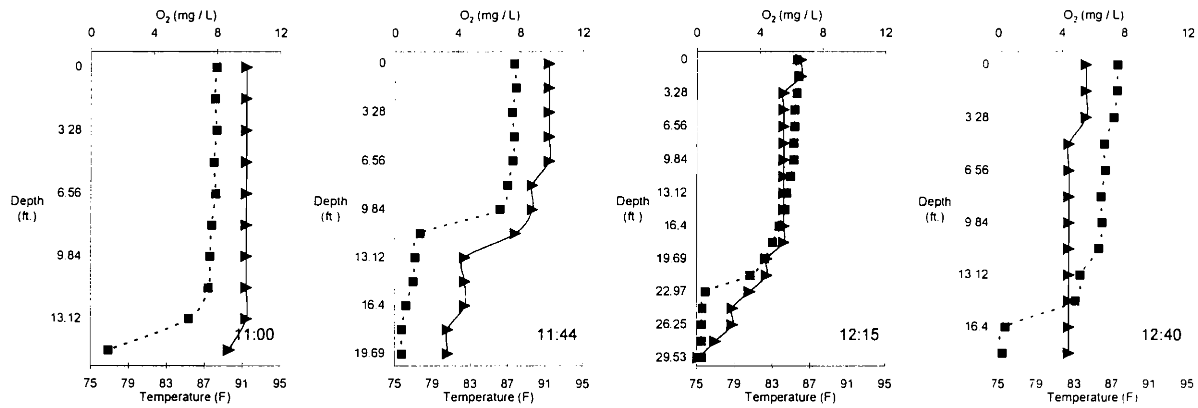


Figure D10. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, August 25, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Newton Lake, August 31, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

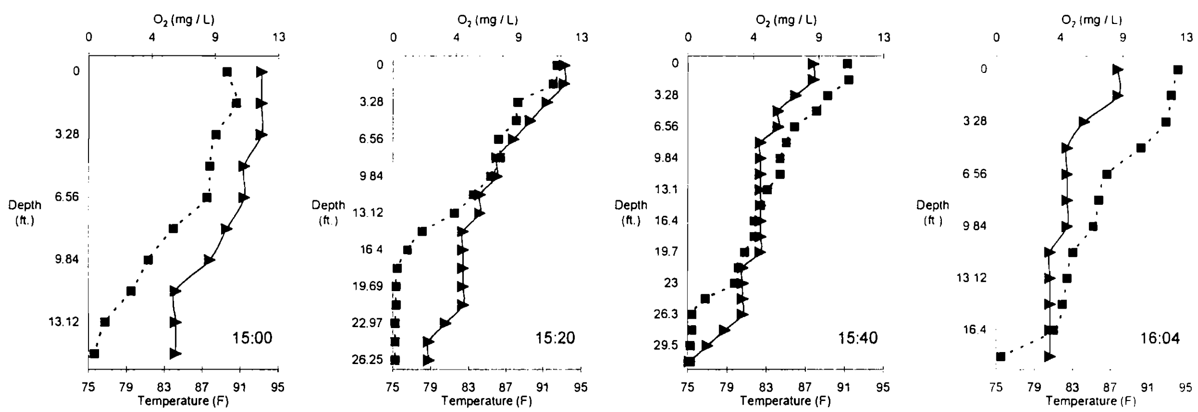
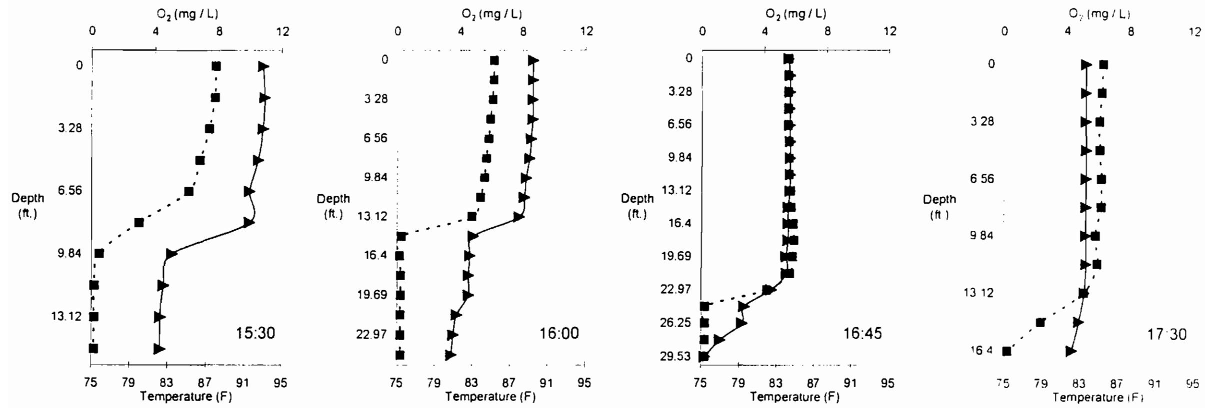


Figure D11. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Newton Lake, September 7, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Newton Lake, September 14, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

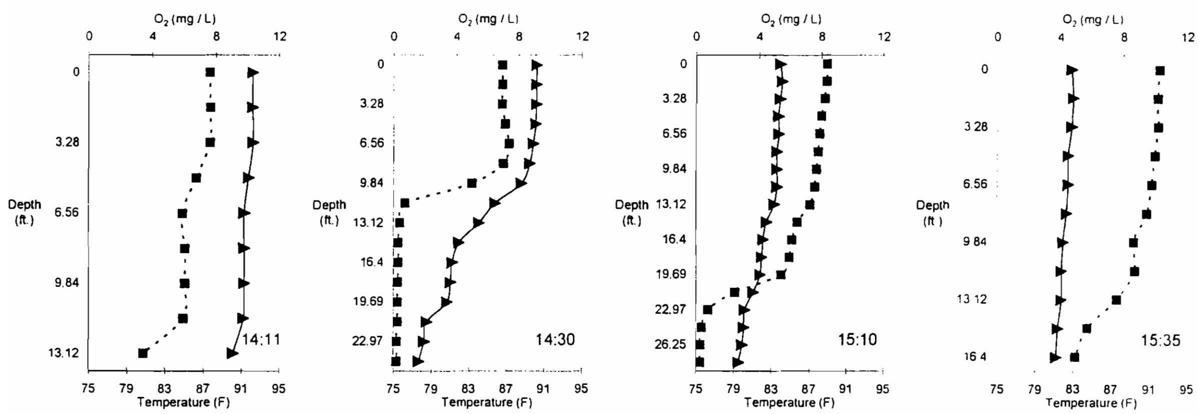


Figure D12. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

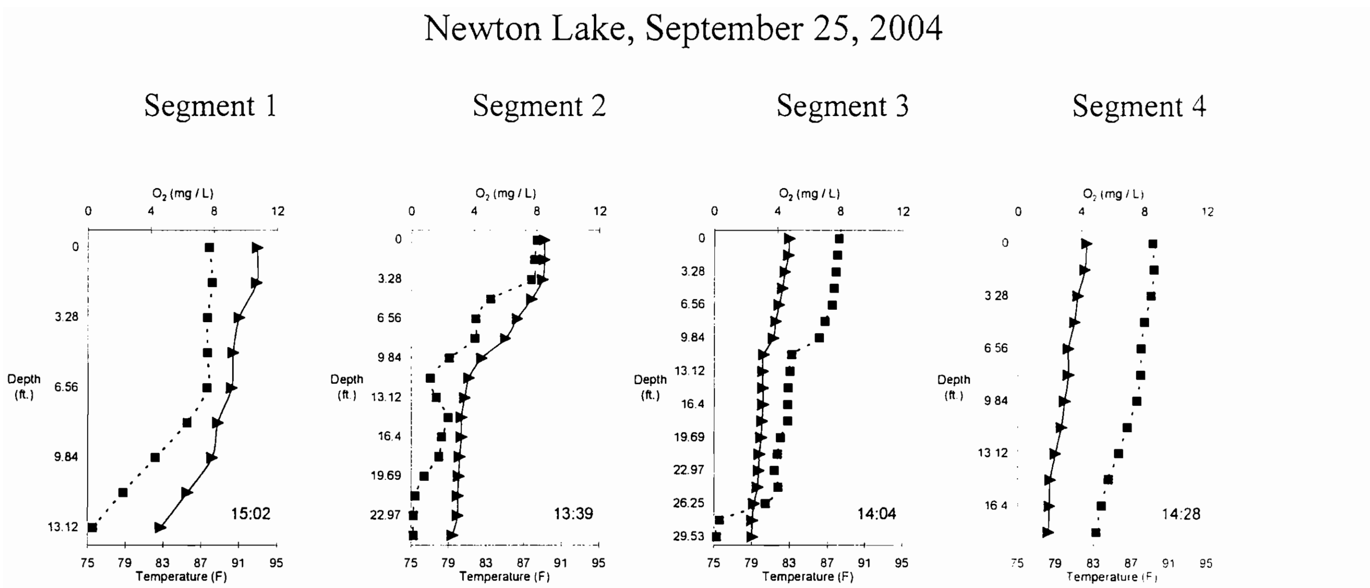
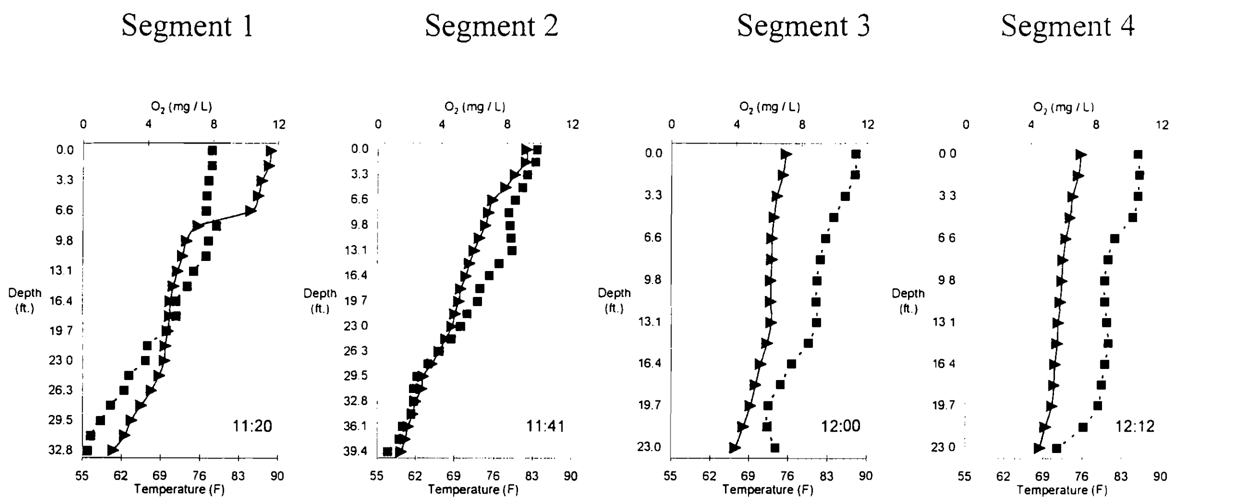


Figure D13. Temperature and dissolved oxygen profiles in 4 segments of Newton Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, May 5, 2004



Coffeen Lake, May 12, 2004

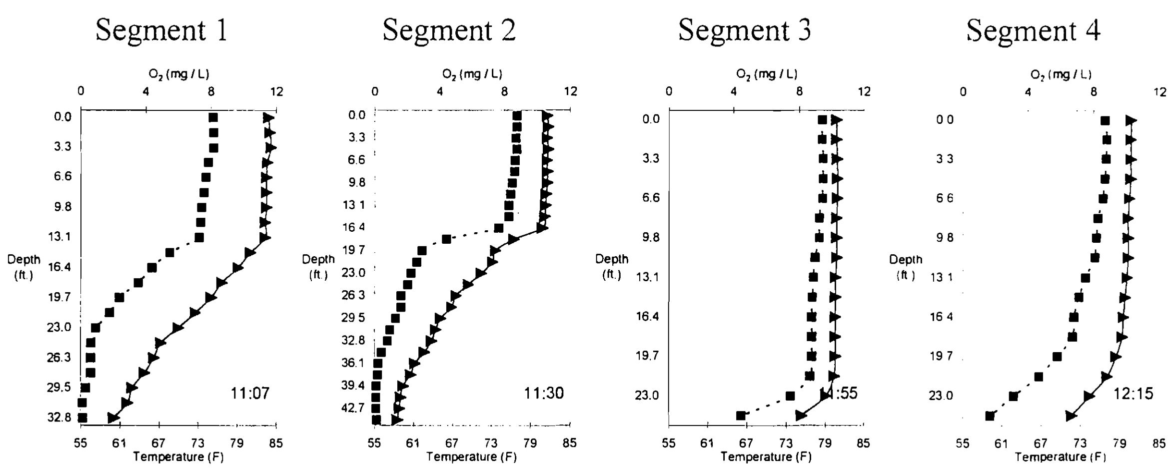
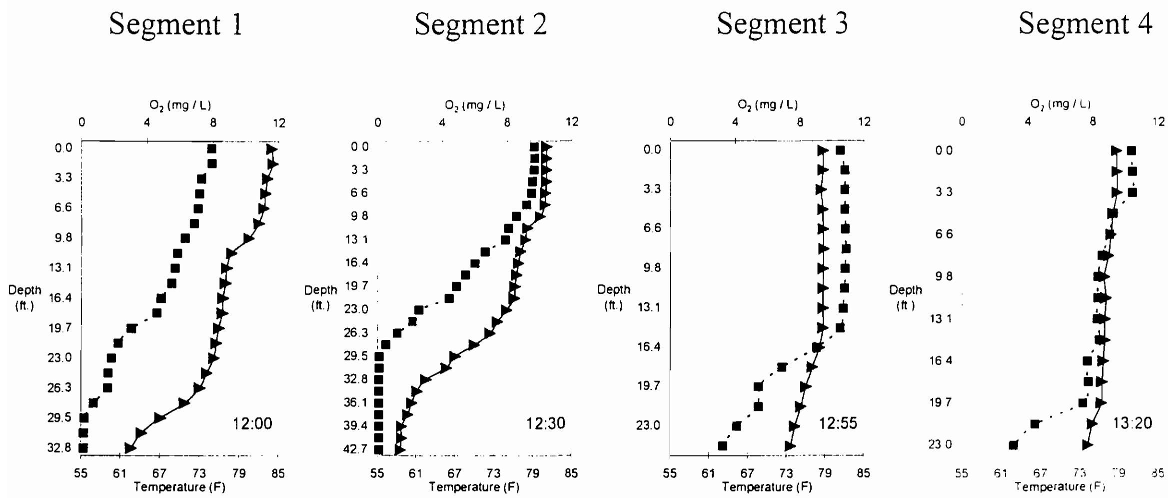


Figure D14. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, May 19, 2004



Coffeen Lake, May 26, 2004

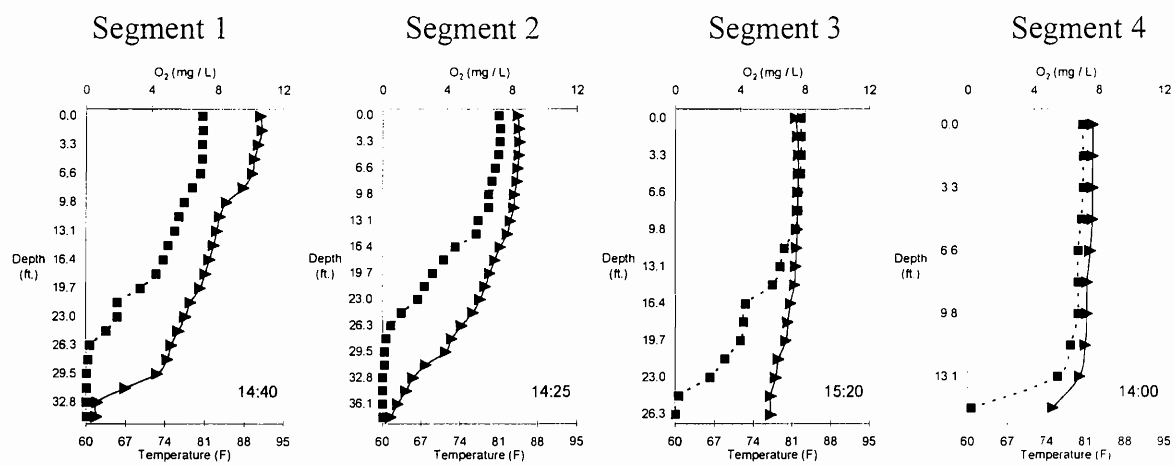
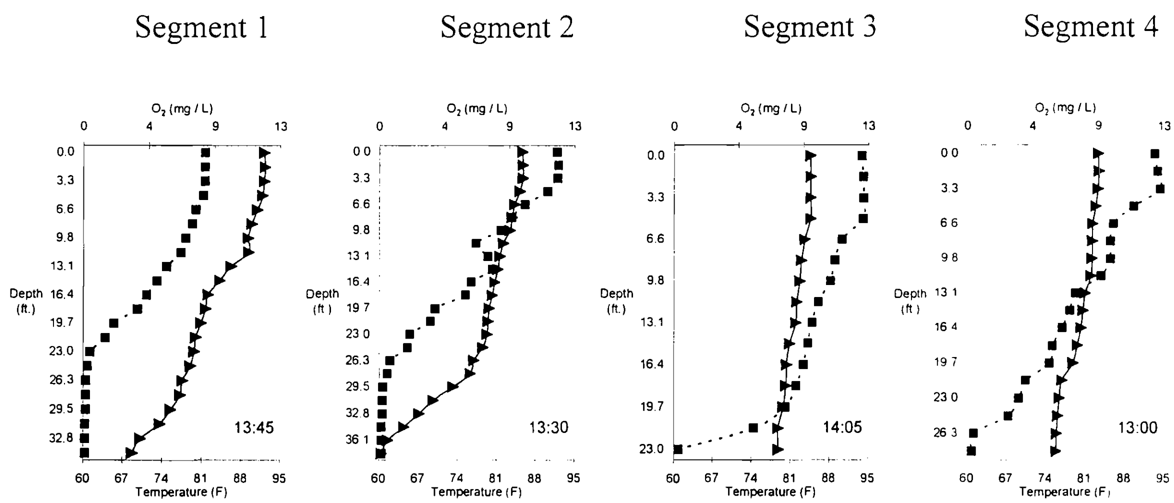


Figure D15. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, June 2, 2004



Coffeen Lake, June 9, 2004

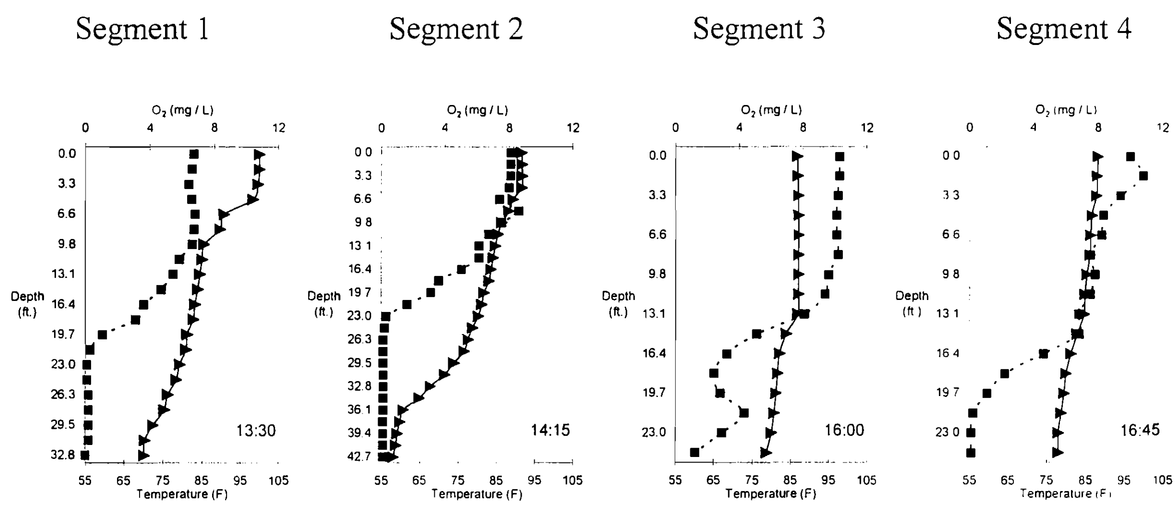
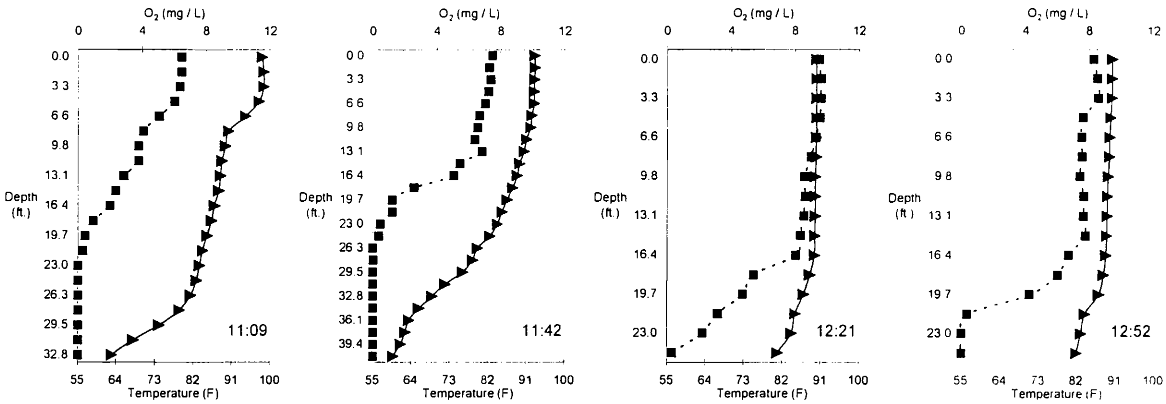


Figure D16. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, June 16, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Coffeen Lake, June 23, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

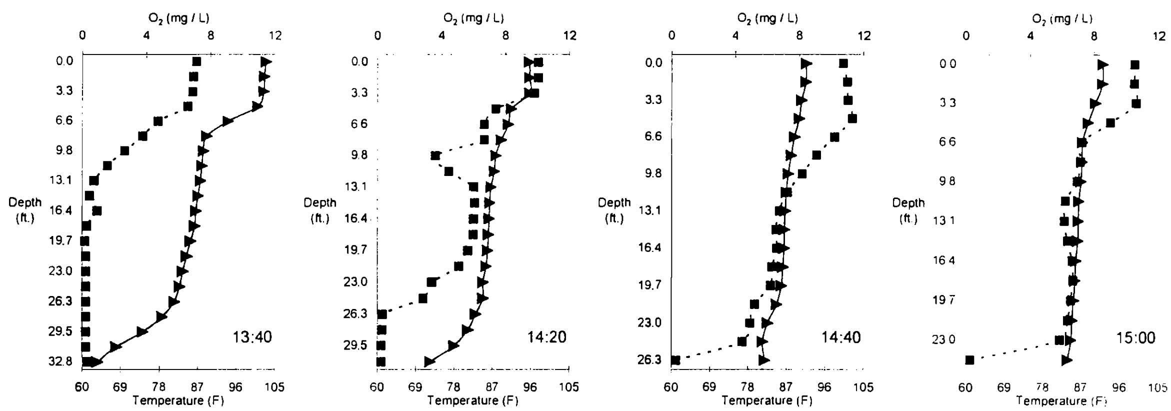
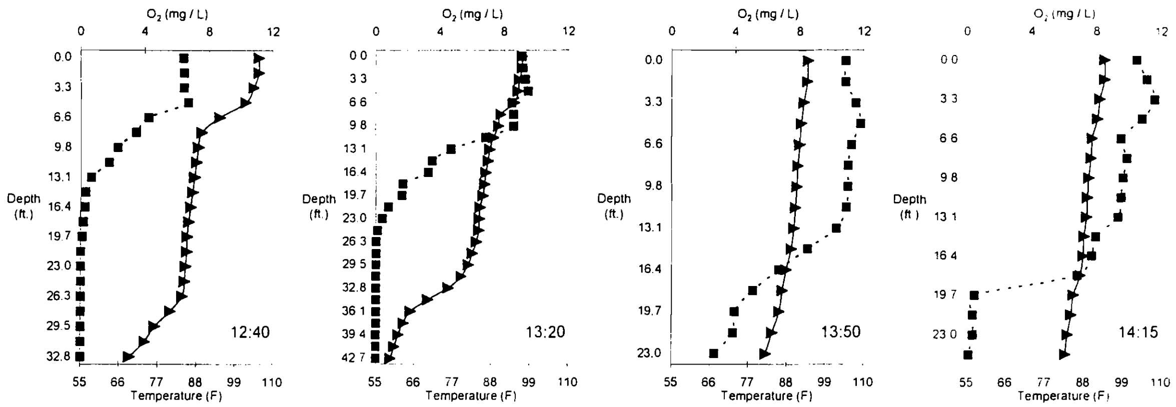


Figure D17. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, June 30, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Coffeen Lake, July 7, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

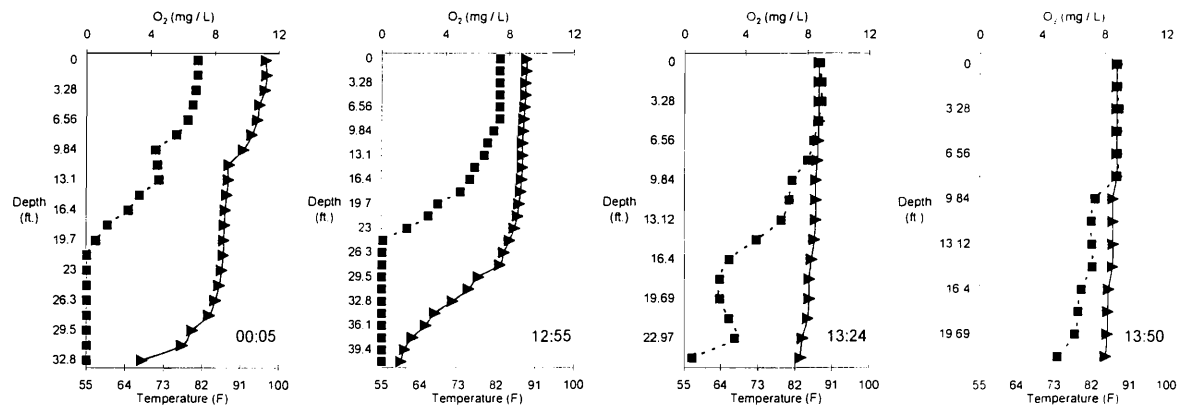


Figure D18. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

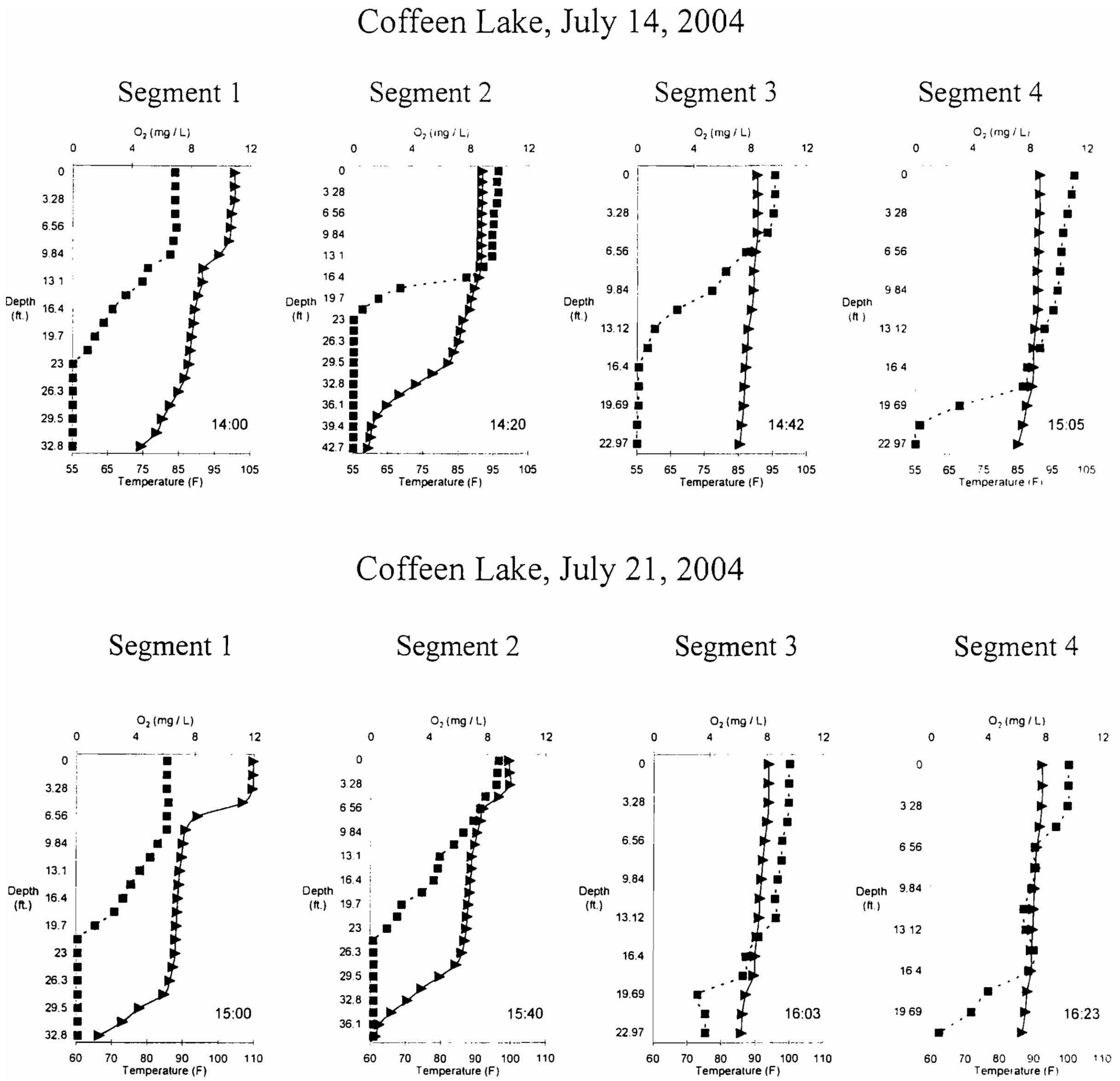
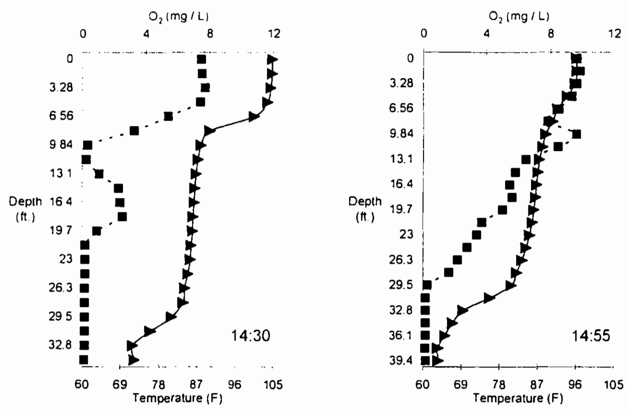


Figure D19. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, July 28, 2004

Segment 1 Segment 2



Coffeen Lake, August 4, 2004

Segment 1 Segment 2 Segment 3 Segment 4

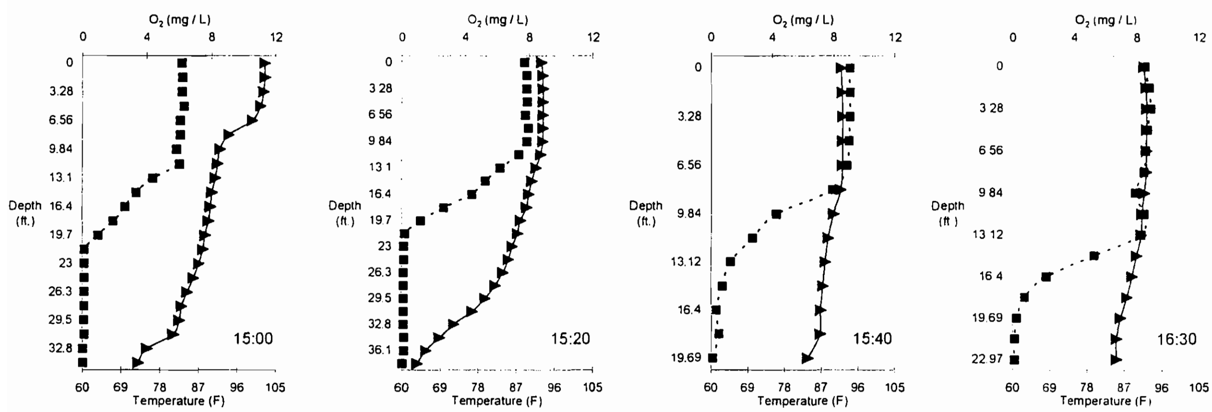
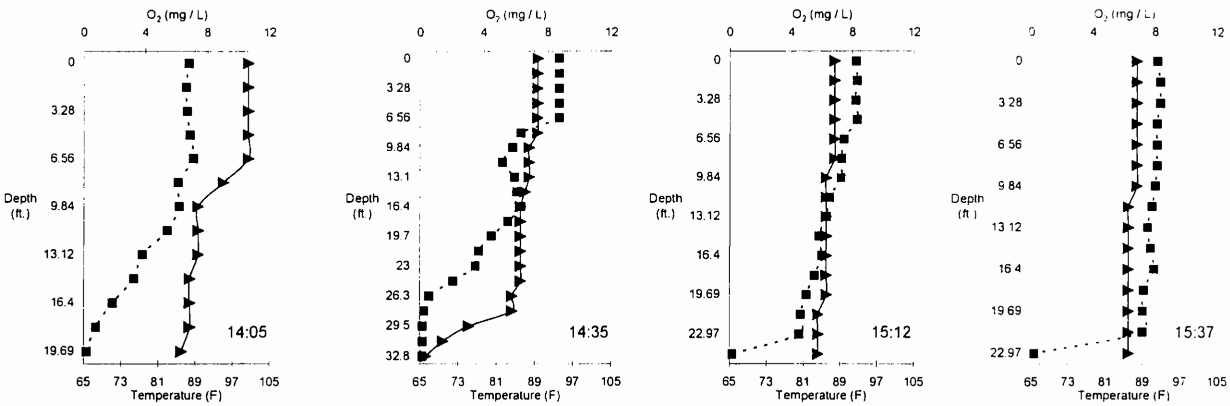


Figure D20. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, August 11, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Coffeen Lake, August 18, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

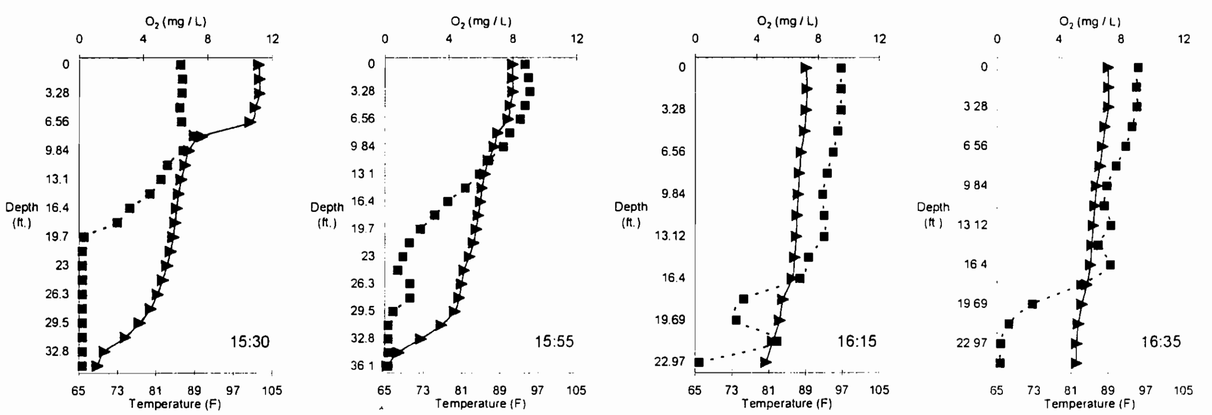


Figure D21. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

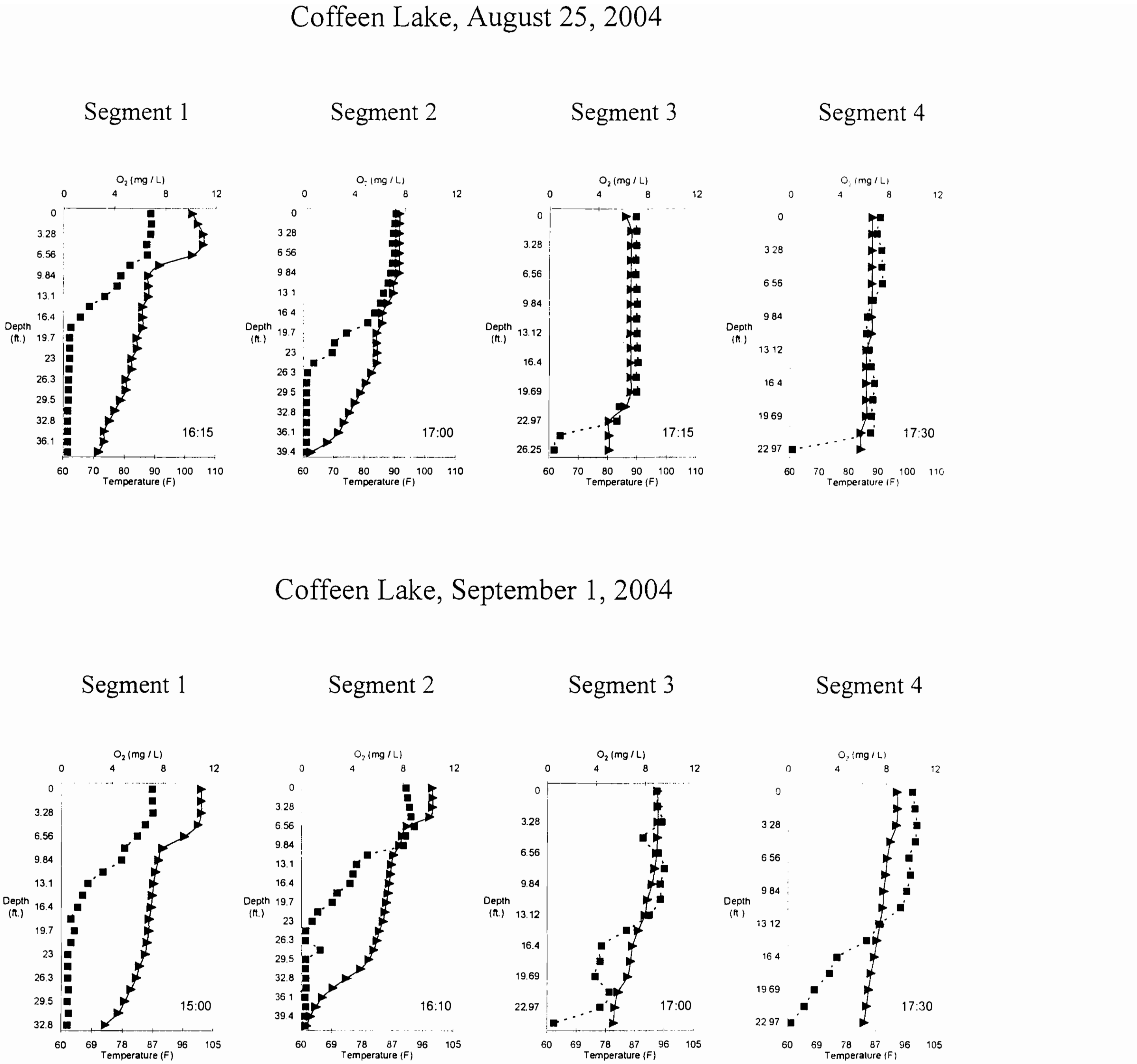
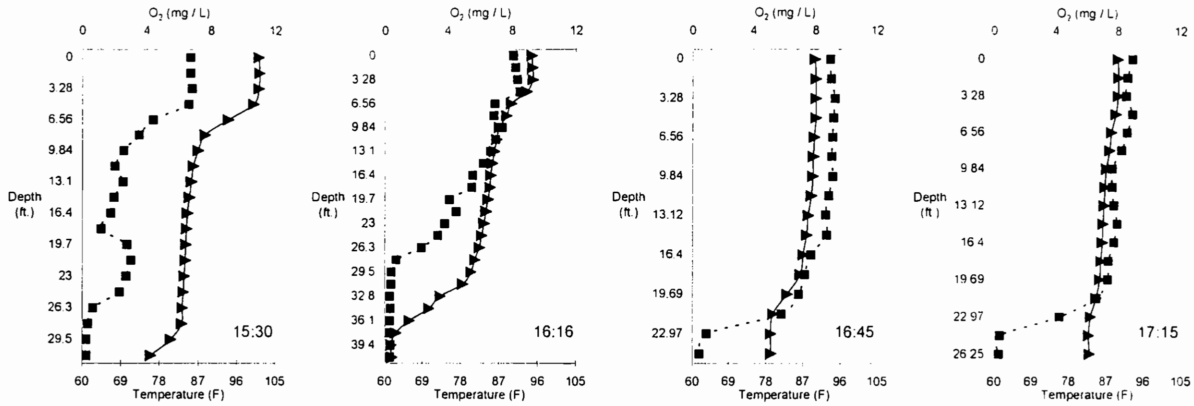


Figure D22. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

Coffeen Lake, September 10, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4



Coffeen Lake, September 15, 2004

Segment 1 | Segment 2 | Segment 3 | Segment 4

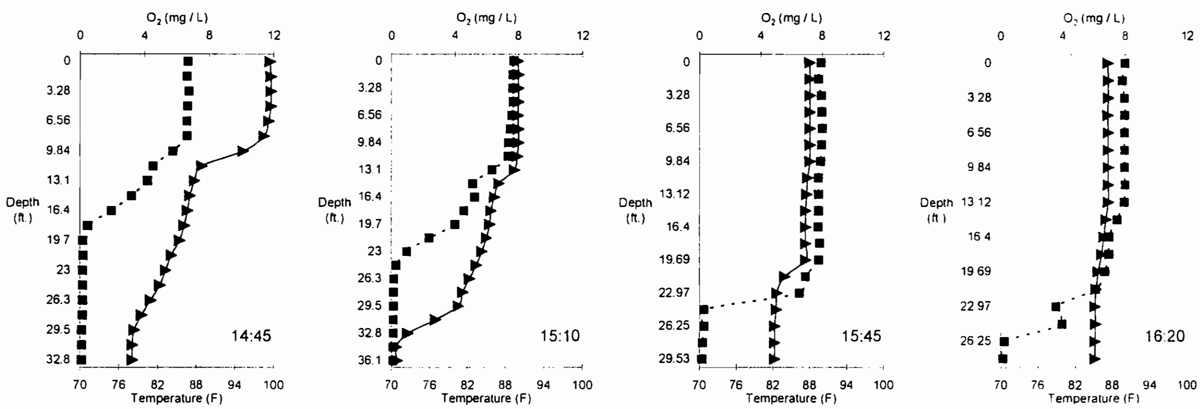


Figure D23. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

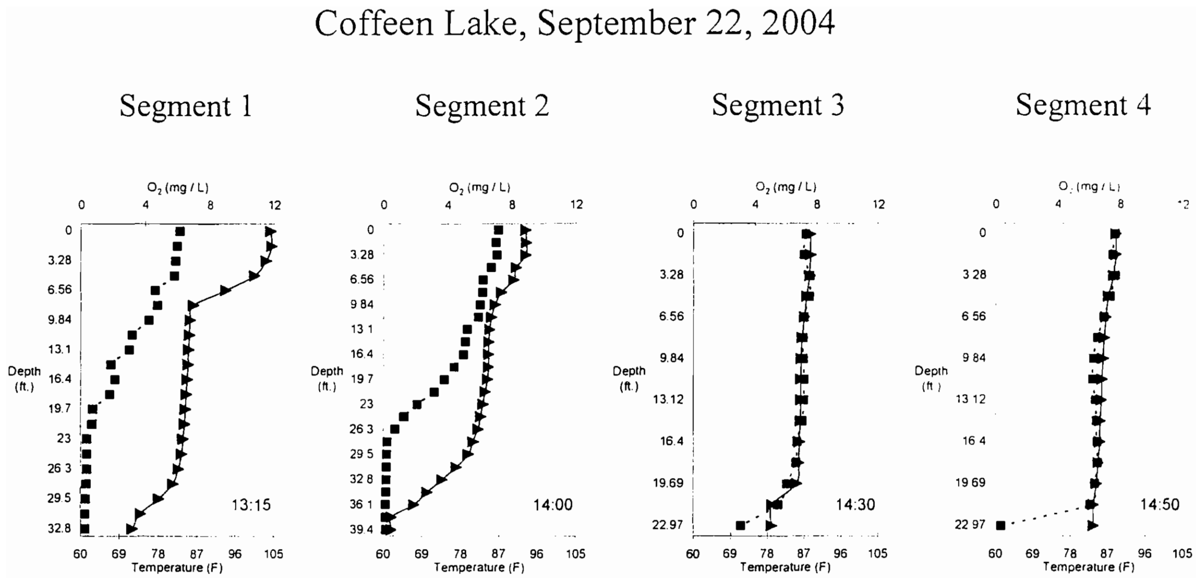


Figure D24. Temperature and dissolved oxygen profiles in 4 segments of Coffeen Lake. Triangles represent temperature (F) and squares represent oxygen (mg / L).

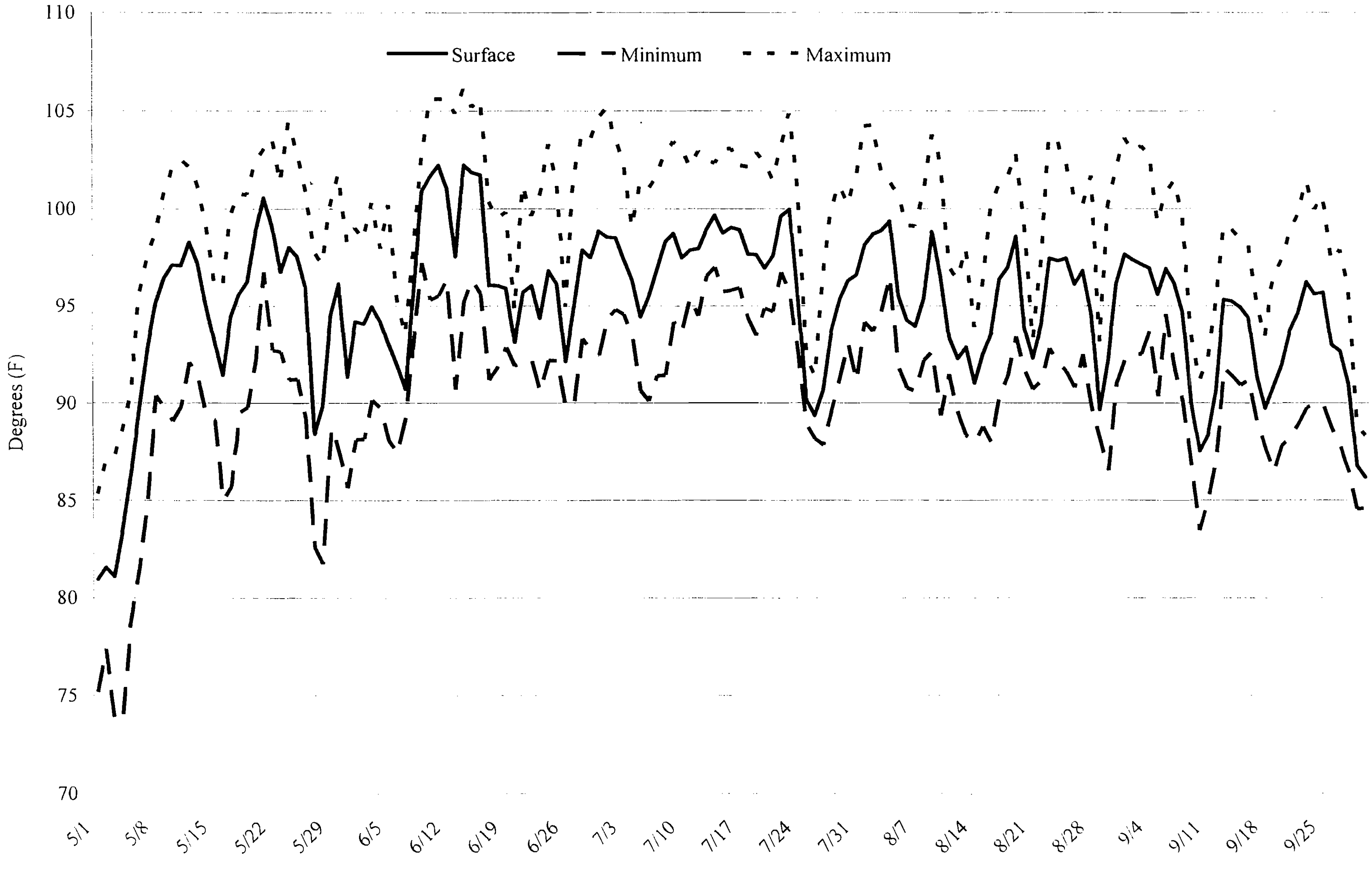


Figure D25.Mean, minimum, and maximum daily surface temperatures during 2004 at the Newton Lake mixing zone.

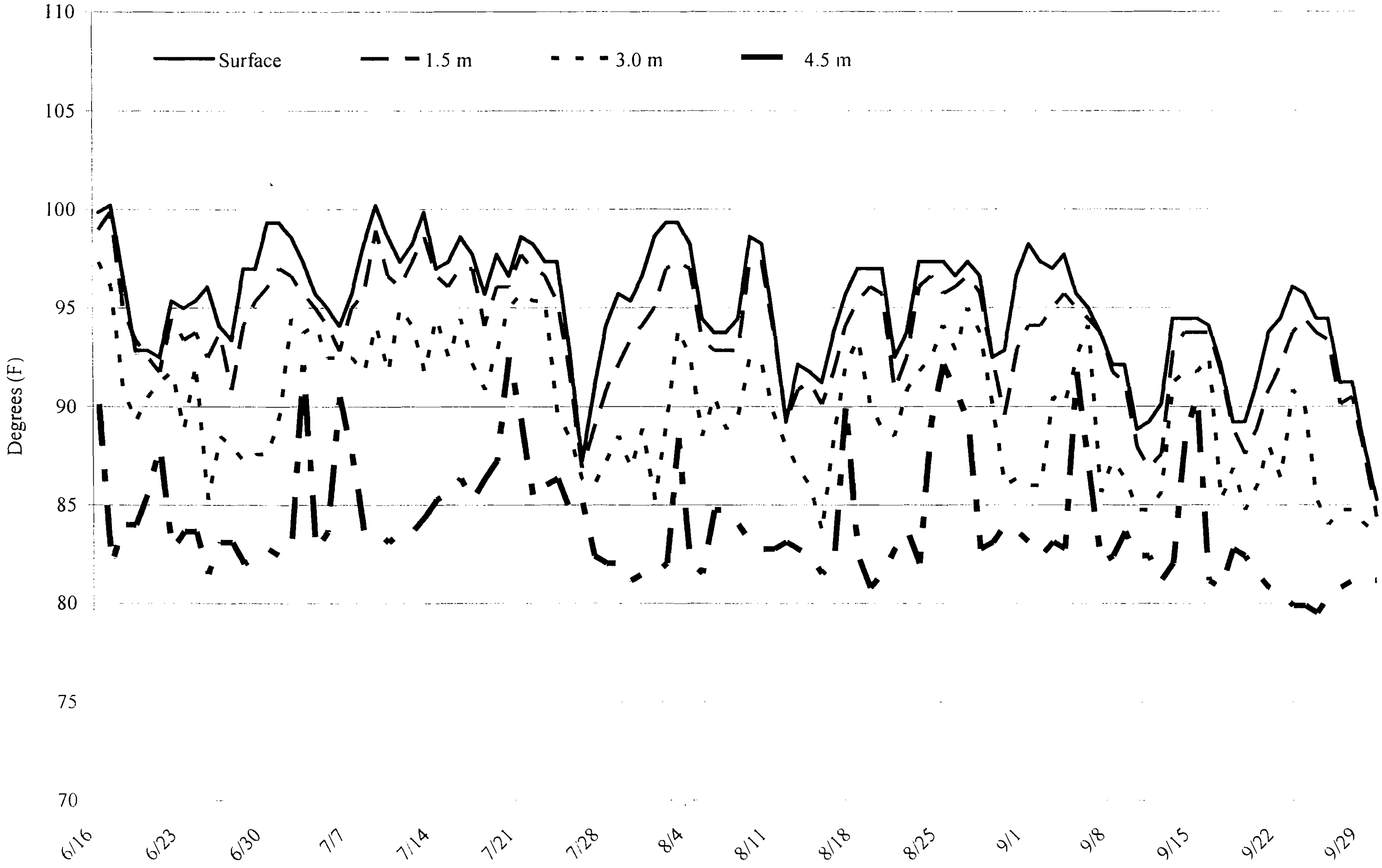


Figure D26. Mean daily temperatures during 2004, Newton Lake Segment 1. Lake bottom is approximately 16.4 feet.

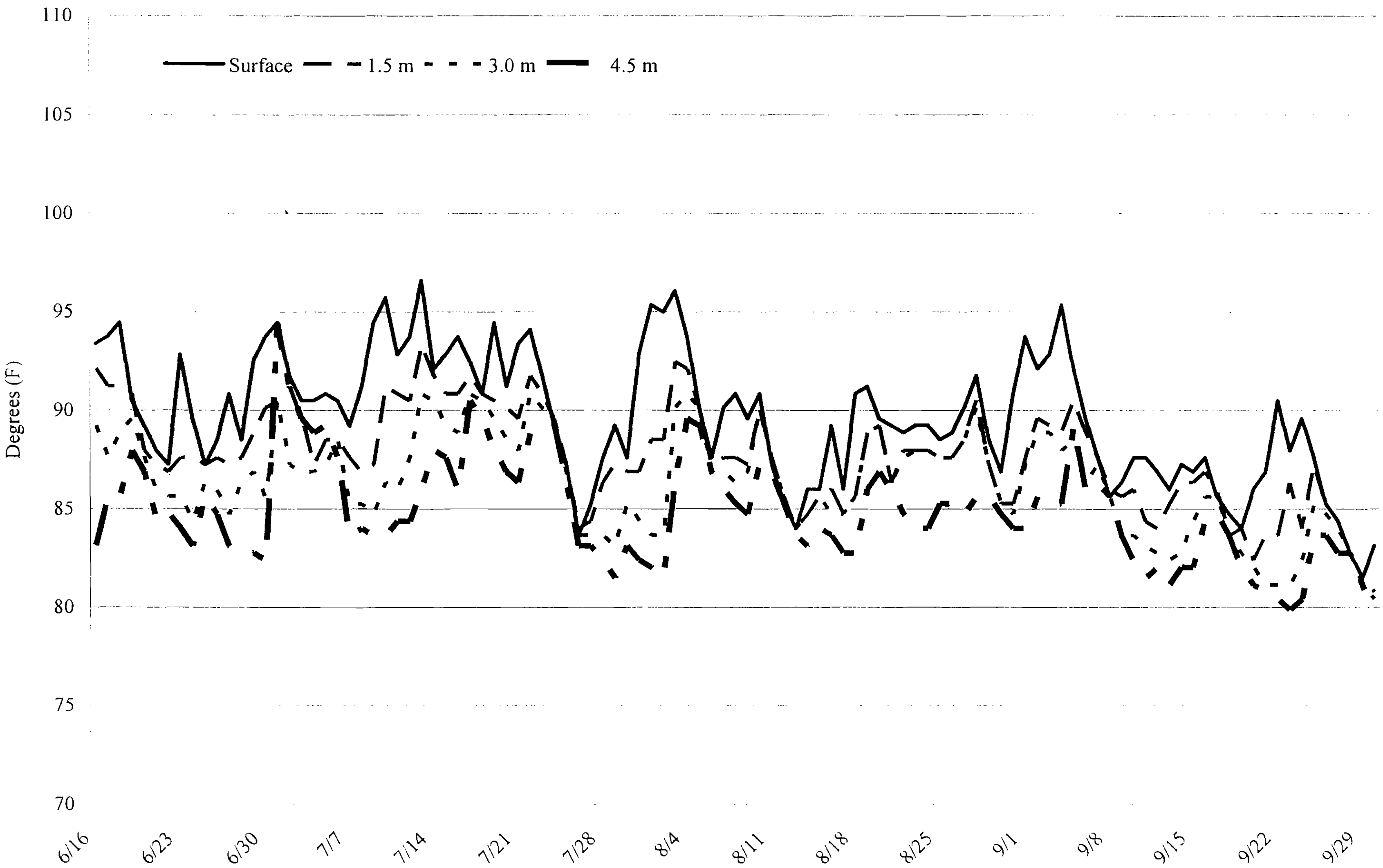


Figure D27. Mean daily temperatures during 2004, Newton Lake Segment 2. Lake bottom is approximately 32.8 feet.

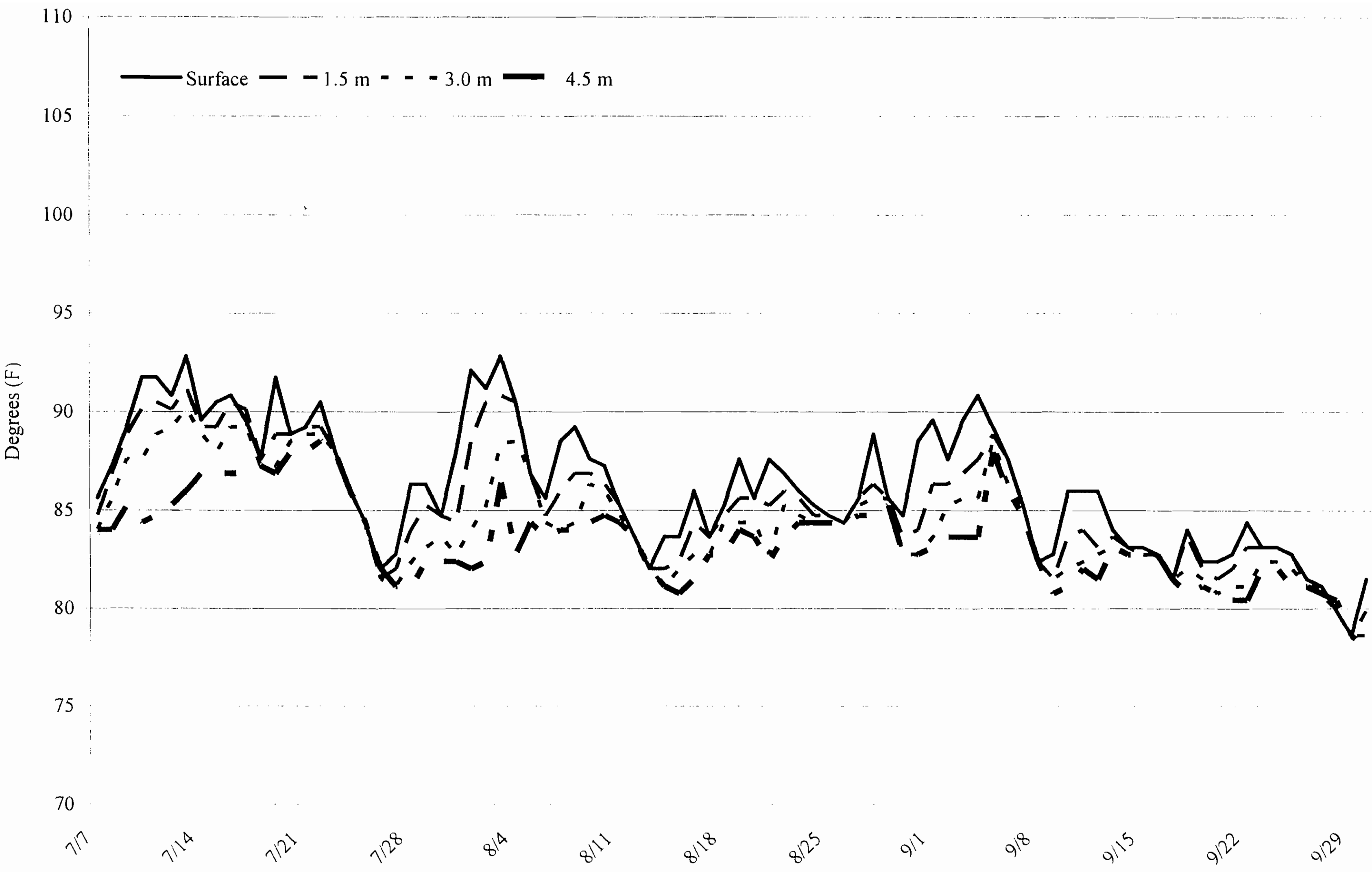


Figure D28. Mean daily temperatures during 2004, Newton Lake Segment 3. Lake bottom is approximately 32.8 feet.

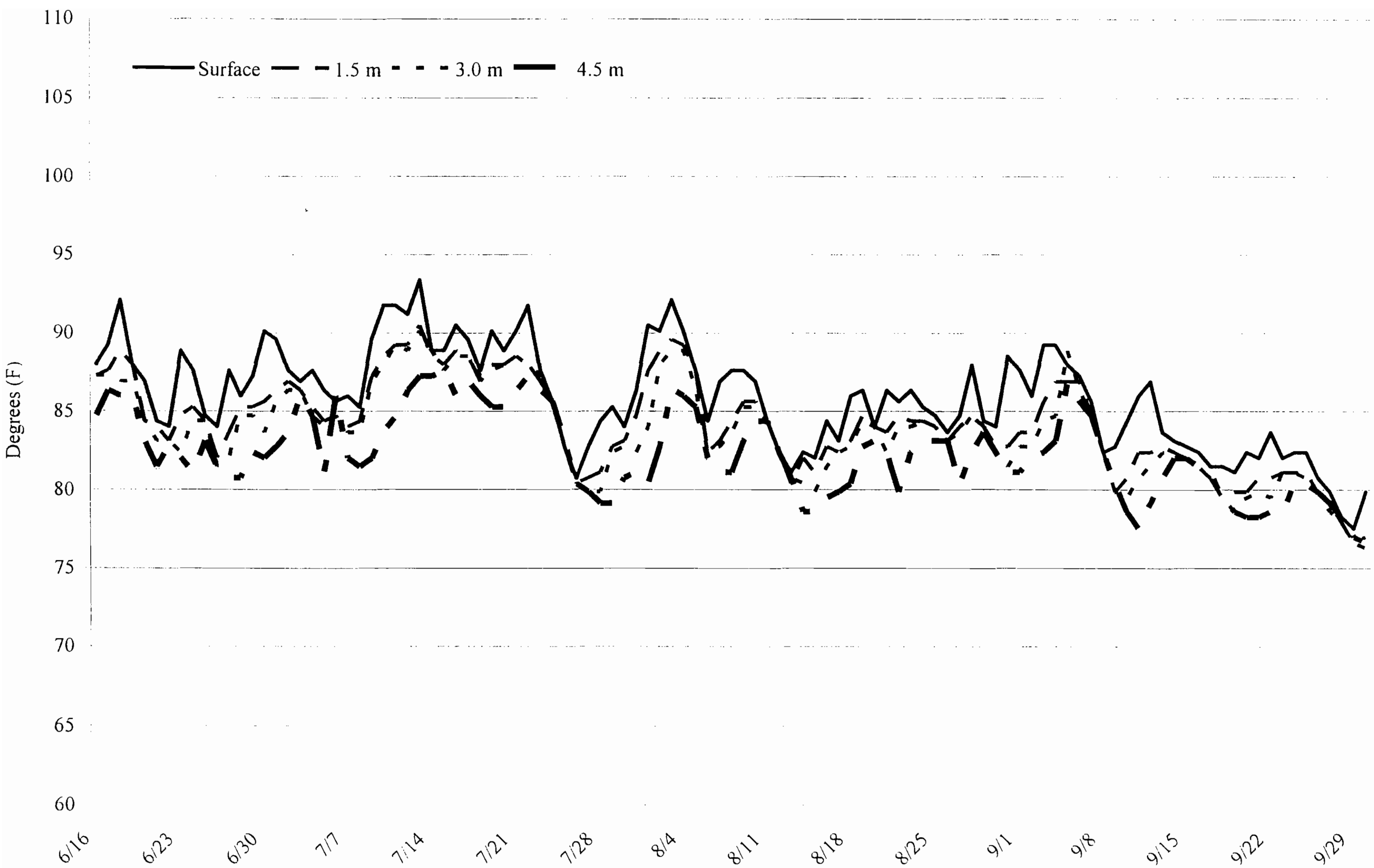


Figure D29. Mean daily temperatures during 2004 in Newton Lake Segment 4. Lake bottom is approximately 29.5 feet.

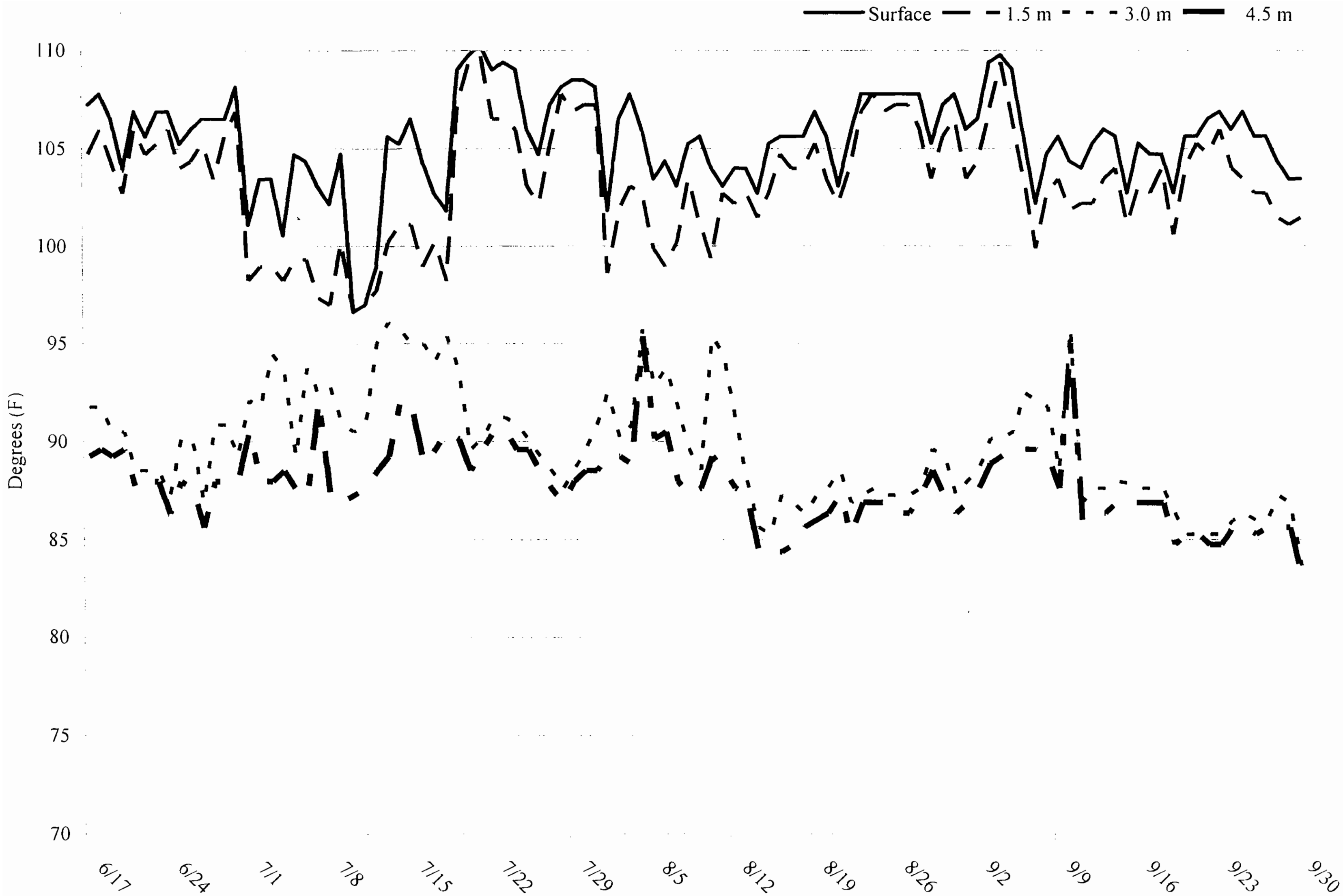


Figure D30. Mean daily temperatures in Segment 1 during 2004, Coffeen Lake mixing zone. Lake bottom is approximately 18.0 feet.

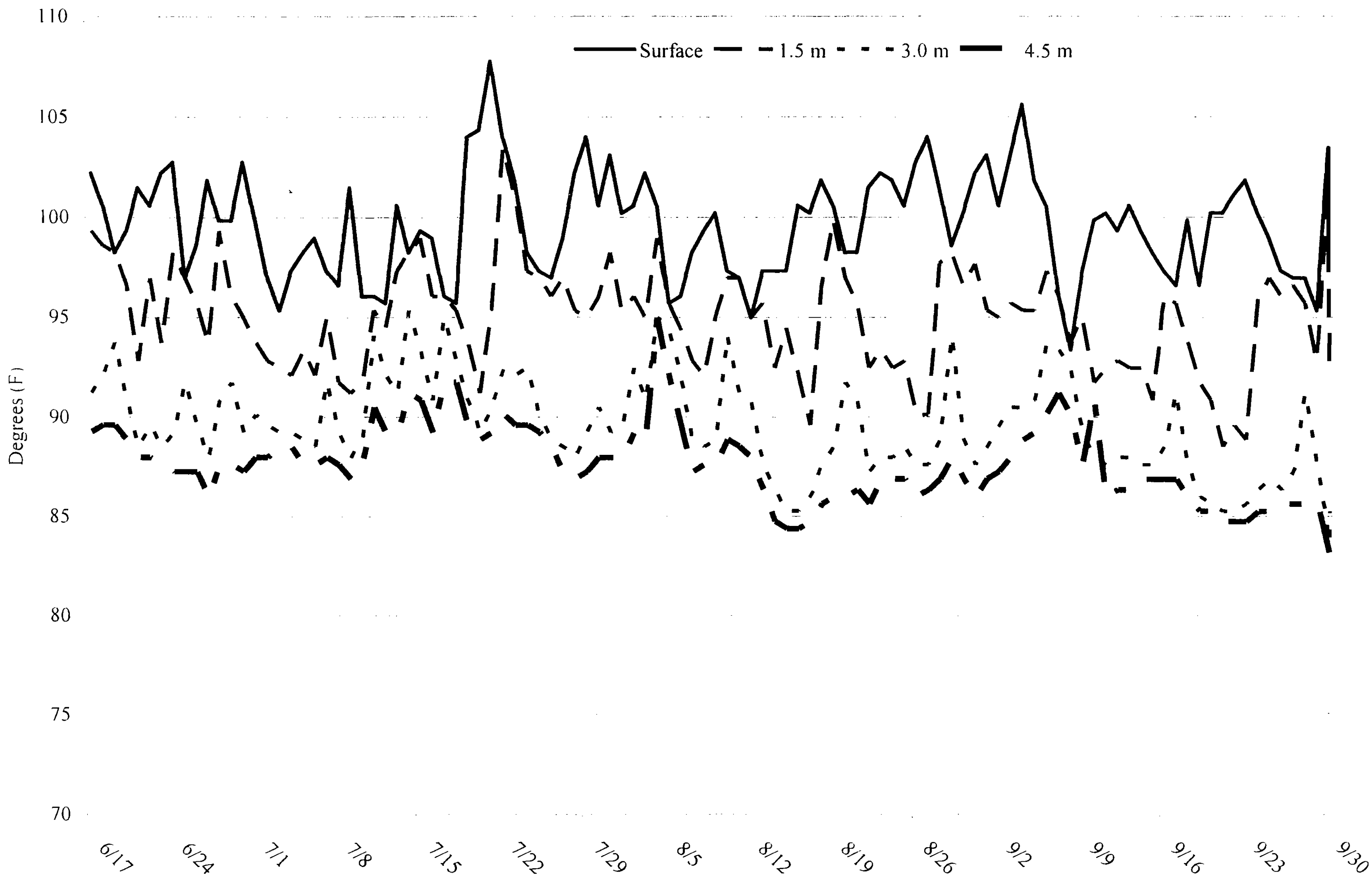


Figure D31. Mean daily temperatures during 2004, Coffeen Lake at the dam. Lake bottom is approximately 42.6 feet.

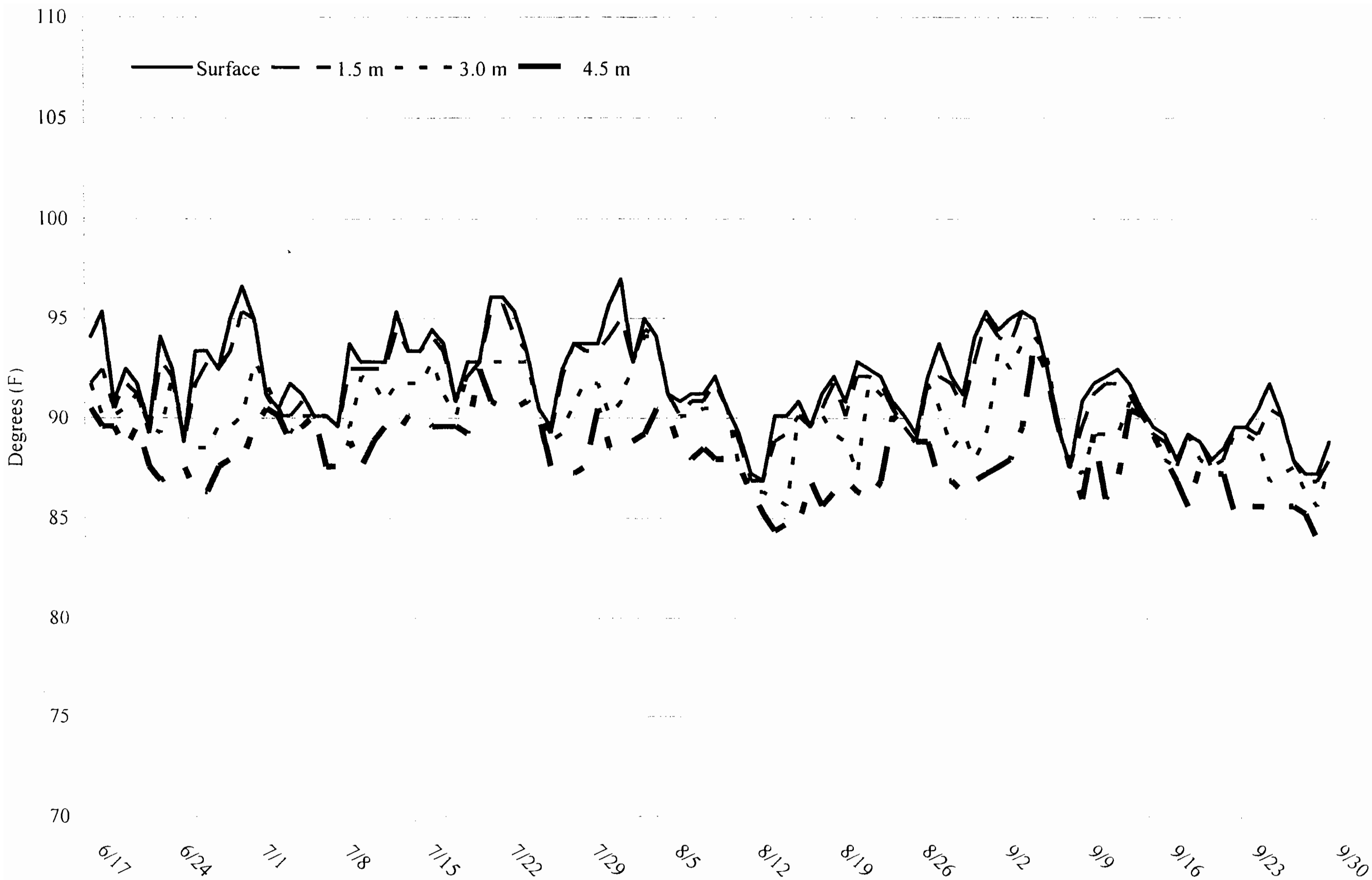


Figure D32. Mean daily temperatures during 2004, Coffeen Lake at the intake. Lake bottom is approximately 26.2 feet.

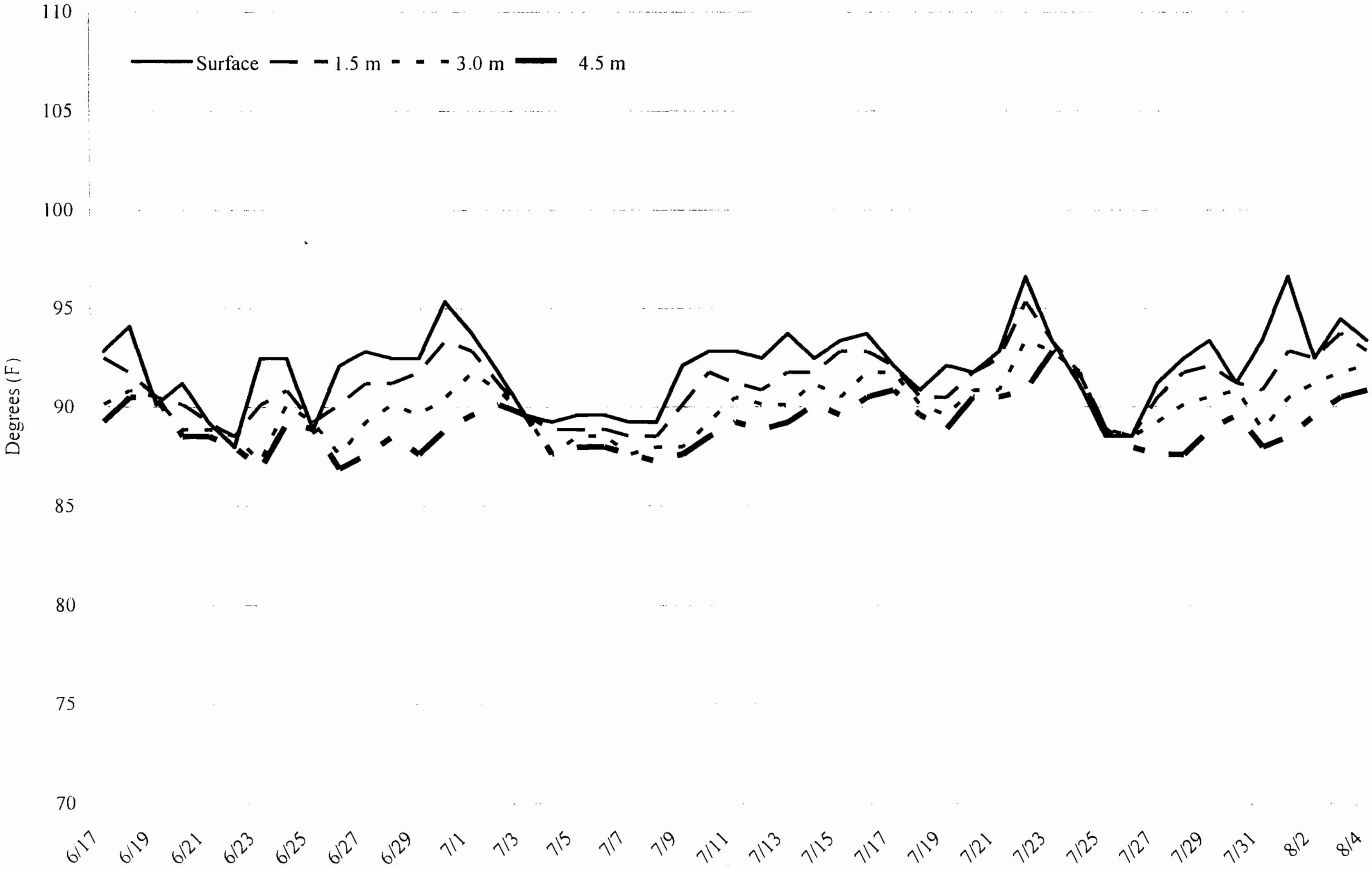


Figure D33. Mean daily temperatures during 2004, Coffeen Lake located in the slough west of the intake near the boat launch. Lake bottom is approximately 24.7 feet.

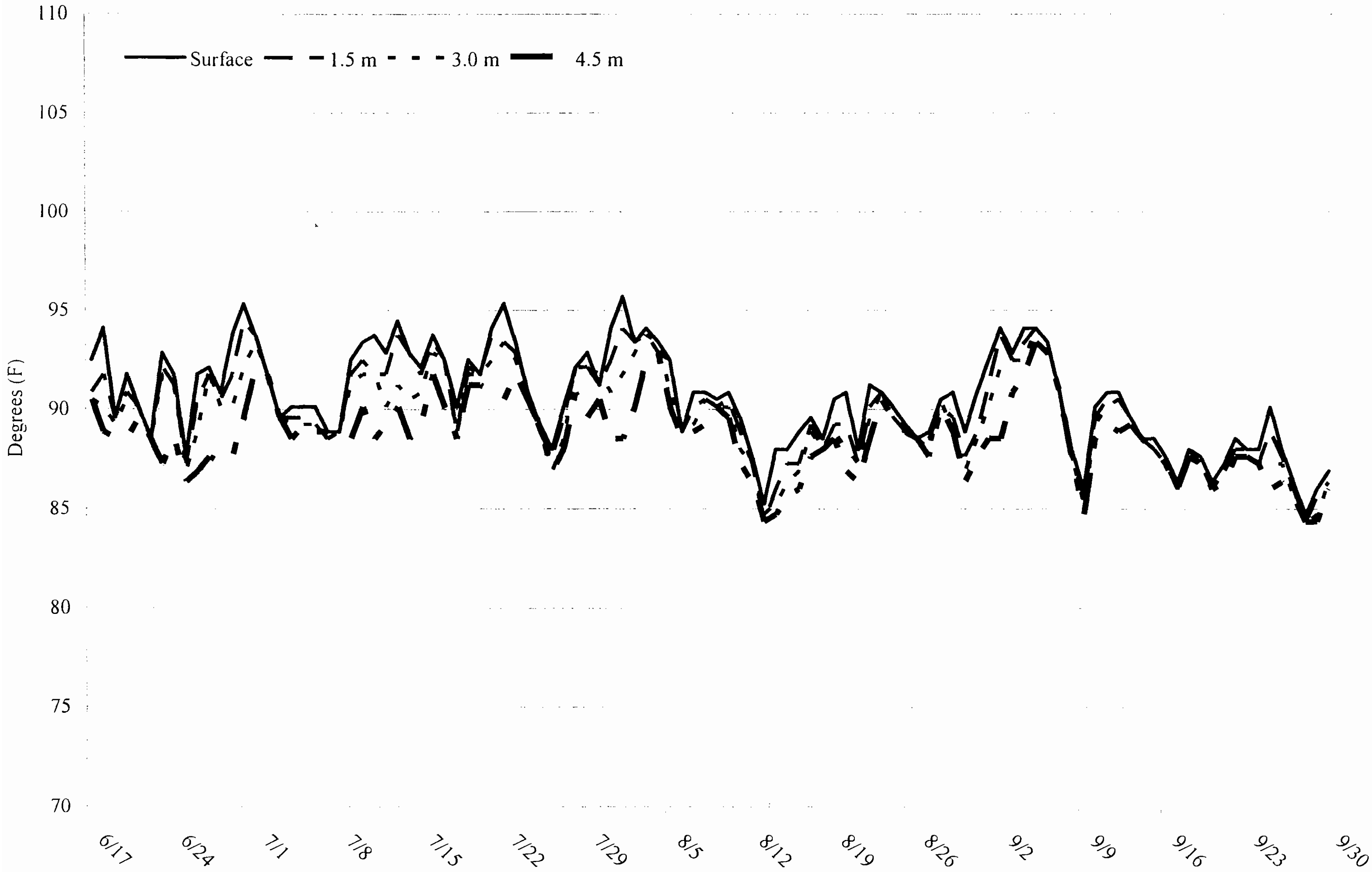


Figure D34. Mean daily temperatures during 2004, Coffeen Lake located midway between the intake and railroad bridge. Lake bottom is approximately 24.7 feet.

Appendix E: Extreme Habitat Conditions in Newton Lake and Coffeen Lake During 1999

Habitat conditions are given for periods in 1999 when summer fish kills occured in Newton and Coffeen Lake.

Table E1. Estimated percent habitat available in Newton Lake, July 24, 1999 (Segment 1 = 9:20 AM, Segment 2 = 10:33AM, Segment 3 = 12:12 PM, Segment 4 = 1:36 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 1	Segment 2	Segment 3	Segment 4	mean
4	87	0	0	0	0	0
4	88	0	0	0	0	0
4	89	0	0	0	0	0
4	90	0	0	0	0	0
4	91	0	0	0	0	0
4	92	0	0	0	10	3
4	93	0	0	6	20	7
4	94	0	0	18	50	17
4	95	0	0	24	80	26
4	96	0	0	38	85	31
4	97	0	0	38	85	31
3	87	0	0	0	0	0
3	88	0	0	0	0	0
3	89	0	0	0	0	0
3	90	0	0	0	0	0
3	91	0	0	0	0	0
3	92	0	0	0	10	3
3	93	0	0	6	20	7
3	94	0	0	18	50	17
3	95	0	0	24	80	26
3	96	0	6	38	85	32
3	97	0	6	38	85	32
2	87	0	0	0	0	0
2	88	0	0	0	0	0
2	89	0	0	0	0	0
2	90	0	0	0	0	0
2	91	0	0	0	0	0
2	92	0	0	0	10	3
2	93	0	6	6	20	8
2	94	0	6	18	50	19
2	95	0	6	24	80	28
2	96	0	13	38	85	34
2	97	0	13	38	85	34
1	87	0	0	0	0	0
1	88	0	0	0	0	0
1	89	0	0	0	0	0
1	90	0	0	0	0	0
1	91	13	0	6	0	5
1	92	13	0	6	10	7
1	93	13	6	12	20	13
1	94	25	6	24	50	26
1	95	25	6	29	80	35
1	96	25	13	44	85	42
1	97	25	13	44	85	42

Table E2. Estimated percent habitat available in Newton Lake, July 29, 1999 (all segments = between 1:00 PM and 5:00 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 3	Segment 3-4 border	Segment 4
4	87	0	0	0
4	88	0	0	0
4	89	0	0	0
4	90	0	0	0
4	91	0	0	0
4	92	14	17	0
4	93	29	17	50
4	94	43	33	50
4	95	43	33	50
4	96	43	33	75
4	97	57	33	75
3	87	0	0	0
3	88	0	0	0
3	89	0	0	0
3	90	0	0	0
3	91	0	0	0
3	92	14	17	0
3	93	29	17	50
3	94	43	33	50
3	95	43	33	50
3	96	43	33	75
3	97	57	33	75
2	87	0	0	0
2	88	0	0	0
2	89	0	0	0
2	90	0	0	0
2	91	0	0	0
2	92	14	17	0
2	93	29	17	50
2	94	43	33	50
2	95	43	33	50
2	96	43	33	75
2	97	57	33	75
1	87	14	17	0
1	88	14	17	0
1	89	14	17	0
1	90	14	17	0
1	91	14	17	0
1	92	29	33	13
1	93	43	33	63
1	94	57	50	63
1	95	57	50	63
1	96	57	50	88
1	97	71	50	88

Table E3. Estimated percent habitat available in Newton Lake, July 30, 1999 (Segment 4a = 4:30 PM, Segment 4b = 6:30 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 4a	Segment 4b
4	87	0	0
4	88	0	0
4	89	0	0
4	90	0	0
4	91	0	0
4	92	13	0
4	93	13	0
4	94	13	20
4	95	13	40
4	96	38	40
4	97	38	40
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	0
3	92	13	0
3	93	13	0
3	94	13	20
3	95	13	40
3	96	38	40
3	97	38	40
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	0
2	91	0	0
2	92	13	0
2	93	13	0
2	94	13	20
2	95	13	40
2	96	38	40
2	97	38	40
1	87	0	10
1	88	0	10
1	89	0	10
1	90	0	10
1	91	0	10
1	92	13	10
1	93	13	10
1	94	13	30
1	95	13	50
1	96	38	50
1	97	38	50

Table E4. Estimated percent habitat available in Newton Lake, August 5, 1999 (Segment 1 = 3:50 PM, Segment 2 = 4:05 PM, Segment 3 = 4:20 PM, Segment 4 = 4:40 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum	Maximum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	87	0	0	0	5	1
4	88	0	0	0	25	6
4	89	0	0	11	55	17
4	90	0	0	11	65	19
4	91	0	6	33	100	35
4	92	0	6	58	100	41
4	93	0	13	58	100	43
4	94	0	13	58	100	43
4	95	0	13	58	100	43
4	96	0	13	58	100	43
4	97	0	25	58	100	46
3	87	0	0	0	5	1
3	88	0	0	0	25	6
3	89	0	6	11	55	18
3	90	0	6	11	65	21
3	91	0	13	33	100	37
3	92	0	13	58	100	43
3	93	0	19	58	100	44
3	94	0	19	58	100	44
3	95	0	19	58	100	44
3	96	13	19	58	100	48
3	97	13	31	58	100	51
2	87	0	0	0	5	1
2	88	0	0	0	25	6
2	89	0	13	11	55	20
2	90	0	13	11	65	22
2	91	0	19	33	100	38
2	92	0	19	58	100	44
2	93	0	25	58	100	46
2	94	0	25	58	100	46
2	95	0	25	58	100	46
2	96	13	25	58	100	49
2	97	13	38	58	100	52
1	87	0	0	6	5	3
1	88	0	6	6	25	9
1	89	0	19	17	55	23
1	90	0	19	17	65	25
1	91	13	25	39	100	44
1	92	13	25	64	100	51
1	93	13	31	64	100	52
1	94	13	31	64	100	52
1	95	13	31	64	100	52
1	96	25	31	64	100	55
1	97	25	44	64	100	58

Table E5. Estimated percent habitat available in Newton Lake, August 18, 1999 (Segment 1 = 3:40 PM, Segment 2 = 3:50 PM, Segment 3 = 4:05 PM, Segment 4 = 4:25 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum	Maximum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	87	0	0	24	95	30
4	88	0	6	24	95	31
4	89	0	6	35	95	34
4	90	0	6	56	95	39
4	91	0	12	56	95	41
4	92	0	12	56	95	41
4	93	0	12	56	95	41
4	94	0	12	56	95	41
4	95	13	18	56	95	46
4	96	13	38	56	95	51
4	97	25	38	56	95	54
3	87	0	0	29	95	31
3	88	0	6	29	95	33
3	89	0	6	41	95	36
3	90	0	6	62	95	41
3	91	0	12	62	95	42
3	92	0	12	62	95	42
3	93	0	12	62	95	42
3	94	0	12	62	95	42
3	95	13	18	62	95	47
3	96	13	38	62	95	52
3	97	25	38	62	95	55
2	87	0	12	35	95	36
2	88	0	18	35	95	37
2	89	0	18	47	95	40
2	90	0	18	68	95	45
2	91	0	24	68	95	47
2	92	0	24	68	95	47
2	93	0	24	68	95	47
2	94	0	24	68	95	47
2	95	13	29	68	95	51
2	96	13	50	68	95	57
2	97	25	50	68	95	60
1	87	0	18	41	100	40
1	88	0	24	41	100	41
1	89	0	24	53	100	44
1	90	0	24	74	100	50
1	91	0	29	74	100	51
1	92	0	29	74	100	51
1	93	0	29	74	100	51
1	94	0	29	74	100	51
1	95	13	35	74	100	56
1	96	13	56	74	100	61
1	97	25	56	74	100	64

Table E6. Estimated percent habitat available in Newton Lake, August 31, 1999 (Segment 1 = 5:10 PM, Segment 2 = 4:51 PM, Segment 3 = 4:33 PM, Segment 4 = 4:08 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum	Maximum	% Habitat Available				
Oxygen (ppm)	Temperature (°F)	Segment 1	Segment 2	Segment 3	Segment 4	mean
4	87	0	19	66	100	46
4	88	0	25	66	100	48
4	89	0	25	66	100	48
4	90	0	38	66	100	51
4	91	0	59	66	100	56
4	92	25	59	66	100	63
4	93	25	59	66	100	63
4	94	38	59	66	100	66
4	95	50	59	66	100	69
4	96	50	59	66	100	69
4	97	63	59	66	100	72
3	87	0	31	66	100	49
3	88	13	38	66	100	54
3	89	13	38	66	100	54
3	90	13	50	66	100	57
3	91	13	72	66	100	63
3	92	38	72	66	100	69
3	93	38	72	66	100	69
3	94	50	72	66	100	72
3	95	63	72	66	100	75
3	96	63	72	66	100	75
3	97	75	72	66	100	78
2	87	0	38	66	100	51
2	88	13	44	66	100	56
2	89	13	44	66	100	56
2	90	13	56	66	100	59
2	91	13	78	66	100	64
2	92	38	78	66	100	71
2	93	38	78	66	100	71
2	94	50	78	66	100	74
2	95	63	78	66	100	77
2	96	63	78	66	100	77
2	97	75	78	66	100	80
1	87	6	38	78	100	56
1	88	19	44	78	100	60
1	89	19	44	78	100	60
1	90	19	56	78	100	63
1	91	19	78	78	100	69
1	92	44	78	78	100	75
1	93	44	78	78	100	75
1	94	56	78	78	100	78
1	95	69	78	78	100	81
1	96	69	78	78	100	81
1	97	81	78	78	100	84

Table E7. Estimated percent habitat available outside of Coffeen Lake cooling loop, July 21, 1999 (time unknown). Data was obtained by AmerenCips. Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum	Maximum	% Habitat Available		
Oxygen (ppm)	Temperature (°F)	Location F1	Location F2	Location G
4	87	0	0	
4	88	0	0	
4	89	0	0	
4	90	0	0	
4	91	0	0	
4	92	0	0	
4	93	0	0	
4	94	6	0	
4	95	6	0	
4	96	36	100	
4	97	53	100	
3	87	0	0	
3	88	0	0	
3	89	0	0	
3	90	0	0	
3	91	0	0	
3	92	6	0	
3	93	11	0	
3	94	17	0	
3	95	17	0	
3	96	47	100	
3	97	64	100	
2	87	0	0	
2	88	0	0	
2	89	0	0	
2	90	11	0	
2	91	17	0	
2	92	22	0	
2	93	28	0	
2	94	33	0	
2	95	33	0	
2	96	64	100	
2	97	81	100	
1	87	0	0	
1	88	0	0	
1	89	6	0	
1	90	17	0	
1	91	22	0	
1	92	28	0	
1	93	33	0	
1	94	39	0	
1	95	39	0	
1	96	69	100	
1	97	86	100	

Table E8. Estimated percent habitat available in Coffeen Lake, July 23, 1999 (Segment 1 = 3:10 PM, Segment 2 = 2:50 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	87	0	0
4	88	0	0
4	89	0	0
4	90	0	0
4	91	0	0
4	92	0	0
4	93	5	0
4	94	10	5
4	95	14	10
4	96	19	20
4	97	24	25
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	5
3	92	5	5
3	93	10	10
3	94	14	15
3	95	19	20
3	96	24	30
3	97	29	35
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	10
2	91	5	15
2	92	10	15
2	93	14	20
2	94	19	25
2	95	24	30
2	96	29	40
2	97	33	45
1	87	0	0
1	88	0	5
1	89	5	5
1	90	10	15
1	91	14	20
1	92	19	20
1	93	24	25
1	94	29	30
1	95	33	35
1	96	38	45
1	97	43	50

Table E9. Estimated percent habitat available in Coffeen Lake, July 31, 1999, at the discharge (upstream from segment 1 midpoint) and dam (border of segments 1 and 2) temperature monitor buoys (Discharge = 4:00 AM, Dam = ca. 4:00 AM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum	Maximum	% Habitat Available	
Oxygen (ppm)	Temperature (°F)	discharge	dam
4	87	0	0
4	88	0	0
4	89	0	0
4	90	0	0
4	91	0	0
4	92	0	0
4	93	0	0
4	94	0	0
4	95	0	0
4	96	0	0
4	97	0	17
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	0
3	92	0	0
3	93	0	0
3	94	0	0
3	95	0	0
3	96	17	17
3	97	17	33
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	0
2	91	0	0
2	92	0	0
2	93	0	0
2	94	0	8
2	95	0	8
2	96	25	25
2	97	25	42
1	87	0	0
1	88	0	0
1	89	0	0
1	90	0	0
1	91	0	0
1	92	0	0
1	93	0	0
1	94	0	8
1	95	0	8
1	96	25	25
1	97	25	42

Table E10. Estimated percent habitat available in Coffeen Lake, August 1, 1999, at the discharge (upstream from segment 1 midpoint) and dam (border of segments 1 and 2) temperature monitor buoys (Discharge = 1:45 AM, Dam = ca. 2:00 AM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	87	0	0
4	88	0	0
4	89	0	0
4	90	0	0
4	91	0	0
4	92	0	0
4	93	0	0
4	94	0	0
4	95	0	0
4	96	0	14
4	97	0	29
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	0
3	92	0	0
3	93	0	0
3	94	0	0
3	95	0	0
3	96	0	21
3	97	10	36
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	0
2	91	0	0
2	92	0	0
2	93	0	0
2	94	0	0
2	95	0	14
2	96	0	36
2	97	10	50
1	87	0	0
1	88	0	0
1	89	0	0
1	90	0	0
1	91	0	0
1	92	0	0
1	93	0	0
1	94	0	0
1	95	0	14
1	96	0	36
1	97	10	50

Table E11. Estimated percent habitat available in Coffeen Lake, August 6, 1999 (Segment 1 = 11:50 AM, Segment 2 = 12:10 PM). Habitat was considered available if it contained no less than the minimum oxygen or no more than the maximum temperature indicated.

Minimum Oxygen (ppm)	Maximum Temperature (°F)	% Habitat Available Segment 1	Segment 2
4	87	0	0
4	88	0	0
4	89	0	0
4	90	0	0
4	91	0	0
4	92	0	9
4	93	0	36
4	94	0	45
4	95	0	45
4	96	0	45
4	97	0	66
3	87	0	0
3	88	0	0
3	89	0	0
3	90	0	0
3	91	0	5
3	92	0	14
3	93	0	41
3	94	0	50
3	95	0	50
3	96	0	50
3	97	6	70
2	87	0	0
2	88	0	0
2	89	0	0
2	90	0	0
2	91	0	9
2	92	0	18
2	93	0	45
2	94	0	55
2	95	0	55
2	96	0	55
2	97	6	75
1	87	0	0
1	88	0	0
1	89	0	5
1	90	0	5
1	91	0	14
1	92	0	23
1	93	6	50
1	94	11	59
1	95	17	59
1	96	17	59
1	97	22	80

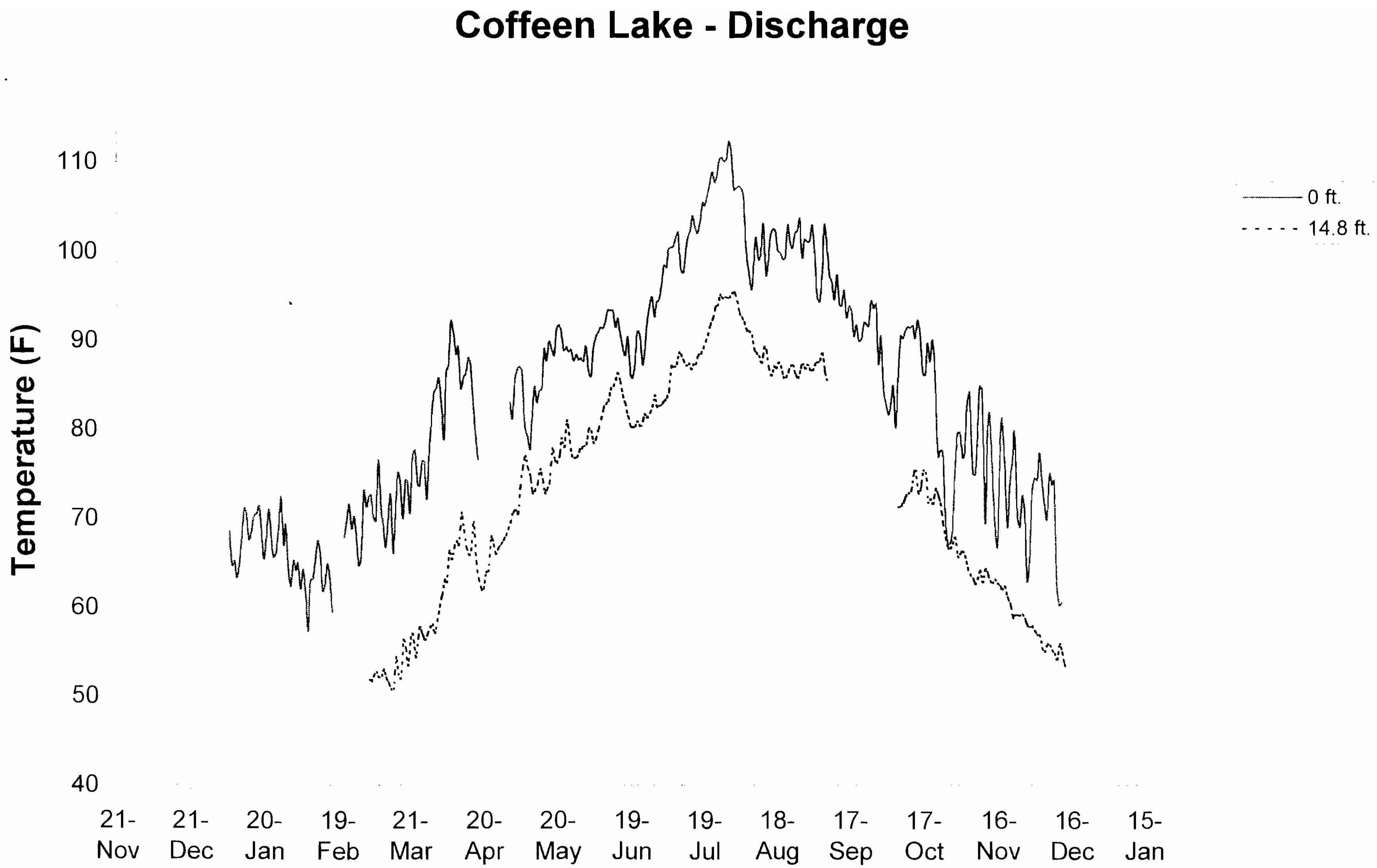


Figure E1. Mean daily temperature during 1999 at the Coffeen Lake discharge mixing zone. Lake bottom is approximately 42.6 feet .

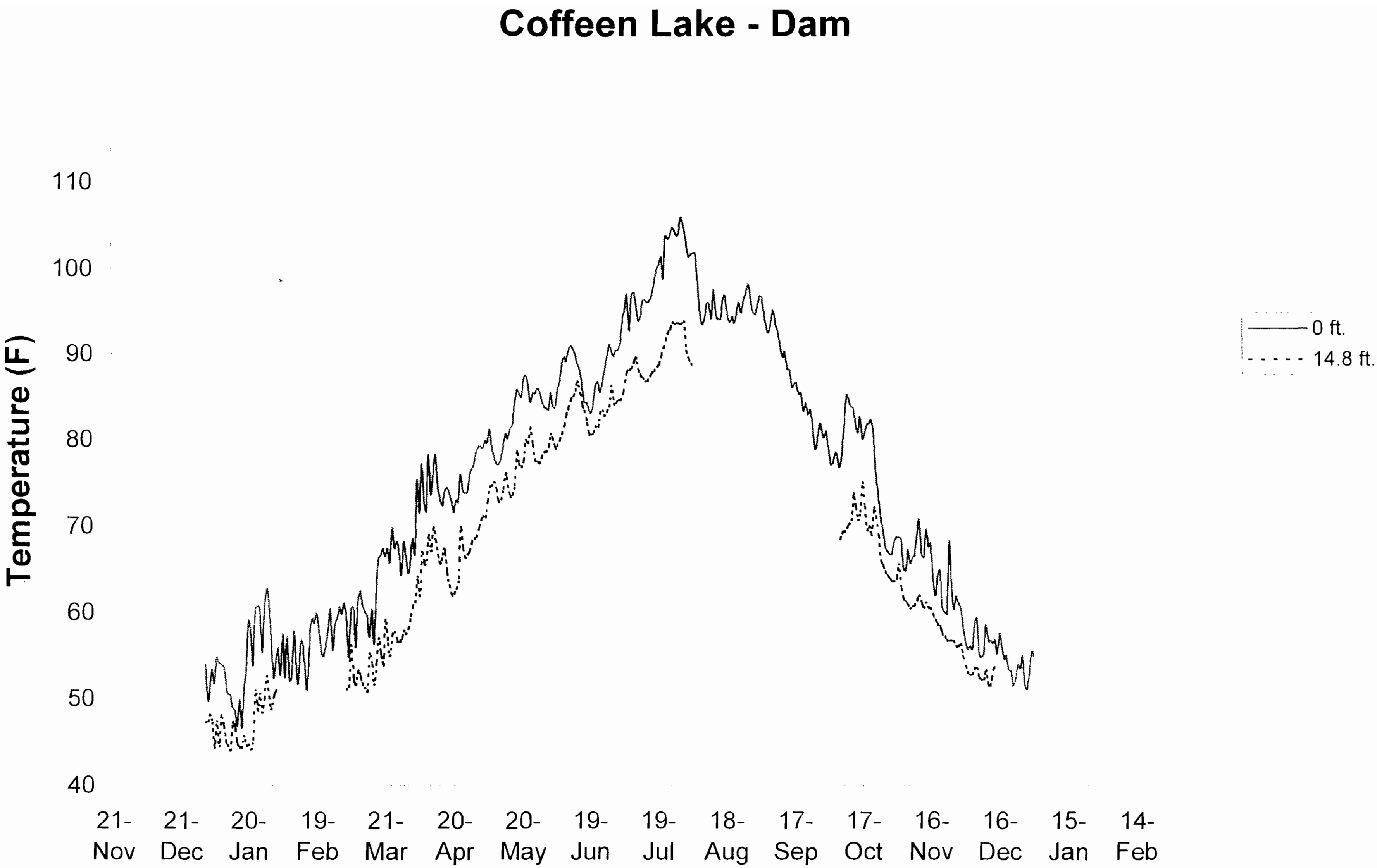


Figure E2. Mean daily temperature during 1999 at the Coffeen Lake dam. Lake bottom is approximately 42.6 feet.

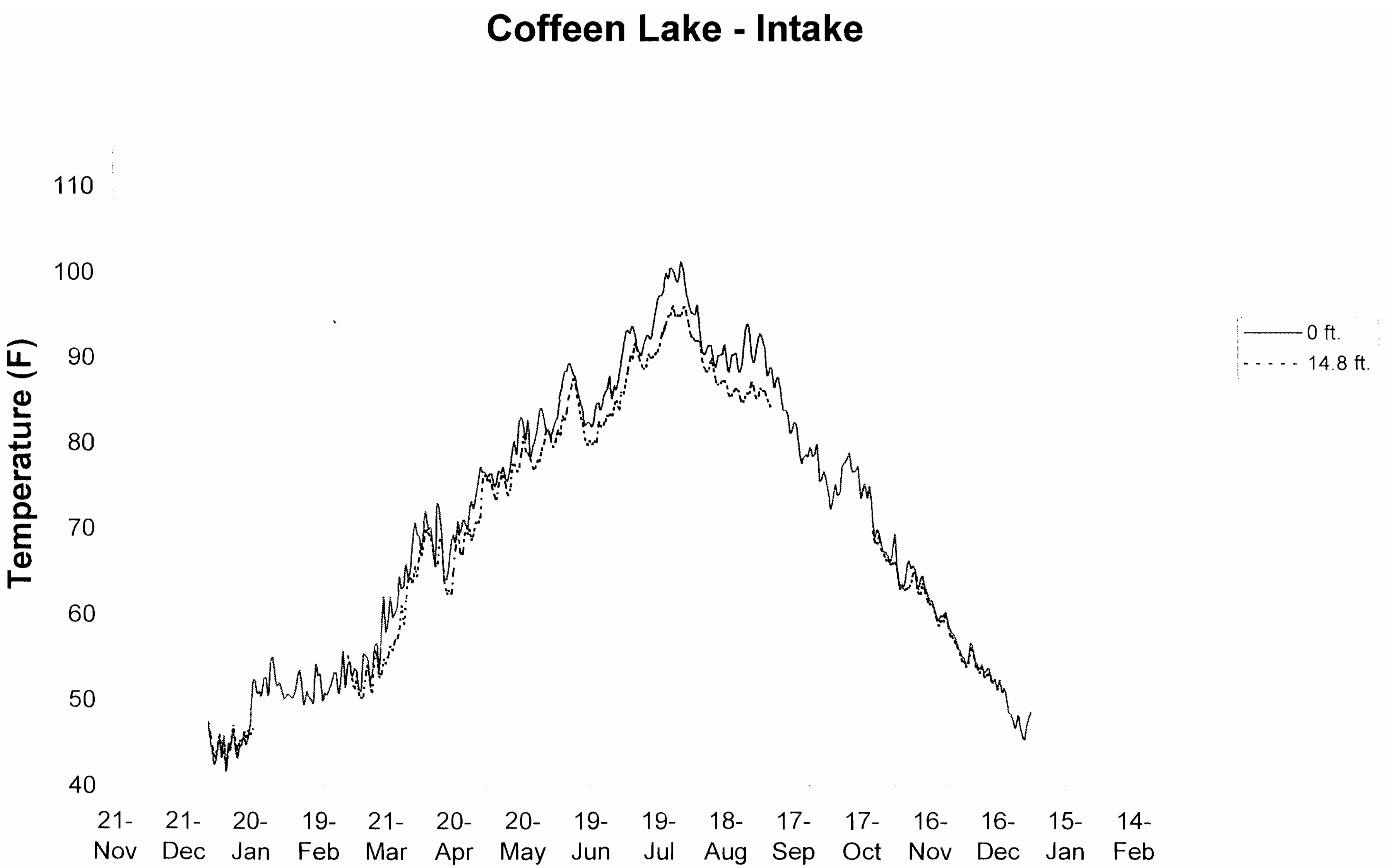


Figure E3. Mean daily temperature during 1999 at the Coffeen Lake intake. Lake bottom is approximately 42.6 feet.

Appendix F: Ash Ponds

Introduction:

The ash ponds of Newton Lake are not in direct contact with the lake, but are connected via a system of drainage pipes. Because of the drop associated with the drainage pipes, fish movement from the lake into the ash ponds is not possible. The potential of the ash ponds to serve as fish nursery ponds provided the impetus to determine fish species currently present in the ash ponds. Additionally, ash ponds were sounded and mapped to identify bottom contour.

Methods:

Two ash ponds of the Newton power plant were surveyed: one 200 hundred acre reservoir and one 3 acre reservoir. A three-phase, AC, boat mounted electrofishing unit was use for sampling on both ponds. Electrofishing was conducted to observe species diversity and to acquire a vague view of abundance. The entire perimeter of each pond was surveyed. Total effort included 80 minutes of electrofishing on the larger pond and 15 minutes on the smaller pond. One person dipped fish while the other maneuvered the boat. Fish were identified to species and counted.

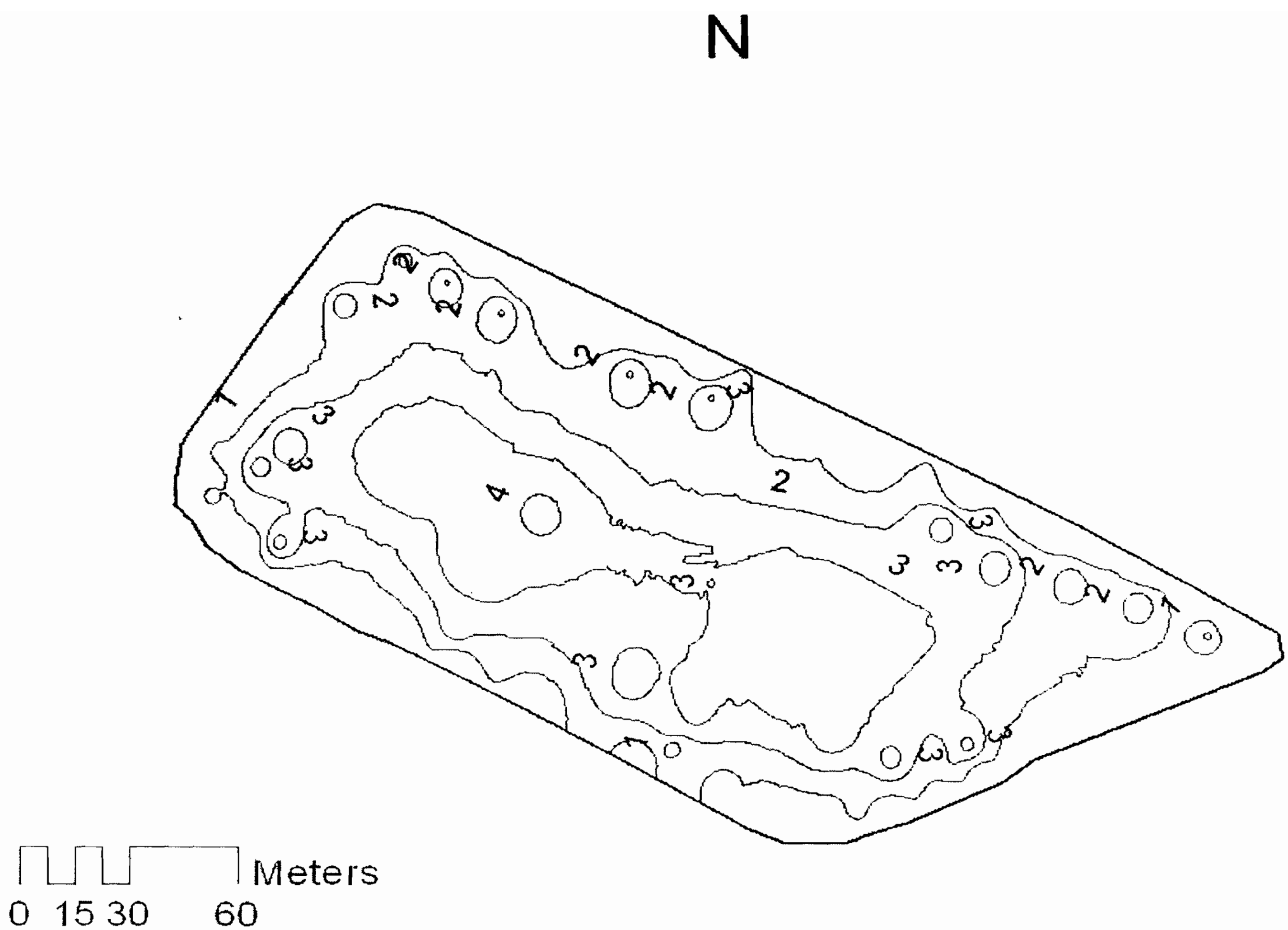
Depth profiles were taken by boat at transects that covered each pond using a Garmin 168S. Data was analyzed and mapped using ArcView 9.0.

Results:

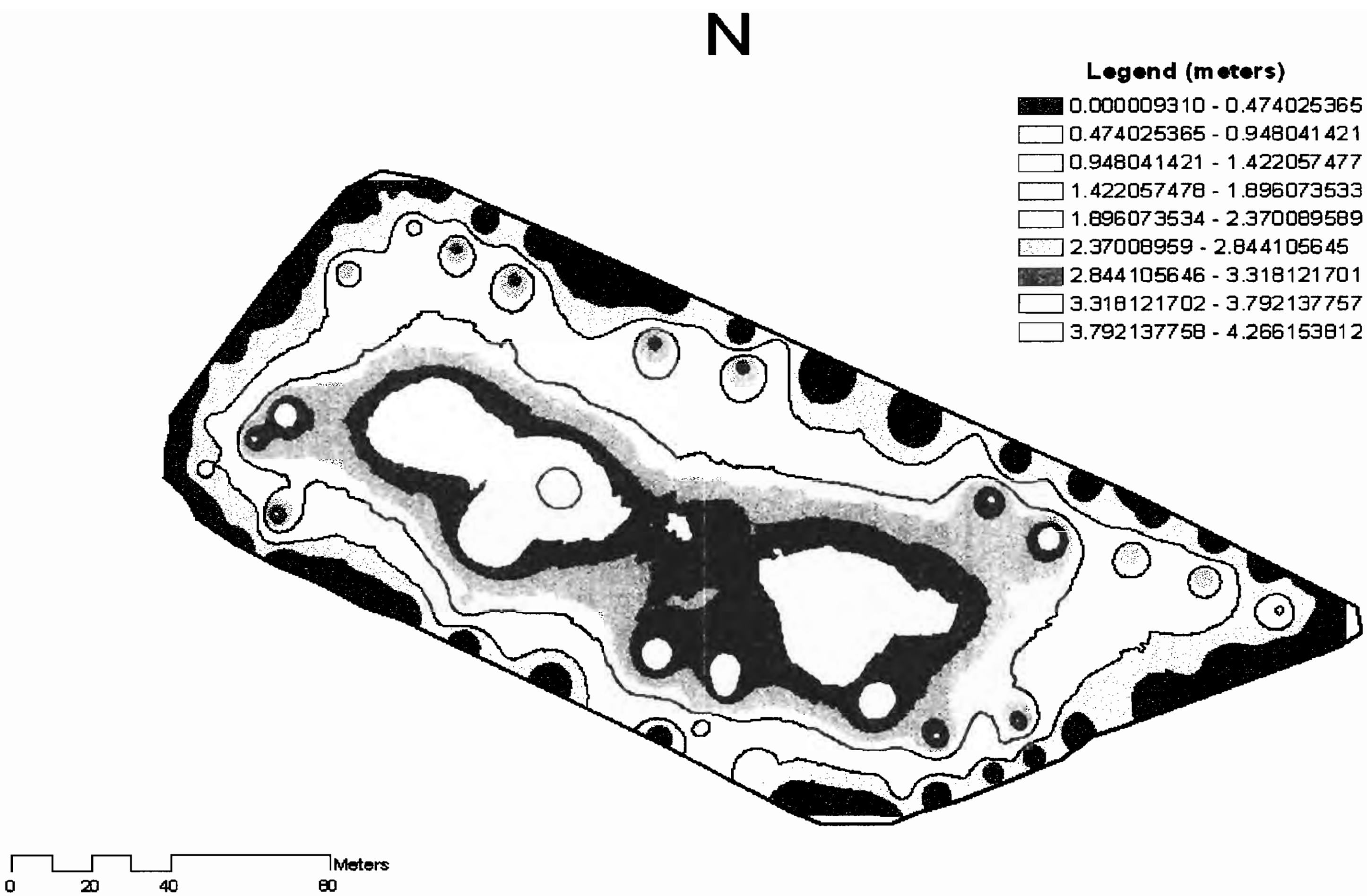
Common carp (*Cyprinus carpio*), orange-spotted sunfish (*Lepomis humilis*), golden shiners (*Notemigonus* crysoleucas), and an unidentified shiner (*Notropis sp.*) were also present in both ponds. All common carp collected were removed from the system. Many of the carp in these systems contained exaggerated scale sizes (which have been described in the literature) which, in this case, are likely due to inbreeding that caused recessive genes to be express the uncommon phenotype. These carp are commonly referred to as mirror carp. All of the carp total lengths ranged from 410mm – 480mm.

Table F1. Species diversity and Total catch by species in ash ponds.

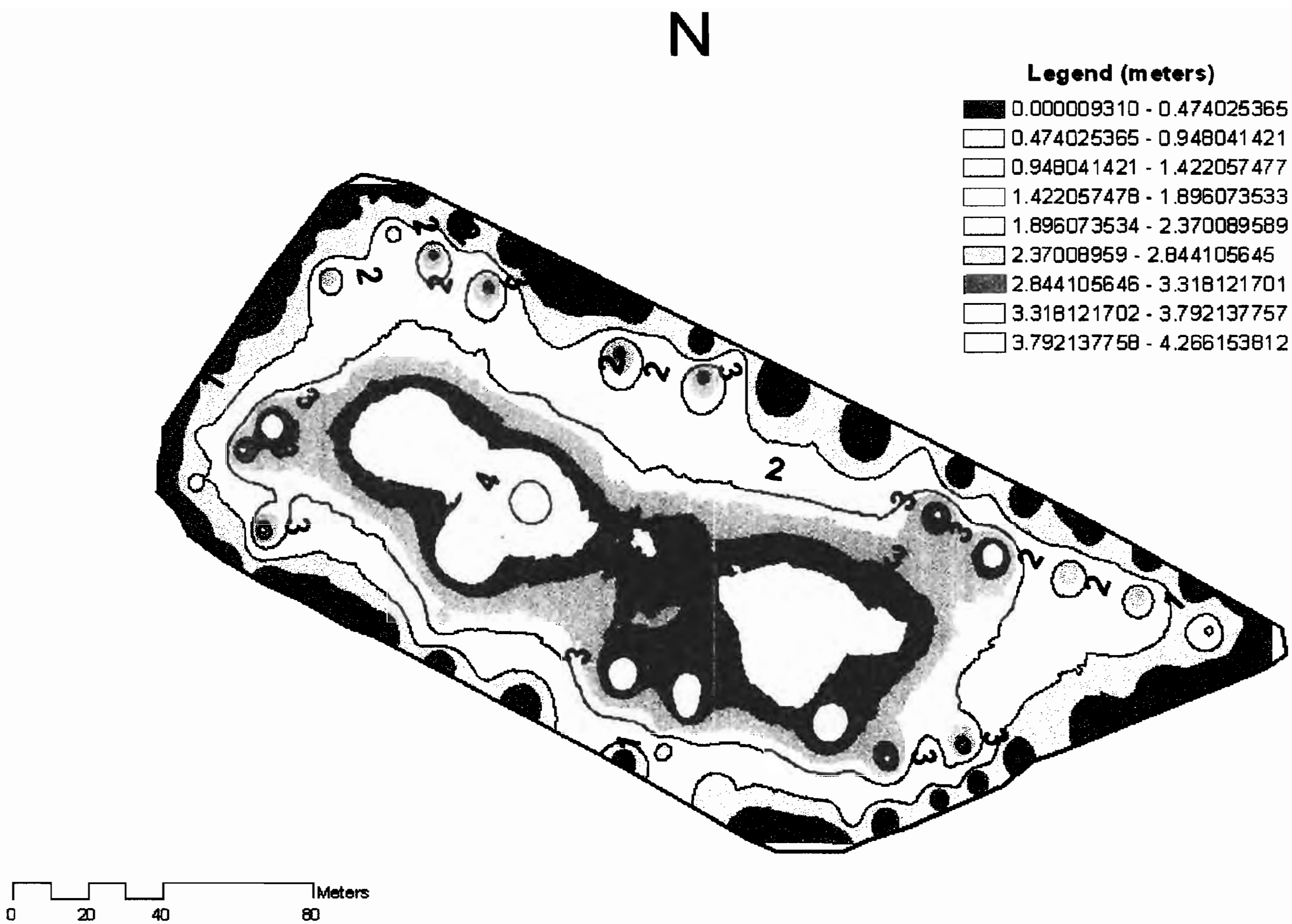
Lake	Species	N
200 acre	Orange Spotted Sunfish	86
	Golden Shiner	24
	Shiner	25
	Common Carp	21
3 acre	Orange Spotted Sunfish	>25
	Golden Shiner	<25
	Shiner	<25
	Common carp	9



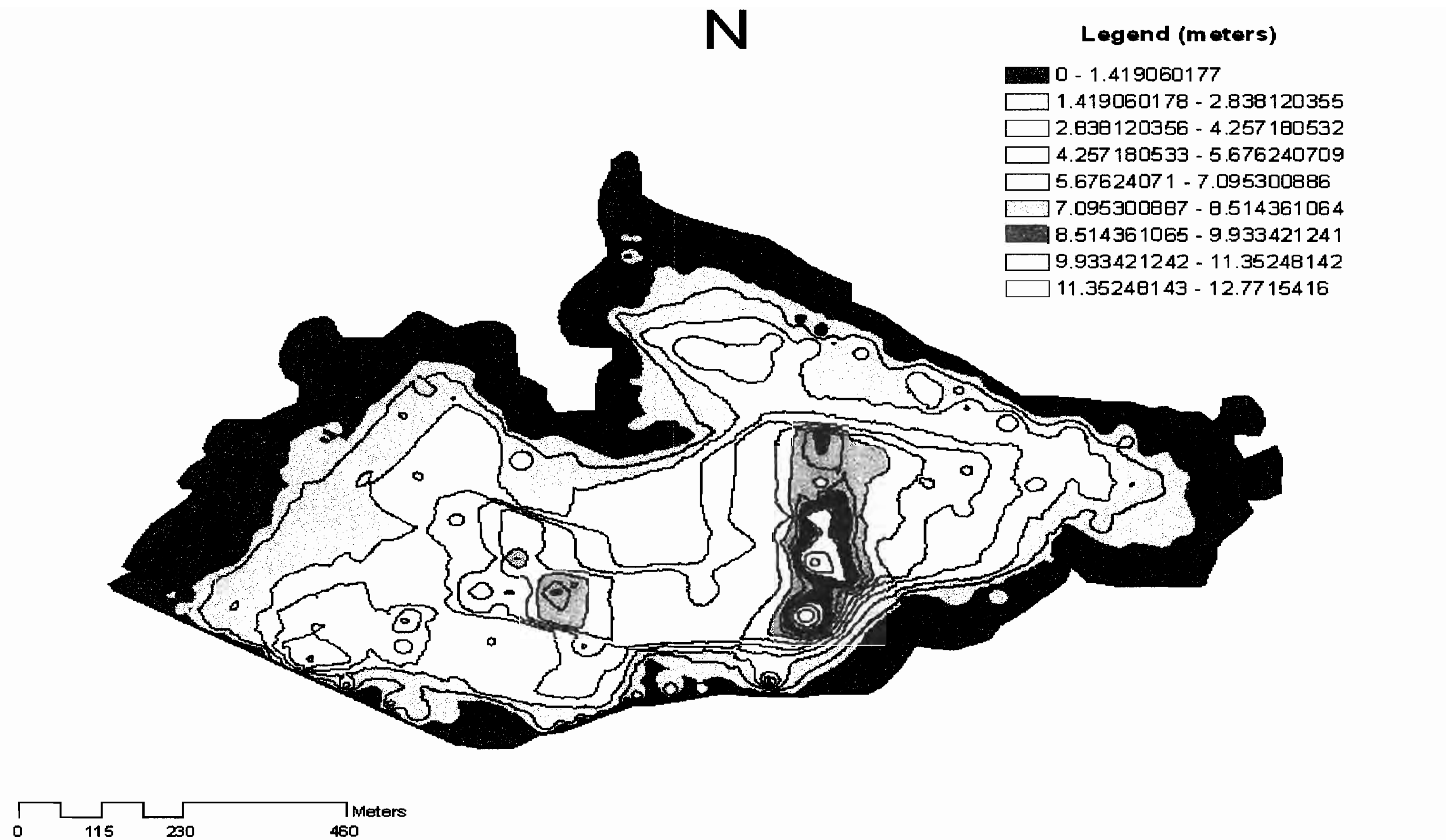
Map F3. Depth Contour of 3 acre pond with labeled contours.



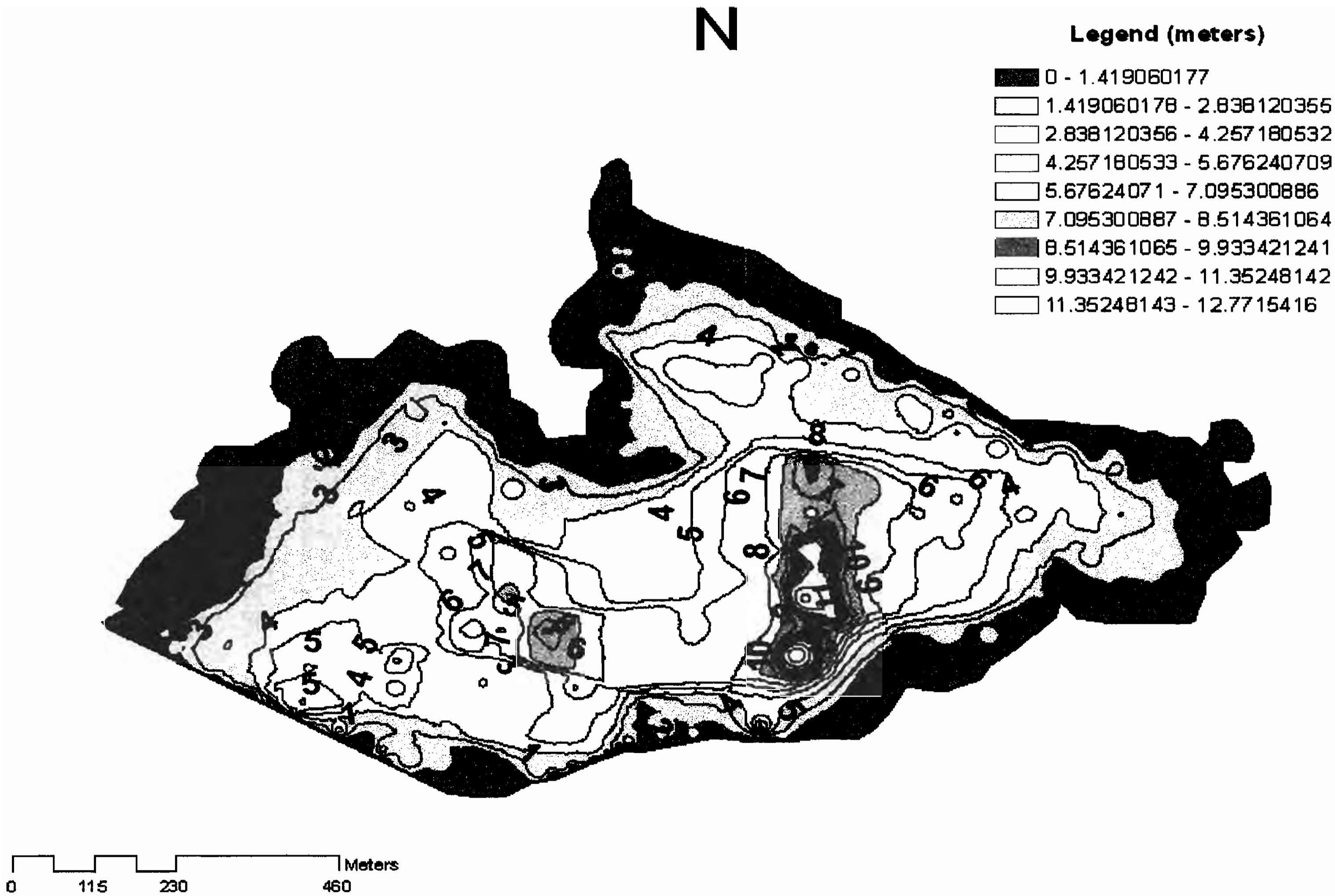
Map F1. Depth Contour of 3-acre ash pond with filled contours.



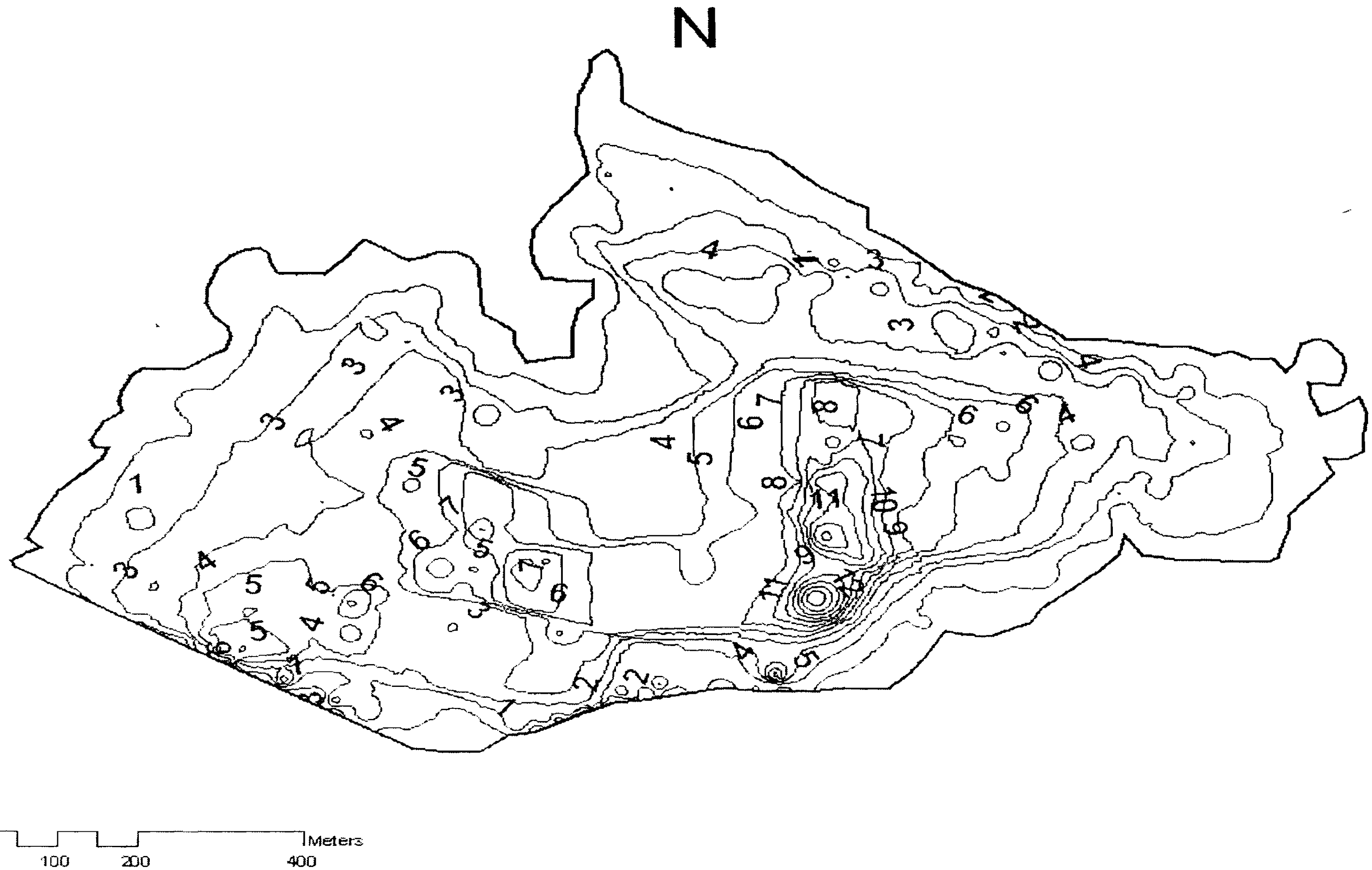
Map F2. Depth Contour of 3 acre pond with filled contours and labels.



Map F4. Depth Contour map of 200 acre pond with filled contours.



Map F5. Depth contour of 200 acre pond with filled contours and labels



Map F6. Depth contour of 200 acre pond with labeled contours.